Energy: Every Day, Everywhere
Lesson 4: Keeping Track of Energy

Grade: 4	**Length of lesson:** 70 minutes	**Placement of lesson:** 4 of 5 lessons on energy
Anchoring Phenomenon: The distance the rubber band is stretched in a toy car launcher affects the energy of a toy car as evidenced by the speed and distance the car travels.		
Unit Learning Goal: The energy of objects and systems can be transferred and/or transformed. Changes in the energy of objects and systems can be observed and compared.		
Lesson Main Learning Goal: The production of heat, light, sound, or motion is evidence that the energy of an object or system has changed. Energy can be changed from one form to another in a variety of ways. **Science and Engineering Practices** Constructing Explanations and Designing Solutions ● Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard). ● Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. ● Identify the evidence that supports particular points in an explanation. **Crosscutting Concepts** Systems and System Models • A system can be described in terms of its components and their interactions.		
Unit Central Question: How does the energy of an object or system change?		**Lesson Focus Question:** How do we detect and represent energy changes in a system?
Science content storyline: Energy is all around us and can be detected using our senses. We can feel heat, see light, hear sound, and see movement. This is evidence that energy is present and changing. Energy changes in a system can be represented with a system diagram that shows the components of the system, the observable changes taking place, where in the system energy changes are occurring, where the energy comes from, and where the energy goes.		
Ideal student response to the Lesson Focus Question: Changes in energy can be detected when an object's motion changes or it gives off heat (changes in temperature), sound, or light. Energy changes can be represented using a system diagram.		

Preparation

<table>
<tr><th>MATERIALS NEEDED</th><th>AHEAD OF TIME</th></tr>
<tr><td>

Teacher Resources

- TE 4.1 *Teacher Key: System Diagram: Wind-Up Toy*
- TE 4.2 *Teacher Key: System Diagram: Hand-Crank Flashlight*
- TE 4.3 *Teacher Key: System Diagram: Noisemaker*
- TE 4.4 *Teacher Key: System Diagram: Rubber Ball*

Student Handouts

1 copy per group of 3; at least 2 groups should be given the same image.

- HO 4.1 *System Diagram: Wind-Up Toy*
- HO 4.2 *System Diagram: Hand-Crank Flashlight*
- HO 4.3 *System Diagram: Noisemaker*
- HO 4.4 *System Diagram: Rubber Ball*

Other materials

Per student

- tape or glue stick
- 10 sticky notes
- 1 fine-tipped marker

Per group of 3

- 1 sheet of chart paper and colored markers
- 1 plastic bag containing the following:
    - 1 wind-up toy that moves
    - 1 hand-crank flashlight
    - 1 noisemaker—one that you don't put in your mouth
    - 1 rubber ball (All balls should be identical.)

Per class

- chart paper and markers
- sticky note arrows
- access to an electrical device that has been running in the classroom (Students need to be able to feel heat from the device. Computers, monitors, and projectors will all work well.)

</td><td>

- Review the information about energy and energy changes in the *Content Background* document.
- Prepare all handouts and resources.
- Plan how you will divide the students into groups of 3.
- Post the Driving Question Board, Notice and Wonder, CSW, and Science Ideas We've Figured Out charts in a visible location.
- Prepare 1 bag of objects for each team of 3 students. The bag should contain a wind-up toy, a hand-crank flashlight, a rubber ball, and a noisemaker.
- Turn on the electrical device that groups will use to observe heat.
- Save the System Diagram Key Components chart for use in Lesson 5.

