PPS 4th Grade Physical Science:

Energy

Contents

Find online units and revisions at the PPS Science website. (http://tinyurl.com/PPSscienceK12)
The kit for this unit will be still be labeled Circuits and Pathways until fall of 2019. Use the drop down menus to navigate to your grade level and unit.

NOTE! If you do not have a box fan for Lesson 7: Windmills and Turbines, please order one from Science Kits at this address. Scroll down to Kit Information, select Grade 4, then select Circuits and Pathways. A form for the ordering a fan should appear.

1. Unit Overview					
Essential question: *How do we know when energy transfer occurs?*					
Lesson link	**Slideshow link**	**Days**	**Time (min)**	**Topic**	**Principal Guiding Question**
1: Phenomenon Day!	Lesson 1 slideshow	1	45	Introduces students to the unit phenomenon of a branch resting on two power lines and catching fire.	Can you explain what is happening with energy in the phenomenon?
2: Circuits are Pathways	Lesson 2 slideshow	1	45	Students create a series circuit.	How can you get a light bulb to light up using a battery and wires?
3: Circuits Continued	Lesson 3 slideshow	1	45	Students use ideas about circuits to build a parallel circuit.	How can you get a motor to run using a battery and wires?
4. Conductors and Insulators	Lesson 4 slideshow	1	45	Students create an open circuit in order to test the conductivity of various classroom objects.	How can we know if something conducts electricity?
5: Engineer a Switch	Lesson 5 slideshow	2	50 30	**Day 1:** Students use their knowledge of circuits, conductors, and insulators to engineer a switch. **Day 2:** Engineering Assessment	How does a light switch work? How can we use materials around us to create a switch?
6: Marbles Colliding	Lesson 6 slideshow	3	 40 40 45	Students design an investigation to examine the relationship between speed and energy. **Day 1**: Lesson phenomenon, teacher set-up and demonstration, student explore time **Day 2**: Student investigations, collect data **Day 3**: Graphing and analyzing data	What happens with energy as marbles collide and in what ways can we measure this?
Assessment-Model of Burning Branch		1	25	Have students fill out Before-During-After chart again for this burning branch phenomenon. How does it compare to their initial model?	

7: **Windmills and Turbines**	Lesson 7 slideshow	2	 30 30	Students construct a pinwheel, watch a video about wind turbines and discuss how each are similar. **Day 1:** Make pinwheel **Day 2**: Read and evaluate	How can we use the wind to do work? How can the wind help us make electric power?
8: **Portland's Energy Resources**	Lesson 8 slideshow	2	 45 30	Students look and communicate information about different energy resources. **Day 1**: Read and complete Frayer organizer **Day 2**: Gallery walk, complete retrieval chart	Where does Portland get its energy? What are the benefits and drawbacks of different energy sources?
9: **Energy Action Plan**	Lesson 9 slideshow	3	 40 40 30-40	Students analyze the benefits and tradeoffs of various sources of energy as part of a plan for Portland to lessen its dependence on hydropower, coal, and natural gas for energy. **Day 1**: Create an energy plan **Day 2**: Create collaborative poster or other presentation **Day 3**: Present plans	What is the impact of different energy sources on climate change? What should be Portland's Energy Action Plan to support energy demands in the next 10 years?
10: **Action on Climate Change**	Lesson 10 slideshow	2	 45 45	Students participate in a role-play about a scenario in which coal is found below the school. **Day 1**: Brief climate change intro, introduce scenario, assign roles, explore perspective **Day 2**: Present arguments	Who decides what happens about climate change?
TOTAL		**19 days**			

