Big Ideas 10 and 11
Forms of Energy and Energy Transformation

Florida Next Generation Sunshine State Standards:

SC.5.P.10.1 – Investigate and describe some basic forms of energy, including light, heat, sound, electrical, chemical, and mechanical.

SC.5.P.10.2 – Investigate and explain that energy has the ability to cause motion or create change.

SC.5.P.10.4 – Investigate and explain that electrical energy can be transformed into heat, light, and sound energy, as well as the energy of motion.

Terms

<table>
<thead>
<tr>
<th>English</th>
<th>Spanish</th>
<th>Haitian Creole</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. absorption</td>
<td>absorción</td>
<td>absòpsyon</td>
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<tr>
<td>2. chemical energy</td>
<td>energía química</td>
<td>chimik, pwod chimik</td>
</tr>
<tr>
<td>3. conductor</td>
<td>conductor</td>
<td>ki kondui kouran</td>
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<tr>
<td>4. electrical energy</td>
<td>energía eléctrica</td>
<td>elektrisite</td>
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<td>5. energy</td>
<td>energía</td>
<td>enèji</td>
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<td>6. heat</td>
<td>calor</td>
<td>chalè</td>
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<tr>
<td>7. heat (thermal) energy</td>
<td>energía térmica</td>
<td>chalè (tèmik) enèji</td>
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<tr>
<td>8. heat transfer</td>
<td>transferencia de calor</td>
<td>transfè chalè</td>
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<tr>
<td>9. insulator</td>
<td>aislador/aislante</td>
<td>izolan</td>
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<tr>
<td>10. light energy</td>
<td>energía luminosa</td>
<td>limyè</td>
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<tr>
<td>11. mechanical energy</td>
<td>energía mecánica</td>
<td>mekanik</td>
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<td>12. pitch</td>
<td>ton</td>
<td>ton</td>
</tr>
<tr>
<td>13. reflection</td>
<td>reflexión</td>
<td>refleksyon</td>
</tr>
<tr>
<td>14. sound energy</td>
<td>son</td>
<td>son</td>
</tr>
<tr>
<td>15. temperature</td>
<td>temperatura</td>
<td>tanperatí</td>
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<tr>
<td>16. vibration</td>
<td>vibración</td>
<td>vibration</td>
</tr>
</tbody>
</table>
Does This Matter to Me?

Could you see when you opened your eyes this morning because there was light from the Sun or from an electric light? Did you watch TV or listen to music this morning? Did you have cold juice or milk for breakfast? Did you get to school by bus or car? Think about how getting ready to come to school today involved using energy in many ways. Let's so you will be able to use ways to save time and conserve resources for the future.

Look at the pictures above. How do these pictures relate to what you read about using energy in the paragraph above?

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Draw a picture of some examples of using energy:
Forms of Energy
(SC.5.P.10.1)

It takes energy for video games and computers to work. It takes energy for people, plants, and animals to grow. It takes energy to cook a meal. As you might realize, there is more than one form of energy. Energy can be classified into many different forms:

**Light energy** comes from any source of light, like a light bulb, a TV screen, or the Sun. Light energy helps plants make food. Light energy can be converted to electricity with solar panels.

**Electrical energy** is produced at power plants and then travels through wires to the electrical outlets in your home. Electrical energy can be produced in different ways. It can be made using chemical energy (from batteries), mechanical energy (from windmills), and nuclear energy (from power plants). Electrical energy makes lights, iPods™, and televisions work.

**Heat (thermal) energy** can boil water, make you sweaty on a hot day, or keep you warm on a cold day. It can come from a stove, the Sun, or your body.

**Sound energy** is produced when an object vibrates. Vibrations from the object travel to your ear, so that you can hear the sound. Some examples include singing, whistling, or thunder. You can even feel the vibrations in your body caused by sound energy when a car goes by playing loud music.

**Chemical energy** in gasoline makes cars and other motor vehicles go. The chemical energy in charged batteries provides energy for battery-powered toys and games. Your body also runs on the chemical energy from the food you eat.
**Mechanical energy** is the energy of moving things. One example is water going through a dam to run power plants. Other examples include a car moving, a ball falling, water falling down a waterfall, and wind blowing to turn a windmill or to make a sail boat move through the water.

**Finding Energy**

Find different forms of energy in your classroom. Record your examples in the chart. When you have finished your energy search, share your answers with the other groups in the class.