</td></tr>
</table>

Lesson 4 General Outline

Time	Phase of lesson	How the science content storyline develops
5 min	**Introduction:** The class revisits the Notice and Wonder and Driving Question Board charts to review ideas they have figured out and connect any ideas related to other evidence that an object has energy besides motion.	
5 min	**Focus Question:** The teacher introduces the Lesson Focus Question. Students share their initial ideas about the question, *How do we detect and represent energy changes in a system?*	We know changes in energy can be detected when there is a change in the movement or position of an object. Changes in energy can also be detected by the presence of light, sound, and/or heat.
10 min	**Setup for Activity:** The teacher introduces system diagrams using the marble and ramp activity from the previous lesson as an example system. The marble-ramp system is used to model the process of drawing a system energy flow diagram.	We can describe a system in terms of its components and their interactions (CCC 4). A system diagram is a model that shows the components of the system, the observable changes taking place, where in the system the energy changes are occurring, where the energy comes from, and where the energy goes.
30 min	**Activity:** Students examine and manipulate several small objects and look for evidence that they have energy. They record their observations in a data table. Students share their ideas and the evidence they found that an object has energy. Student groups create a system diagram as a model for one of the small objects by drawing energy flow diagrams to show where in the system energy changes are occurring, where the energy comes from, and where the energy goes?	Energy is all around us and the presence of energy can be detected. The energy of objects can be detected in various ways as we observe light, sound, changes in heat, and/or motion of the object. Sometimes light is brighter (more energy) or dimmer (less energy), objects move faster (more energy) or slower (less energy), sound is louder (more energy) or softer (less energy), and changes in heat are greater (more energy) or lesser (less energy). Energy flows in and out of systems (CCC 5). Energy changes can be tracked with an energy flow system diagram.
10 min	**Follow-Up to Activity:** Groups diagramming the same object pair to provide feedback based on the System Diagram Key Components criteria (energy	We can use system diagrams to construct an explanation of observed relationships in energy changes (SEP 6).

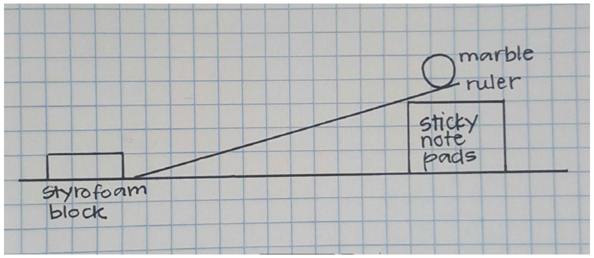
Time	Phase of lesson	How the science content storyline develops
	lens questions) introduced in the set up for the activity. Groups revise their system diagram based on the feedback.	
5 min	**Summarize and Synthesize:** Students add to and revise their response to the Lesson Focus Question. The class summarizes the science ideas and how system diagrams can be used to represent changes in energy within a system.	We can see evidence of energy changes in many ways. The amount of energy an object has determines the amount of energy that can be changed (transformed) into other types of energy such as light, sound, motion, and/or heat. (CCC 5)
5 min	**Link to Next Lesson:** The class revisits the Driving Question Board and Science Ideas We've Figured Out charts to review ideas they have figured out. The teacher forecasts that in the next lesson, we will use everything we've figured out to explain all the energy changes in the car launcher system.	We can use everything we've learned to explain all the energy changes in the rubber band car launcher.

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
5 min	**Introduction** <u>Synopsis</u>: The class revisits the Notice and Wonder and Driving Question Board charts to review ideas they have figured out and connect any ideas related to other evidence that an object has energy besides motion.	Link science ideas to other science ideas.	Let's look at our Driving Question Board, our DQB. Our Unit Central Question, which is the title of the DQB, is "How does the energy of an object or system change?" We learned a lot last time to help us with the concept of energy change, or energy transformation or conversion. Please turn in your science notebook to your revised answer to the focus question from the last lesson, reread your response, and quietly think about your learning. Once you've done that, refer to the Science Ideas We've Figured Out chart. **What did we figure out in the last lesson?** ***NOTE TO TEACHER:*** *Provide a few moments for silent think time. Mark rows 6 and 7 on the CSW chart and encourage students to use sentence stems from these rows as they share their ideas with the class.* *As students share their ideas, listen for the distinction between what we <u>did</u> and what we <u>figured out</u>. Ask elicit and probe questions as needed to support students to focus on what we <u>figured out</u>.* **In our ruler-marble-Styrofoam block system last time, where did the marble have the most position (potential) energy?** **Will someone share what happened to that energy as the marble rolled down the ramp?**	We learned about another kind of energy—position. **Yes, so far, we have learned about two forms of energy. What is position (potential) energy?** It's if something is at a place that is higher than another place. At the top of the ramp right before we let go of it because it was highest there. The position got less and less, and the motion got more and more. **What do others think? Do you have anything to add to that?** We learned that was called transform—when one kind of energy changes to another.