Summary Chart for Unit

Lesson	What did we do?	What did we learn?	How does this help us understand the burning branch?
1	We watched the video clip of a branch on two power lines. We observed the branch catch fire, make screeching sounds, smoke and make a kind of explosion. We then created a model of what happened and asked more questions.	(*N/A for the phenomenon debut.*)	(*N/A for the phenomenon debut*.)
2	We created a simple circuit with one light, then more.	Open circuits do not allow energy to transfer from the battery to the light bulb. Closed circuits allow the energy to transfer through electric current. When you add more lights to the circuit, the lights do not shine as brightly.	The branch is interrupting the normal flow of electricity in the phenomenon. The branch doesn't look like it is opening the circuit, but it is doing something to disrupt the normal flow of electric current. In the circuit, the flow of stored energy from the battery is interrupted when the circuit is open.
3	We created circuits that continued to function even if one light bulb was removed. We used solar panels as well.	The circuits we made before did not work once a light bulb was removed. Today, we made parallel circuits, so when a light bulb was removed there was a path for the electricity to power the remaining light bulb.	In the circuits, the electric current was changing into light and heat as the current passed through the bulbs. In the phenomenon, the current changed into light, heat and sound as it tried to pass through the branch.
4	We designed a conductivity tester and tested materials for conductivity.	Many of the materials that conduct electricity are metallic. An open circuit tester works well to determine if things conduct electricity.	The wires in the phenomenon were conductors and the branch was an insulator. Insulators can transform the electricity into things like sound and heat, but our low power circuits only do that when they light bulbs and turn motors.
5	Engineered a switch to turn on and	A switch uses insulating materials and	Flow of electricity can be interrupted by

	off a light bulb (motor).	conductors to close and open the circuit so that the light (motor) turns on and off.	insulators. The switch uses insulators, the branch was made of insulator material as well.
6	We carried out an investigation with colliding marbles and looked for patterns in the data. Graphing the data allowed us to more clearly see and share these patterns.	We learned that the faster an object (the marble) is traveling, the more energy it has. If it is released from a higher point, gravity will help it have more stored (potential) energy, which transforms into motion (kinetic) energy when dropped. Our evidence is in the data; the higher the marble dropped, the more energy was transferred to the resting marble and made it go farther. Other energy was transformed to heat (through friction) or sound (when marbles clicked).	The amount of energy in the marble mattered when it collided with another marble. The more energy the moving marble had, the farther the second marble was pushed. In the phenomenon, the greater the amount of electricity in the wire, the greater the reaction when the branch lands on it. There must be a lot of energy in that electric current to make that explosion. Because energy is conserved, the energy in the marble and the wire is transformed into many energy forms.
	What did we do?	What did we learn?	How does this help us know when energy transfer occurs?
7	We made models of windmills using paper and wood skewers. We also watched a video about wind turbines.	Wind can turn pinwheel (or windmill or wind turbine) blades, which makes other parts of the pinwheel turn and can be used to do work. Wind turbines work in a similar way. Instead of lifting a load, they transform energy from the wind to electricity.	We know that energy transfers from the wind to the pinwheel, because we can see the pinwheel spin. The motion energy of the pinwheel is transferred to motion energy that pulls up the paper clips. The motions of the pinwheel and wind turbines also create sound (which carries energy through the air).
8	We looked at and read about different sources of energy that may be used to generate Portland's energy.	We learned that there are renewable energy sources that will not run out, and nonrenewable energy sources that are limited. We also learned that every source has positive and negative impacts on the world.	Electrical energy can be generated by transferring energy from multiple resources. When something is moving (wind, water) or is burned (coal, biofuel), it has energy. When the movement or heat is used to produce electricity, we know that energy transfer has occurred.

2. NGSS Alignment
Performance Expectations (PE)
4-PS3-1 **Use evidence to construct an explanation relating the speed of an object to the energy of that object.** [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]
4-PS3-2 **Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.** [Assessment Boundary: Assessment does not include quantitative measurements of energy.]
4-PS3-3 **Ask questions and predict outcomes about the changes in energy that occur when objects collide.** [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.][Assessment Boundary: Assessment does not include quantitative measurements of energy.]
4-PS3-4 **Apply scientific ideas to design,test, and refine a device that converts energy from one form to another.*** [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy in to motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.][Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]
4-ESS3-1 **Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment.** [Clarification Statement: Examples of non-renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning fossil fuels.]
Science and Engineering Practice (SEP) Focus
Asking questions (science) and defining problems (engineering).
Constructing explanations (science) and designing solutions (engineering).
Engaging in argument from evidence.
Obtaining, evaluating, and communicating information.
Crosscutting Concept (CCC) Focus
Patterns
Cause and effect
Energy and matter