<table>
<thead>
<tr>
<th>Forms of Energy</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Light energy</td>
<td></td>
</tr>
<tr>
<td>2. Sound energy</td>
<td></td>
</tr>
<tr>
<td>3. Electrical energy</td>
<td></td>
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<tr>
<td>4. Thermal energy</td>
<td></td>
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<tr>
<td>5. Chemical energy</td>
<td></td>
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<tr>
<td>6. Mechanical energy</td>
<td></td>
</tr>
</tbody>
</table>

As you see, there are many different forms of energy in your classroom. Think about different forms of energy outside of your classroom. For example, a moving car has energy, the stove in your kitchen uses energy to cook food, and a basketball player running down the court is using energy.

Let's take a closer look at some forms of energy: light, sound, electrical, and thermal energy.
Light Energy

Some objects absorb (take in) light, while others reflect (bounce back) light. Light moves in a straight line unless something reflects or bends it. When light hits an object, the light bounces off and is reflected into your eyes. It’s really the reflection of light that you see when you’re looking at an object.

Light that includes all of the colors is called white light. The colors of light are red, orange, yellow, green, blue, indigo, and violet. You see the same colors in a rainbow. An object gets its color from the color of light that is reflected back to your eyes. All other colors are absorbed by the object, so you do not see those colors. For example, if your teacher uses a red marker on the board, the ink is reflecting red light to your eyes and absorbing all of the other colors. An object that reflects all colors is white. What is the color of an object that absorbs all colors?

Light energy is related to heat (thermal) energy. Black objects absorb all colors of light at the same time. That is why a black shirt gets hot when you are in the Sun, but a white shirt does not get as hot. Sources of light energy are often also sources of thermal energy. Some examples of sources of both light energy and heat energy are the Sun, a light bulb, and a stove burner.

What color(s) of light do you think green leaves reflect? What color(s) do they absorb?

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Have you ever tried to get an object out of a bathtub or swimming pool and the object was not where it appeared to be? The object looks like it is in a different place because light travels through different materials (air, water, and glass) in different ways. Light travels faster in air and slower in water. As a result, when light moves from water to air, the light rays bend and the location of the object is distorted and appears different.

Light Activity: Exploring the Bending of Light

In this activity, you will explore the bending of light.

Materials (per small group):
- plastic cup
- pencil
- water

Procedures:
1. Fill a plastic cup with water and place the pencil inside the cup.
2. Move the pencil around inside the cup and observe the image of the pencil above the water and below the water.
3. Describe your observations.

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Conclusion:

1. How does the image of the pencil change when it is upright, compared to when it is at an angle?

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2. How does the image of the pencil in the same position change if you look at it from a different angle?

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______________________________________________________________
In this activity, you have learned that the location of an object above water and below water appears different due to the bending of light (refraction) caused by the different speeds at which light travels through water and air.

**Sound Energy**

Some ways that sound can be described are by loudness (or intensity) and by pitch. We can relate to loudness, because we often use the volume for our televisions or iPods™ to make the sound louder (more intense) or quieter (less intense). **Pitch** is a description of how high or low a sound is. Some sounds have a high pitch, like a chirping bird, while some have a low pitch, like a growling dog. Fast **vibrations** cause high pitch, and slow vibrations cause low pitch. The sound of a guitar is produced when a string is strummed and vibrates. If the vibrating part of the string is made shorter by moving a finger up the string toward the center of the guitar, the string vibrates faster and the pitch gets higher. Lengthening the vibrating part of the string by moving a finger away from the center of the guitar causes a slower vibration and a lower pitch.

In Inquiry 6 below, you will investigate how sound waves travel through different materials, such as solids, liquids, or gases.

**Inquiry 6: How Does Sound Travel through Different Materials?**
(Sc.5.P.10.1)

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**Inquiry Framework**

<table>
<thead>
<tr>
<th>1. Questioning</th>
<th>State the problem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>How do sound waves travel through different materials?</em></td>
</tr>
</tbody>
</table>

Make a prediction

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2. Planning

**Read the materials and procedures**

- Do I have all of the necessary materials?
  - □ Yes □ No

- Have I read the procedures?
  - □ Yes □ No

- Summarize the procedures in your own words.

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3. Implementing

**Gather the materials**
- 2 Ziploc™ bags
- water
- 2.5 cm (1 in) thick textbook
- pencil

**Follow the procedures**

1. □ Blow into one bag to fill it with air and seal it. Fill another bag nearly full with water and seal it.
2. □ Place the bag filled with air on a desk. Place your ear over the bag to hear any sound through it.
3. □ Have your partner knock on the desk with a pencil as you listen for the sound through the bag of air.
4. □ Repeat steps 2 and 3 with the bag of water and then with the textbook. Make sure that your partner knocks on the desk with the same pencil and in the same way for all trials.
5. □ Record your observations in the Data Table.