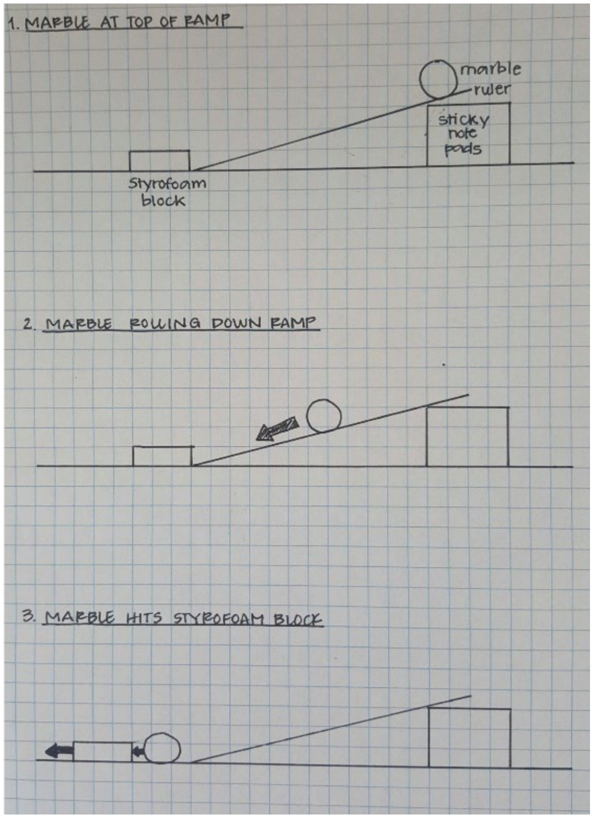
Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			Great job, everyone! Now, what happened to energy when the marble collided with the Styrofoam block?	Well, it had all motion energy then and gave some of it to the block. **Will someone remind us what term we use when one moving object gives another object motion (kinetic) energy in a collision?** We called it transfer of energy.
5 min	**Focus Question** <u>Synopsis:</u> The teacher introduces the Lesson Focus Question. Students share their initial ideas about the question, *How do we detect and represent energy changes in a system know that the energy of an object or system has changed?*	Set the purpose with a focus question. Ask questions to elicit student ideas and predictions.	Today, we are going to dig into some of the other kinds of energy that we have questions about, such as light, heat, and sound. ***NOTE TO TEACHER:*** *Draw students' attention to the Notice and Wonder chart and the Driving Question Board. Be sure to point out any ideas related to light, heat, and/or sound on either of the charts.* Our Lesson Focus Question today is, **How do we detect and represent energy changes in a system?** ***NOTE TO TEACHER:*** *Provide time for students to set up their notebook for a new lesson. Remind them that they should start on a new page and write the date and lesson title. Write this lesson's focus question on the board and have students also write it in their notebook and draw a box around it. Refer to the focus question often throughout the lesson.* Let's begin our answer with a sentence starter. Write it in your notebook under the Lesson Focus Question and leave plenty of room after it to add to and revise your ideas as we investigate. *So far, I know that the energy of an object or system has changed ...*	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			NOTE TO TEACHER: *Ask students to think about the answer now and to write their initial ideas. Remind students that we are just beginning the lesson, so they may not know the full answer, but they should think about their best ideas about the question. Share that they will have a chance to revise their ideas as they work through the lesson. Allow time for students to write and respond to the focus question. Ask elicit and probe questions to encourage students to share with the class their best idea about the focus question so far.*	
10 min	**Setup for Activity** <u>Synopsis</u>: The teacher introduces system diagrams using the marble and ramp activity from the previous lesson as an example system. The marble-ramp system is used to model the process of drawing a system diagram. <u>Main science ideas</u> When an object or system loses energy, it goes to another object or part of the system or leaves the system. We can track energy changes using system diagrams.	Ask questions to elicit student ideas and predictions. Ask questions to probe student ideas and predictions.	We have talked about systems in every lesson. **Can anyone name a system we have investigated?** **What do you think is meant by a *system*?** ***NOTE TO TEACHER:*** *Students may also want to include the paper used to mark how far the Styrofoam piece moved. You can include it in the diagram if raised by students, but it should not be emphasized.*	Well, we explored the car launcher system, and we used the ruler-marble-Styrofoam system. I think a system is a group of things. **What do others think?** I agree with (____). **Can you say more about the group of things?** I think the things in the group work together or work with each other. **If that is the case, what was our system in the last lesson's investigation?** The marble and the ramp. **Were there any more parts to that system?**