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

3. Unit Goals
Science In this unit students will explore the crosscutting concepts of energy and matter; and the interdependence of science, engineering, and technology. In the fourth grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas. Students will first learn about energy and types of energy. Then, students investigate solar and wind energy, including designing and engineering a switch and a wind turbine. After that, students learn about energy resources and their various effects upon our world. Finally, students end the unit with designing an energy plan for Portland over the next several years. **English Language Development** One of the goals of this unit is to create opportunities for ELs (English learners, also referred to as Emergent Bilinguals) to work toward English proficiency within the academic content area of science. The current English Language Proficiency Standards require that ELs receive language development opportunities that are integrated within a content area, rather than in isolation which was the common practice some years ago. In PPS, ESL and some general education teachers have received training in QTEL (Quality Teaching for English Learners) an approach which comes out of Stanford University and West Ed. This approach leans heavily on student interaction where students practice language with peers of all levels of proficiency through structured interaction activities which are included in these lessons. This unit is designed to be an English Language Development unit, addressing ELP standards along with Science standards, in contrast to Sheltered Science, in which language development is ancillary to the content learning goals. See Lesson Guide for a breakdown of ELP standards in each lesson.

Essential Questions:
The essential question is one meant to be explored and answered broadly, across the course of the unit. By revisiting throughout the essential question(s) throughout the unit, students have the opportunity to add to and extend their understanding of science and engineering practices, crosscutting concepts, and science content, leading to deep understanding of the phenomenon, and ultimately the performance expectation.

In this unit the essential question is:

- How do we know when energy transfer occurs?

While it may not be the primary focus of each lesson, this essential question appears on each lesson plan.

Guiding Questions:
Guiding questions are more content, even lesson, specific questions that are not as likely to be revisited throughout a unit of study. Guiding questions may be the same or similar from lesson to lesson, or they may be quite different. Like essential questions, guiding questions drive instruction and provide students with regular opportunities for synthesis of experiences and knowledge.

4. Tracking Progress

Summary Chart

In NGSS-based lessons, students delve deep into topics. It is advantageous to keep a class record of what goes on in the lessons. This can be handy reference for both teachers and students. This could be on butcher or chart paper, or even a shared document if that can be done in your classroom. This section on summary charts briefly describes what goes in each section. Each lesson has a sample summary chart that you may use to help guide your closing discussion at the end of each lesson. You may even notice glaring omissions from your students that could help you guide the next day's lesson.

What did we do?	What did you learn?	How does this relate to the phenomenon?
This is a list of activities that were done in class on this day. Just the facts!	*This is a list of conceptual understandings gained from this lesson. While the first column was all facts, this is where students can connect facts with inferences and learning about concepts.*	*It is important to circle back to the phenomenon whenever appropriate. The summary chart is typically done at the end of a lesson, but be on the lookout for students who make these connections early, hopefully you can enlist them to share when the lesson is debriefed at the end of class.*

Burning Questions

In lesson 1, students generate questions about the phenomenon. Refer to these questions as often as you can, especially when the answer to one can be uncovered. As time goes on, students have a real record of what they have learned and what questions are still on their mind!

Report Card Correlations and Checklists

As of November 2018, our report card does not correlate with NGSS. Here is a checklist that can simplify student evaluation.

4. General Science Background for Teachers

Disciplinary Core Ideas addressed in this unit, from the Framework for K-12 Science Education:

Everyday language surrounding energy contains many shortcuts that lead to misunderstandings. For this reason, the concept is not developed at all in K-2 and only very generally in grades 3-5. Instead, the elementary grades focus on recognition of conservation of matter and of the flow of matter into, out of, and within systems under study.
Forms of energy, such as thermal energy, mechanical energy, and chemical energy are all, at the atomic scale, some mixture of kinetic energy, stored energy, and radiation. Sound and light are phenomena that transfer energy from place to place and between objects.

PS3A: Definitions of Energy
(While energy is defined as the ability to do work, in K-5 NGSS there no attempt is made to give a precise or complete definition of energy.)

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

PS3.B: Conservation of Energy and Energy Transfer

(The grades 3-5 band of NGSS lead up to understanding in high school that the total change of energy in any system is always equal to the total energy transferred into or out of the system. This is called conservation of energy. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.)

- Energy is present whenever there are moving objects, sound, light, or heat.
- When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
- Light also transfers energy from place to place. For example, energy radiated from the sun is transferred to Earth by light. When this light is absorbed, it warms Earth's land, air, and water and facilitates plant growth.
- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy (e.g., moving water driving a spinning turbine which generates electric currents).