**Observe and record the results**
Describe the loudness (or intensity) and pitch of the sound you heard through each material. You may want to use words such as loud or soft, and high or low.

<table>
<thead>
<tr>
<th>Material</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air (gas)</td>
<td></td>
</tr>
<tr>
<td>Water (liquid)</td>
<td></td>
</tr>
<tr>
<td>Textbook (solid)</td>
<td></td>
</tr>
</tbody>
</table>

4. Concluding

Draw a conclusion
What did you find out?
Compare what you thought would happen with what actually happened. Did the results support your prediction?

☐ Yes  ☐ No

Describe the differences in the sound you heard through the bag with air, the bag with water, and the textbook.

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5. Reporting

Share your results
What do you want to tell others about the activity?
Talk with your group members about what you did and what you observed.

Produce a report
Record what you did so others can learn. Write answers to the following questions:

1. How did sound waves travel through the different materials?
2. Do you think sound waves travel better through solids, liquids, or gases? Explain your reasoning.

3. You are in a swimming pool, and your friend is talking at the other end of the pool. Will it be easier to hear her above the water or below the water? Explain your reasoning.

6. Inquiry Extension

Reflect on your results

- If I did this inquiry again, how would I improve it?
- What would be a good follow-up experiment based on what I learned?
7. Application

Make connections
- How does this activity relate to what happens in the real world?
- How could I apply the results in new situations?

In this activity, you have learned that sound waves travel differently through solids, liquids, and gases. We use this finding as a model to demonstrate that sound loudness (intensity) and pitch vary when sound travels through different materials. Sound was loudest when it traveled through the textbook, which is a solid. When sound traveled through water, which is a liquid, it was quieter. Sound was quietest when it traveled through air, which is a gas.

Electrical Energy

Have you ever heard the phrase, “Opposites attract?” This notion comes from the properties of charged objects. Think back to the magnet activity in Big Idea 9. Do you remember what happened when you put two north poles together? What happened when you put the north and south poles together?

A positively charged object will attract a negatively charged object. A negatively charged object will repel a negatively charged object. What do you think will happen if we place a positively charged object next to a positively charged object?

Static Electricity Activity: Exploring Electrical Charges

In this activity, you will investigate the behavior of electrically charged objects. Most objects have equal numbers of positive and negative charges, so they are neutral. This is why when you grab your pencil or paper you do not get an electrical shock. There are times when we can “charge” an object by rubbing it, which adds or subtracts negative
charges. Have you ever walked on carpet and gotten a shock when you touched a doorknob afterwards?

Materials (per small group):
- balloon
- sweatshirt (if available)
- pieces of paper (cut to less than 1 cm²)

Procedures:
1. Inflate the balloon.
2. Move the balloon over the pieces of paper and observe what happens. Draw your observations in the box below.
3. Rub the balloon on your hair or a sweatshirt.
4. Move the balloon over the pieces of paper and observe what happens. Draw your observations in the box below.

<table>
<thead>
<tr>
<th>Before rubbing the balloon</th>
<th>After rubbing the balloon</th>
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</table>

1. Describe what happened the first time you held the balloon over the pieces of paper.

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2. What happened the second time you held the balloon over the pieces of paper? Explain why the pieces of paper reacted as they did to the balloon.

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In this activity, you have learned that an object can be electrically charged by rubbing, and that opposite charges attract. When we rubbed the balloon, the surface of the balloon became charged. Then, the balloon attracted the pieces of paper.

Electricity can be made to move from one place to another. An electrical circuit is a closed loop, like a circle, where electricity can continuously flow in one direction.

**Stored Electricity Activity: Exploring Electrical Energy**

In this activity, you will learn how a simple electrical circuit works. Our example of a circuit has three parts:

1. a battery as an energy source
2. metal wire to carry the electricity in one direction through the circuit
3. a bulb that lights when the circuit is working. If the bulb does not light, then the circuit is not set up correctly

**Materials (per small group):**
- 2 pieces of wire
- 1 D-cell battery
- 1 low voltage light bulb
- pencil
- eraser
- paper clip

**Procedures:**
1. Examine the battery, the bulb, and 2 pieces of wire.
2. Think about how you would use two wires and the battery to light the bulb. Predict what the set-up would look like. Draw your prediction of the set-up.

**Prediction Diagram – 2 Wires**

Describe the circuit. Why do you think the circuit that you drew would make the bulb light up?
3. Test your design to see if the bulb lights up. If the bulb does not light, try other designs until you get the bulb to light up. Draw your successful circuit in the box.