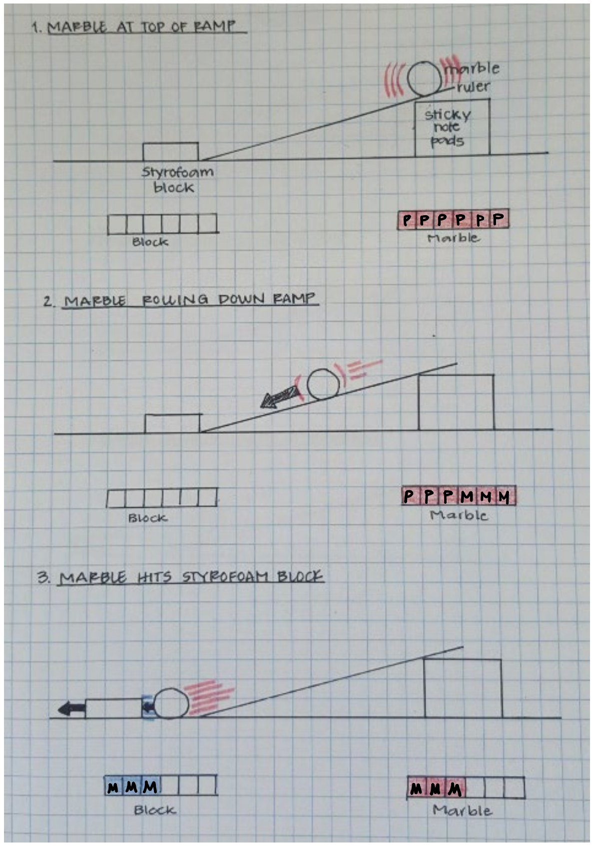
Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			Every system is made of parts or components like our ruler-marble-Styrofoam block system we investigated last time. You've just named the components of the last lesson's system. **What are the components of the marble-ruler system we used first?**	Oh, the Styrofoam block!
				A marble and a ruler. **What do others think?** There were two marbles—red and blue.
			Yes, each of our systems has had different components, but in all of them we have looked for and observed changes occurring in the system to find out where energy changes were happening. Think back to our review we did last time for the ruler-marble-Styrofoam block system. You shared a lot of changes that happened in the system. As we observed, we wanted to keep track of those changes. One way to keep track of all these changes in the system is to represent them with a model called a *system diagram*. A good system diagram includes several key components: • The parts of the system with labels • Observable changes taking place • Where in the system energy changes are occurring • Where the energy in the system comes from • Where the energy in the system goes—where it is transferred or transformed ***NOTE TO TEACHER:*** *Chart the parts of a good system diagram and give the chart paper the title "System*	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			Diagram Key Components". Students will refer to this chart later in the lesson to develop their own system diagram and provide feedback to other groups. Save this chart for use in Lesson 5. Let's begin by co-constructing a system diagram together. In other words, I will draw a diagram up here as we discuss and decide what to add. Please make a diagram in your science notebook as we go. We will start with our ruler-marble-Styrofoam block system. First, we will sketch and label the components of the system. Our sketch doesn't have to be a piece of art; shapes and symbols can represent the parts of the system. ***NOTE TO TEACHER:*** *Throughout this part of the lesson, there are diagrams included, such as figure 1, as a guide to assist you with thinking aloud as you draw and engage students in the process. Yours may look different but should include all components shown.*  Figure 1: Ruler-marble-Styrofoam system components Notice I am adding sticky note arrows to row 6: Listen to others' ideas and ask clarifying questions, and row 7: Agree or disagree with others' ideas and add onto someone else's ideas. Please refer to and use sentence stems from these rows as we continue to develop our system diagram.	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			OK, now that we have our system sketched and labeled, our second step is to represent the observable changes—changes we actually saw—in the system. Let's share ideas and discuss this to come to consensus. Then we will add our ideas to the diagram. ***NOTE TO TEACHER:*** *See figure 2 for guidance. If students struggle with ideas about how to represent the observable changes in the system, encourage them to refer to the energy representations symbols of the ruler-marble-Styrofoam block system used in HO 3.1 from last lesson. Note that you can represent the parts of the system at different points in the action.*	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			 Figure 2: Observable changes in the ruler-marble-Styrofoam system Our next step is to represent where and what energy changes are occurring in our system. Think about ideas we used in our previous lessons. **To get us started, what symbol did we use to represent motion (kinetic) energy? What about position (potential) energy?** Good start! Let's continue our discussion to decide how we will represent energy changes in the diagram.	We used lines for motion energy and parentheses for position energy.