PS3.D Energy in Chemical Processes in Everyday Life

- The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use—for example, the stored energy of water behind a dam is released so that it flows downhill and drives a turbine generator to produce electricity.

- It is important to be able to concentrate energy so that it is available for use where and when it is needed. For example, batteries are physically transportable energy storage devices, whereas electricity generated by power plants is transferred from place to place through distribution systems.

(*More background*: In ordinary language, people speak of “producing” or “using” energy. This refers to the fact that energy in concentrated form is useful for generating electricity, moving or heating objects, and producing light, whereas diffuse energy in the environment is not readily captured for practical use. Therefore, to produce energy typically means to convert some stored energy into a desired form—for example, the stored energy of water behind a dam is released as the water flows downhill and drives a turbine generator to produce electricity, which is then delivered to users through distribution systems. Food, fuel, and batteries are especially convenient energy resources because they can be moved from place to place to provide processes that release energy where needed. A system does not destroy energy when carrying out any process. However, the process cannot occur without energy being available. The energy is also not destroyed by the end of the process. Most often some or all of it has been transferred to heat the surrounding environment; in the same sense that paper is not destroyed when it is written on, it still exists but is not readily available for further use.)

Electric power generation is based on fossil fuels (i.e., coal, oil, and natural gas), nuclear fission, or renewable resources (e.g., solar, wind, tidal, geothermal, and hydro power). Transportation today chiefly depends on fossil fuels, but the use of electric and alternative fuel (e.g., hydrogen, biofuel) vehicles is increasing. All forms of electricity generation and transportation fuels have associated economic, social, and environmental costs and benefits, both short and long term. Technological advances and regulatory decisions can change the balance of those costs and benefits.

ESS3.A: Natural Resources

- All materials, energy, and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

For more reading, see the Framework for K-12 Science Education.

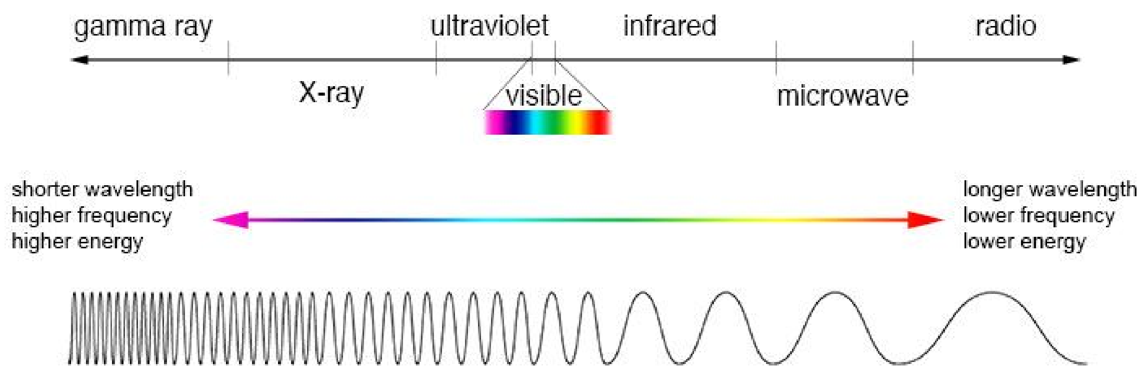
Read This First!: Why are we talking about energy in this way?

Scientists have significant gaps in their knowledge of energy, but it is known that energy must be transferred along waves or through matter. So, when we talk about sound energy, we really mean to talk about energy transferred along sound waves. For the most part, we will be referring to heat, light, sound and electric current without the tag of “energy” throughout this unit. As a teacher talking to students, it may be very hard to change this way of talking. You do not need to fully embrace this! Many resources and texts refer to heat energy, mechanical energy, chemical energy and so on.

Adapted from: "5 Dimension 3: Disciplinary Core Ideas - Physical Sciences." National Research Council. 2012. *A Framework for K-12 Science*

Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press. doi: 10.17226/13165.× p. 124

Energy is an abstract concept and can only be observed during energy transfer or transformation. The term *energy transfer* refers to the transfer of energy between objects or matter, such as the motion (kinetic) energy of a rolling marble transferring to a stationary marble. The term *energy transformation* refers to the change of energy from one form, such as motion (kinetic) energy of a marble, to another form of energy, such as sound when the marble strikes a stationary marble and makes a click.