**Successful Circuit – 2 Wires**

4. Now think about how you would use one wire and the battery to light the bulb. Predict what the set-up would look like. Draw your prediction of the set-up.

**Prediction Diagram – 1 Wire**

5. Test your design to see if the bulb lights up. If the bulb does not light, try other designs until you get the bulb to light up. Draw your successful circuit with one wire in the box.

**Successful Circuit – 1 Wire**
6. Compare your circuit diagrams to those of other groups in your class. Explain why some worked and why some did not work.

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Objects that allow the movement of electricity are called **conductors**. When electricity moves along a conductor, it is called a current. Objects that slow or prevent the movement of electricity are called **insulators**. Have you ever seen the tools of an electrician? The tools of electricians all have plastic or rubber handles. Why do you think that is?

7. Explore some common objects around your classroom to observe which are conductors or insulators.

<table>
<thead>
<tr>
<th>Object Name</th>
<th>Insulator or Conductor?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pencil lead</td>
<td></td>
</tr>
<tr>
<td>Eraser</td>
<td></td>
</tr>
<tr>
<td>Paper clip</td>
<td></td>
</tr>
</tbody>
</table>

In this activity, you have learned that the flow of electrical energy, or electricity, through a circuit is like the flow of water through the pipes in your home. If a pipe is plugged or broken, the water cannot go through the pipe and the flow of water stops. In an electrical
circuit, if the path for the electricity is not complete, the flow stops and the bulb will not light.

In order for a circuit to work, there must be a complete (closed) path. Electricity must be able to flow out of one end of the battery, go through the wire, light up the bulb, and then return to the other end of the battery. When the bulb lights up, electrical energy is transformed into light energy. What other form of energy was electricity transformed into?

**Heat (Thermal) Energy**

In the previous activity, when the bulb got warm, some of the electrical energy was transformed into thermal energy. This is because most things that emit light also produce thermal energy. Thermal energy is also known as heat. Rub your hands together. Are the palms of your hands warmer now? Friction from rubbing two objects together produces thermal energy.

If warm and cool objects touch each other, the energy moves from the warmer object to the cooler object. This energy flow from warmer to cooler objects is called heat (thermal) transfer. Heat energy flows from the warmer object to the cooler object until both objects are at the same temperature. You already learned that electricity can flow through some objects (conductors), but not others (insulators). The same is true for the transfer of heat, although the objects may be different. Some objects are made of materials that allow thermal energy to move easily. These objects are called conductors. Iron, copper, and aluminum are good conductors of heat. Insulators are materials that do not allow the heat energy to move easily. Plastic, wood, and Styrofoam™ are good insulators of heat.

**Mechanical Energy (Energy of Motion)**

Mechanical energy is the energy that an object has when it is in motion. The mass and speed of an object affect the amount of energy it possesses.

If a train and a car are moving at the same speed, the train has more energy than the car because the train has more mass.
On the other hand, if two trucks have the same mass, the truck that is moving faster would have more energy than the slower moving truck.

Picture yourself at the playground with your friends. Imagine that your friend sits down on the swing, but does not move. What can you do to get your friend moving on the swing?

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What about if you wanted to fly a kite that is lying on the ground? What would you do to get the kite to move?

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In the examples above, energy from a force known as a push is transferred to the swing to get it to move. Energy from a force known as a pull is transferred to the kite to get it to fly. In both cases, a person, you, are getting the swing to move by pushing or pulling. But can objects move without being pushed or pulled by a person or another object? Can wind energy be a source of energy that makes things move?

In Inquiry 7 below, you will investigate how wind energy can be a source of energy that makes things move.

**Inquiry 7: Wind Energy**  
(SC.5.P.10.2, SC.5.P.10.4)

**Inquiry Framework**

<table>
<thead>
<tr>
<th>1. Questioning</th>
<th>State the problem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Which method works best for trying to move a ping-pong ball across a pan?</em></td>
</tr>
</tbody>
</table>
(1) blowing it with a stirrer  
(2) blowing it with a straw  
(3) fanning it with a piece of paper

Make a prediction

__________________________________________________________________________
__________________________________________________________________________
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2. Planning

Read the materials and procedures
- Do I have all of the necessary materials?  
  □ Yes □ No
- Have I read the procedures?  
  □ Yes □ No
- Summarize the procedures in your own words.
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3. Implementing

Gather the materials
- 3 large roasting pans  
- 3 ping-pong balls  
- 1 stirrer  
- 1 straw  
- 1 sheet of paper to make a fan (please prepare ahead of time)
Follow the procedures
1. Fill each roasting pan with 3000 ml of water (a little less than half full).
2. Place each roasting pan on a flat and level surface lengthwise.
3. Place a ping-pong ball centered at one end of the roasting pan.
4. Before starting the investigation, make sure the water is still (not moving).
5. There will be a pan for each method:
   - Pan 1: One person will blow into a stirrer.
   - Pan 2: One person will blow into a straw.
   - Pan 3: One person will use a fan.
6. Each person will use wind energy to try to get their ping-pong ball to the end of the pan as fast as possible by blowing into a stirrer, blowing into a straw, or fanning with the paper fan.