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			NOTE TO TEACHER: *Invite students to share their ideas with the class. Encourage students to use CSW sentence stems as they share their ideas. Highlight ideas from previous lessons, such as the following:* • Position (potential) energy can be represented with parentheses and energy of motion (kinetic) with lines. • Amounts of energy can be represented with the number and thickness of lines and parentheses. • Energy bars can represent changes in energy. • Different colors can represent the energy of different objects. • Letters can be used to label different types of energy, e.g., P = position (potential) energy, M = motion (kinetic) energy. OK, since we agreed to use representations from other lessons, let's begin to add them. We will start with representations of energy. ***NOTE TO TEACHER:*** *As you use the ideas from class consensus to develop the diagram, refer to figure 3, model a think and talk aloud to make it easy for students to follow along and make their own diagram in their notebook. Use elicit, probe, and challenge questions to engage students in this process. Stop intermittently to ensure students are with you and have time for questions.*	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			 Figure 3: Energy changes in the system Now, our next step is to add labels to the energy changes that we have just represented. To do this, think about where energy comes from and where it goes in each change. Let's start with the marble at the top of the ramp. **Based on the symbol we used, how should we label the energy at this point?** **OK, let's pause for a moment to check our diagram for the necessary components. I will name each**	The parentheses mean position energy, so that is how we should label it. I think we definitely have the first three components. **I see most of you nodding. What do others think?**

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			component. Please look closely to make sure it has been included. Did you • **draw and label all parts of our system?** • **note the observable changes?** • **show and label everywhere an energy change occurs?** • **indicate where the energy comes from?** • **indicate where the energy goes?** **Based on our components, do you have any suggestions to improve our system diagram?**	I agree with ____. All of those are included, but I'm not sure about the last two. **OK, take a minute to re-read the last two components to see if we agree with ____.** I'm not sure we really indicate where the energy comes from and goes. **Good point. Who has ideas about how we can do that?** At the bottom of the ramp, could we add something like "transferred from marble to block"? **What do others think?** We added a "p" in the boxes on the energy bars to represent position energy.

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			Now that we have added your suggestions, let's consider our energy bar model. **How did we represent that form of energy on the energy bar?** Yes, let's continue to add labels to the energy changes in our diagram and on the energy bars. Let me remind you that to label energy changes, we have to also think about whether the energy is being transferred or transformed so we can include that with the letters we add to the energy bars. ***NOTE TO TEACHER:*** *Engage students to suggest where and what kind of label(s) should be added. Use elicit, probe, and challenge questions to draw out thinking and come to consensus about labels. Highlight student ideas that include transformation and transfer of energy. Figure 4 is an example.*	

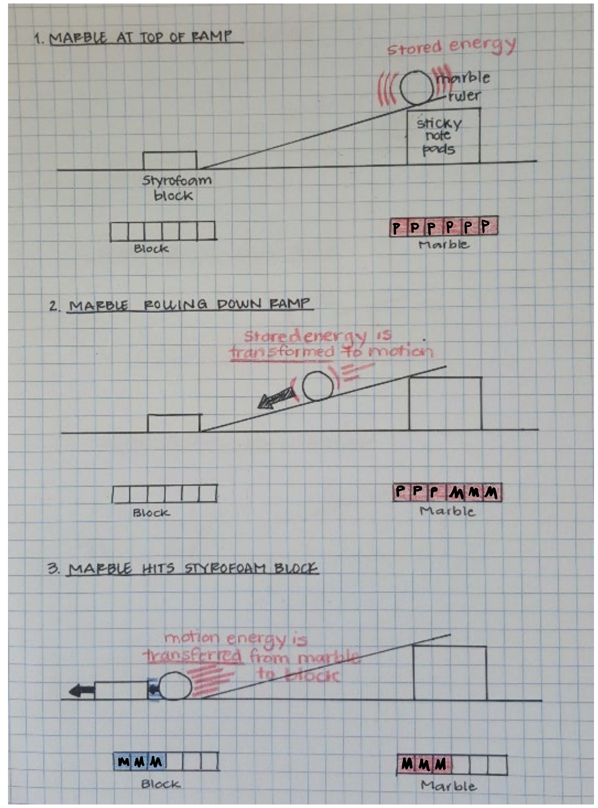
<table>
<tr><th>Time</th><th>Phase of lesson and how the science content storyline develops</th><th>STeLLA strategy</th><th>Teacher talk and questions</th><th>Possible student and teacher dialogue</th></tr>
<tr><td></td><td></td><td></td><td>

Figure 4: Adding energy change labels

Congratulations! We have just completed our first system diagram. Look up here to review the System Diagram Key Components list for the things that a good system diagram should include. Turn to your elbow partner to consider if our class diagram includes all the things on the list and if your own diagrams are also complete. Discuss what feedback you might provide to improve our class system diagram, as well as your own. Be prepared to share your ideas and suggestions with the class.</td><td>Well, if something was moving, then that gave us evidence of motion energy.