What is electricity?

Electricity is the collection or flow of electrical charges from one material to another.

What is happening in the phenomenon?

(This is for teacher understanding and explaining with students later in the unit, not during Lesson 1.)
In the video, you see a branch laying across two power lines. At the beginning of the video, it is apparent that the branch is very hot, as portions of it are sparking and beginning to catch fire. The branch appears to get hotter and hotter throughout the clip, becoming more fiery and emitting steam and high pitched noises. Students may compare them to the air being let out of a balloon. At the end of the video, a large arc of fire or plasma seems to be released from the branch, connecting the two power lines. When it dissipates, the interaction between the branch and wires seems to have ended. Most likely a high impedance fault (HIF) has occurred.

What is a High Impedance Fault?

A high impedance ground fault results when a primary conductor makes unwanted electrical contact with a road surface, sidewalk, sod, tree limb, or with some other surface, or object which restricts the flow of fault current to a level below that reliably detectable by conventional overcurrent devices.
Source: grouper.ieee.org

In layman's terms, these faults occur in the form of downed power lines or power lines that have had the flow of electricity disrupted by a fallen branch or other high resistance fallen object. These are those typical ways in which power lines can fail and cause minor outages during storms or other events. These are very common and a lot of work has gone into developing technology that helps power companies find these disruptions quickly.

Why does the branch cause this to happen?

When you think about electricity, you have to think about whether substances conduct electricity or not. Conductors, like what our power lines are made out of, let electricity flow more freely. Insulators, like the branch, provide a lot of resistance to electricity and transform some of the energy in the electric current into heat. Electricity flows through insulators, but very poorly. Here are a list of common conductors and insulators:

Conductors	Semiconductors	Insulators
Copper, Mercury,Silver, Aluminium and all other metals, Water, Acids, Human body, Metallic salts,Charcoal	Germanium, Silicon, Cotton, Wool, Marble, Sand, Paper, Ivory, Moist air	Wood, Rubber, Glass,Ebonite, Mica, Sulphur, Dry air

Semiconductors have conductivity between that of a conductor or insulator. Some, like silicon are put to great use in electronics applications. These will not come into play in this unit.

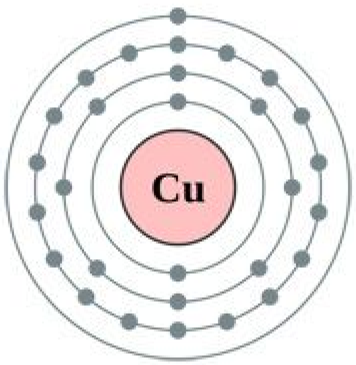
Since the wood of the branch is an insulator, the considerable voltage (somewhere around 11,000 volts) is trying to interact with the wood as if it were a conductor, but the properties of wood make it an insulator. In this instance, when electricity flows into the wood, the energy in the electric current is being transformed into heat (evidenced by the fire) and sound (evidenced by the screeching and popping sounds).

Since copper is a widely used conductor, many of the examples below will deal with copper wire.

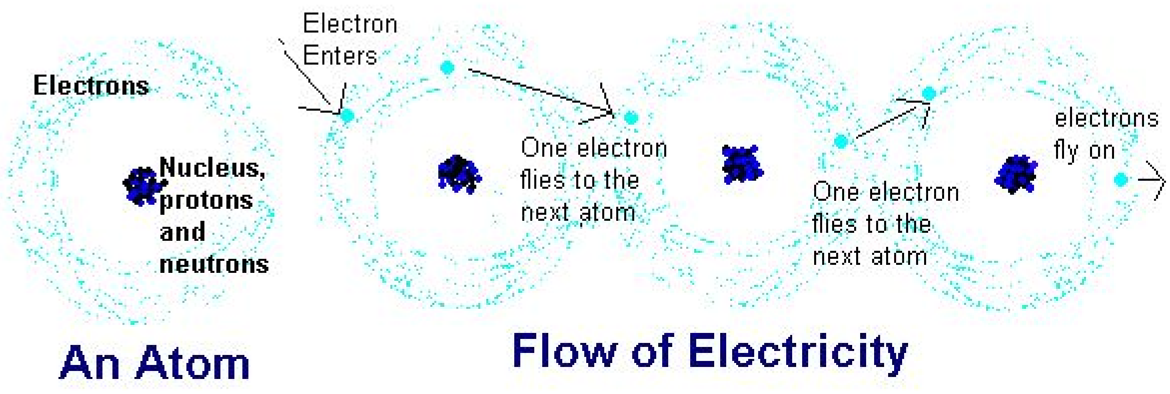
How do electrons flow through conductors and insulators?