7. Another group member should be responsible for starting the investigation. This person should say, “On your mark, get set, GO!” Once the first trial is complete, record in Data Table 1 which object caused the ball to reach the end of the roasting pan first.

8. Perform steps 3 through 7 two additional times, for a total of three trials.

Observe and record the results

9. Record the quantitative data for the second and third trials in Data Table 1. The quantitative data should be recorded as first, second, and third.

10. In Data Table 2, describe how wind energy from the stirrer, straw, and fan caused the ping-pong ball to move. Use qualitative data.

Data Table 1: Movement of the Ping-Pong Balls
(Quantitative Data)

<table>
<thead>
<tr>
<th></th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stirrer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Record time by using the terms first, second, and third.
Data Table 2: Movement of the Ping-Pong Balls
(Qualitative Data)

Did wind energy cause the ping-pong ball to move? Describe how the wind energy from the stirrer, straw, and fan caused the ping-pong ball to move. [Hint: Use terms like more/most or less/least wind energy.]

<table>
<thead>
<tr>
<th>Object</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stirrer</td>
<td></td>
</tr>
<tr>
<td>Straw</td>
<td></td>
</tr>
<tr>
<td>Fan</td>
<td></td>
</tr>
</tbody>
</table>

4. Concluding

Draw a conclusion
What did you find out?

1. Compare what you thought would happen with what actually happened. Did the results support your prediction?
2. Describe how the difference in wind energy from the stirrer, straw, and fan caused the ping-pong ball to move. [Hint: Use terms like more/most or less/least wind energy.]

3. Which object, the stirrer or the straw, provided more wind energy?

4. Based on the investigation, did the amount of wind energy affect how quickly the ping-pong ball reached the opposite end of the pan? Explain your reasoning.

5. Why do you think you performed three trials with the stirrer, straw, and fan?
5. Reporting

**Share your results**
What do you want to tell others about the inquiry? Talk with your group members about what you did and what you observed.

**Produce a report**
Record what you did so others can learn. Write answers to the following questions:

1. *To move the ping-pong ball across the pan, which method (stirrer, straw, or fan) worked best?* Provide your evidence.

2. Explain how wind is a source of energy that makes the ball move. Use the term mechanical energy in your answer.

3. During a strong windstorm, what do you think will happen to objects that are not bolted to the ground? Why?
4. After trimming the trees in front of the school, the lawn is covered with leaves and twigs. How would the school’s landscaper use a leaf blower to clean up? Based on this investigation, if the landscaper turned the leaf blower on low, would that make the cleanup process faster or slower? Use the data from the experiment to explain your reasoning.

5. In this activity, you investigated three different methods of controlling the amount of wind energy used to move an object, a ping-pong ball. Another way to think about wind is how best to harness (or capture) its mechanical energy.

Based on what you observed in the activity, which of these three sailboats do you think would harness the most wind energy? Provide your evidence.
6. Inquiry Extension

Reflect on your results

- If I did this activity again, how would I improve it?
- What would be a good follow-up experiment based on what I learned?

7. Application

Make connections

- How does this activity relate to what happens in the real world?
- How could I apply the results in new situations?
In this activity, you have learned that wind energy can be used to move things. Wind energy is a form of mechanical energy that causes motion or creates change.
In this chapter, you learned that energy comes in many forms. Energy has the ability to cause motion or create change.

Light is a form of energy. When light shines on an object, some colors are reflected and other colors are absorbed. When light moves from one material to another, like from air to water, light is bent.

A sound is produced when sound waves move through matter. The sound waves produced by mechanical energy start vibrations that moves through solids, liquids, or gases. Sound waves can be described by their loudness (intensity) and pitch.

You built electrical circuits to investigate energy. Chemical energy in a battery is changed into electrical energy and then into light energy and heat energy in the bulb. An electrical circuit is a closed loop where electricity continuously flows from one end of a battery, through the circuit, and back to the battery.

One way heat (thermal) energy is produced is when two objects are rubbed against each other, like when you rub your hands together. We receive radiant thermal energy from the Sun.

Mechanical energy can move objects. You observed mechanical energy in action when you used wind energy to move ping-pong balls across water.