In metals such as copper, silver and aluminum the electrons are not tightly bound to the atoms. They are called "free electrons". This makes them good conductors. As stated before, conductors are materials that allow electricity to flow easily. When a negative charge is brought near one end of a conductor electrons are repelled. When a positively charged object is placed near a conductor electrons are attracted the the object.

--Source: Adapted from Edinformatics http://www.edinformatics.com/math_science/why-do-electrons-flow.html



In the copper atom above, you can see the electron that is occupying it’s own ring, or valence. This electron is a “free electron” and has a looser bond with the atom than the rest. When electricity flows through a copper wire, the free electron is bumped from one atom to the next, and the atom from that neighboring atom is bumped to another. It is a chain reaction not unlike something one would witness in a multiple rear-end collision or at bumper cars! It is important to know that a single electron does not and cannot flow through all the atoms in the wire, it is a succession of electrons bumping each other into neighboring atoms. See the illustration below:



In an insulator, the atoms have few or no free electrons. The best example of an insulator is air. Electricity has a great deal of trouble traveling through air. This is evident if one were to cut a wire on a simple circuit leaving a gap between the two wires. Since air is an insulator, the electrons will not move across the gap.

The wooden branch from the phenomenon works in the same way. Most of the atoms in the wood have few or no free electrons, impeding the flow of the electricity into the material. This energy is transformed into sound and heat instead of continuing on as the energy in electric current.

How does this connect to our phenomenon?
The kids do not really need to get this deep into concepts of electron movement. In lesson 2, there is a slight connection between energy being transferred between marbles and the free electrons in atoms being bumped from one to the next. Also, the electric current is trying to make its way through the branch. As there are fewer free electrons in wood, the energy in the electric is being transferred, hence the squealing and popping sounds (sound) and the glowing embers (heat and light).

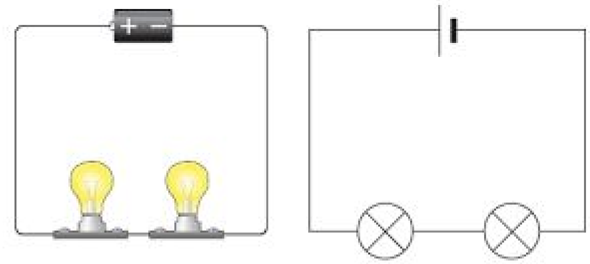
What are series and parallel circuits?

An electric circuit is a complete path through which electric current can pass.

This video from Bozeman science gives a lot of information about how these circuits work:

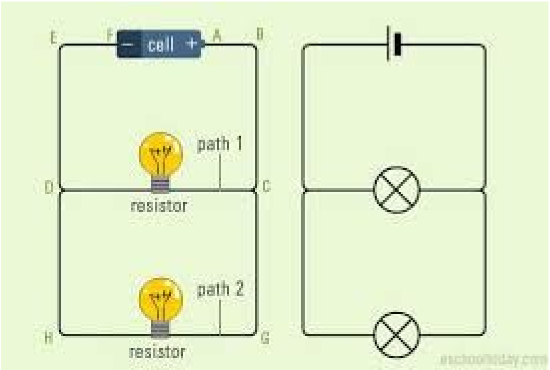
If you would like to access a circuit simulation like the one in the video, here is one courtesy of Phet: Simple Circuits.

Series Circuits



In a series arrangement of holiday lights, the bulbs are connected together in a daisy-chain, one after the other. Current flows through each bulb because it has no other paths to follow. Each bulb reduces the total current from the power source; so the more bulbs you have in a series circuit, the less current flows through the circuit.

Parallel Circuits



Light bulbs connected in a parallel circuit resemble the rungs of a ladder, in which each rung is connected to the ladder legs, and all rungs are parallel to one another. In this arrangement, current flowing through one bulb has no effect on the current in the others. Each additional bulb increases the total current, so a string with 20 bulbs uses 20 times the current of a single bulb.

--Source: Sciencing.com https://sciencing.com/parallel-circuit-different-series-circuit-8251047.html

How does this connect to our phenomenon?
The energy present in the electric current moves along the path of the wires. Once it hits some resistance (the light bulb), that energy is transferred onto light waves (producing light) and infrared waves (producing heat).

Final Note: Two Wires and a Branch Phenomenon and this Unit

In many phenomena-based units, students are tasked with unpacking the phenomena and discovering why it is occuring. During the first half of this unit, students will be focusing on the phenomena and why is is happening. However, after lesson 5, the students will have discovered as much as developmentally appropriate, according to the grade level standards.

From lesson 6 and on, students will be focusing on the transfer of energy. In the phenomenon, the transfer of energy is evident due to the presence of embers on the branch (light and heat) and screeches and squeals (sound). In lesson 6 and beyond, students will be focusing on how they can witness the transfer of energy in subsequent activities.

So, in short, the discussion that closes each lesson should be as follows:

- Lessons 2-5: How does this activity help us explain the phenomenon?
- Lessons 6-10: How do we know when energy transfer occurs?

Overview of English Language Proficiency Standards in This Unit

There are 10 ELP standards that are consistent K-12. The lessons in this unit address the following.

		lesson									
		1	2	3	4	5	6	7	8	9	10
ELP Standards	1 – construct meaning	X				X		X	X	X	X
	2 – participate	X	X	X	X	X	X	X	X	X	X
	3 – speak and write		X	X	X	X	X	X	X	X	X
	4 – construct claims	X	X			X	X			X	X
	5 – conduct research		X	X	X	X	X	X	X	X	X
	6 – analyze claims						X			X	X
	7 – adapt language										X
	8 – determine meaning										
	9* – create clear speech and text										
	10* – standard English										

* ELP standards 8, 9, and 10 ongoing in every lesson

ELP Standards

1- Construct meaning from oral presentations and literary and informational text through grade-appropriate listening, reading, and viewing

2 - Participate in grade-appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions

3 - Speak and write about grade-appropriate complex literary and informational texts and topics

4 - Construct grade-appropriate oral and written claims and support them with reasoning and evidence

5 - Conduct research and evaluate and communicate findings to answer questions or solve problems

6 - Analyze and critique the arguments of others orally and in writing

7 - Adapt language choices to purpose, task, and audience when speaking and writing

8 - Determine the meaning of words and phrases in oral presentations and literary and informational text

9 - Create clear and coherent grade-appropriate speech and text

10 - Make accurate use of standard English to communicate in grade- appropriate speech and writing

ELP standards and descriptors of proficiency levels available here.

	Lesson									
Language Development and Interaction Strategies	1	2	3	4	5	6	7	8	9	10
Accountable Talk Bookmark										X
Coding the Text										
Collaborative Writing Dialogue										
Collaborative Paragraph Writing		X								
Collaborative Poster										X
Discussion Diamond					X					

Gallery Walk								X		
Novel Ideas Only			X							X
Partner Speaking and Listening Strategies		X	X		X			X		
Quiz, Quiz, Trade							X			
Role Play								X		
Sentence Frame/Starters	X	X			X		X			X
Think, Pair, Share/ Think, Write, Pair, Share	X	X	X				X		X	

Common Language and Development Strategies document

6. Vocabulary Lists

Unit Vocabulary List		
Cross-disciplinary and Multiple Meaning Words	Academic (non-subject specific) Vocabulary	General Vocabulary that ELLs May Have Trouble With
• energy • transfer/transform • model • conduct/conductivity • insulate/insulator • engineer • resource • consequences • extract/extraction • resource, source • install cost • maintenance cost	• predict/prediction • increase • result • similar to • alike • conduct/conductivity • insulate/insulator • design • generate • harness • generate/generation • criteria • constraint	• heat • sound • power line • wires • distance • height • motion • release • ramp • speed • flow • fuse • switch • reverse • device • grain • wheat • barley • pump • grind • source • blade (as in fan blade) • mill • benefit • drawback • advantage • disadvantage • drought

		- climate - combat (as in we need to combat climate change) - atmosphere - mine (as in coal mine) - benefit - drawback - trade-off - firm (as in engineering firm)

State Vocabulary List (for 5th grade test)				
This list of words come from the 5th Grade OSAS Item Specifications document. These words ***may*** be assessed at the 5th grade level as part of the state science assessment. Below is a list by Performance Expectation. Some of these words are not addressed by this unit as of this revision. This list is not a list of have-to words, it is simply a resource.				
4-PS3-1	4-PS3-2	4-PS3-3	4-PS3-4	4-ESS3-1
- volume - collision - heat transfer - spring (coil) - forms of energy - sound - heat - light - motion - conservation of energy - stored energy - energy transfer - gravity - speeds up - slows down	- energy transfer - current - heat transfer - collision - speed - flow - electrical - heat conduction - conversion	- sound - light - heat - electrical currents - motion - magnets - magnetic	- electric current - electrical energy - magnetic - motion - speed - conservation - measurement of motion - gravitational - battery - conversion - properties - chemical	- environment - nature - recycle - reuse - coal - habitat - pollution - dam - population - atmosphere - oil - resource - fossil fuel - renewable - nonrenewable - conservation

<table>
<tr><th colspan="5">Students are NOT expected to know the following for the purposes of OSAS:</th></tr>
<tr>
<td>potential energy
kinetic energy
thermal energy
acceleration
velocity</td>
<td>potential energy
kinetic energy
radiation
convection
transmission
reflection
decibels
resonance
friction
hertz
electromagnetic radiation
magnitude
motion energy
electric circuit
thermal
conservation of energy</td>
<td>potential energy
kinetic energy
friction
force fields
vector
magnitude
elastic
inelastic</td>
<td>mass
net force
velocity
relative position
constant speed
direction of motion
direction of force
deceleration
independent
economic
control
impact
inertia
Newton’s laws
stationary
frame of reference
potential energy
kinetic energy
mechanical energy
conserve
motion energy
relative
chemical energy</td>
<td>agricultural
biosphere
mineral
geological
hydrothermal
metal ore
organic
deposition
petroleum
derive
extract
natural gas
oil shale
sustainability
tar sand</td>
</tr>
</table>

7. Extending Student Learning	
Location or Lesson Pairing	**Explanation**
Lessons 02 and 03: Circuits and Pathways	Extend learning and understanding by using the Phet: Simple Circuits simulation. Students can model the work they did in class and see how the flow of electricity works.
Lesson 05: Engineer a Switch	Extend the engineering lesson for an extra day, allowing students to refine their designs based on the analysis of their first switch.
Lesson 06: Marbles Colliding	Split the investigation into 2 sessions. Day 1 can include setting up the investigation and Day 2 can be running the investigation and analyzing data.
Lesson 07: Windmills and Turbines, Explore section, Teacher Note	Engineering opportunity for students to design their own pinwheels
Lesson 07: Windmills and Turbines	MacGuyver Windmill Activity. This could be an extension for a class, or individual, with a great interest in wind power. As a plus, all the necessary materials are in the kit!
Lesson 08: Portland's Energy Resources, Assess heading	Use the optional formative assessment to give the students an option to carefully weigh resource choices.
Lessons 8-10	Jason Energy City is an online game that simulates the energy choices the leaders of a city might make. There are different difficulties for each city. A teacher could simply assign a city as a task or ask kids to "stress test" the simulation: ● What happens if you only use fossil fuels? What is your evidence? ● What happens if you only use renewables? What is your evidence? ● Is there a "winning combination" of energy resources that works in most scenarios? What is your evidence? ● What happens if you only approve of one group's requests? What is your evidence? ● Is there are group whose requests end up benefiting everyone? What is your evidence? ● Is there a group whose requests do not usually benefit the community? What is your evidence? ● What is the most powerful resource? What is your evidence? ● What is the least powerful resource? What is your evidence?

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Community Partners:

ce CLEAN ENERGY BRIGHT FUTURES

Emily Dinan, edinan@b-e-f.org, Program Manager, CE
Anne Le, ale@b-e-f.org, Program Manager, CE
Parker Mullins, pmullins@b-e-f.org, Senior Program Manager, CE

PPS Teachers:

Andrew Boehm
Jocelyn Gary
Martha Gross
Janelle Hutchinson
Rebecca Levison
Jenny Miles-Gonzales
Jen Scherzinger
Geoff Stonecipher
Jeff Sturges
Nadine Trinchero
Sue Wilcox
Kate Yocum