OK, so a change in motion is a way to detect energy changes. Can anyone add to that?

We said that when an object is at a higher place, it has position energy.</td></tr>
</table>

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			NOTE TO TEACHER: *The purpose of this step is to practice giving feedback to improve a system diagram. Groups will give each other feedback on their system diagrams later in the lesson.* System diagrams are useful ways to represent the energy changes in a system. It was very helpful when we considered the energy changes of the ruler-marble-Styrofoam block system as the marble rolled down the ramp and hit the Styrofoam block. We will be using system diagrams in our next lesson, too. Every time we draw one, it will be important to look at it through the lens of the necessary components. Let's look up here at our focus question. **So far, what evidence have we used to detect energy changes? How did we know an energy change had occurred?**	Seeing an object move is evidence that its energy has changed. **What do others think?** I agree, like, when we saw the Styrofoam block started to move when the marble collided with it and transferred some of its energy. It changed the energy of the Styrofoam block.

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			Great thinking—change in motion or change from a higher place to a lower one (or opposite) are both observations we have used as evidence for energy changes. **I wonder if there are other ways that we can detect changes in energy?** ***NOTE TO TEACHER:*** *Invite students to look at the Driving Question Board to name other forms of energy they have questions about. Ask them to think about how we might be able to detect those changes.* You both mentioned using our senses. **Did we use our senses to detect motion (kinetic) or position (potential) changes?**	I am using my sense of sight when I see something move. And I use sight to see where the marble is on the ramp.
30 min	**Activity** <u>Synopsis</u>: Students examine and manipulate several small objects and look for evidence that they have energy. They record their observations in a data table. Students share their ideas and the evidence they found that an object has energy. Student groups create a system diagram as a model for one of the small	Ask questions to elicit student ideas and predictions.	Yes, we have said so far that our observations give us evidence for a change in energy. Our observations rely on our senses! We will continue to gather evidence that an object has energy and changes in energy by using our senses. We're going to examine some different objects. You will try to figure out if the objects have energy and what energy changes are occurring. You may have to do something to the objects to look for energy changes, and, if you do, record what you do and what you observe. As you explore, remember that you are trying to detect energy changes in the objects. ***NOTE TO TEACHER:*** *Show students the objects in one of the bags.*	

<table>
<thead>
<tr><th>Time</th><th>Phase of lesson and how the science content storyline develops</th><th>STeLLA strategy</th><th>Teacher talk and questions</th><th>Possible student and teacher dialogue</th></tr>
</thead>
<tbody>
<tr>
<td></td>
<td>objects by drawing energy flow diagrams to show where in the system energy changes are occurring, where the energy comes from, and where the energy goes.

<u>Main science ideas</u>

Objects exhibit energy in various ways.

Energy of motion (cranking a flashlight) can be converted or changed into light, heat, and sound.

Energy of position is converted or changed to energy of motion and vice versa.</td>
<td></td>
<td>While you explore each item, record how you know the object has energy—what did you observe? What is your evidence that the object has energy? We will use a data table to record our ideas.

NOTE TO TEACHER: Make a data table on the board similar to the one pictured below and have students also create the data table in their notebook (they should leave extra room at the bottom for more rows). Wait to fill in the first row until students have made their table with the column heads. Fill in the first row together using the marble rolling down the ramp as an example.

<table>
<tr><th>Object</th><th>Evidence of energy</th></tr>
<tr><td>Marble rolling down the ramp</td><td>Moving</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
</table>

Let’s complete one together.

What about the marble moving down the ramp? Did it have energy? How do we know this? What is the evidence?

NOTE TO TEACHER: Point to the picture and student ideas that you recorded from the system diagram.

Yes, so let’s record that in our data table. Now, you will continue to explore energy changes and the evidence of energy changes. You will explore different objects to see if they have energy. As you explore, ask yourself: Do you think the object can have energy? What other forms of energy do you know of besides position (potential) and motion (kinetic)? What would the evidence be? Remember that you are using your senses to detect the changes in energy.

NOTE TO TEACHER: Hold up each object for this investigation. Place students in groups of 3. Give students about 15 minutes to explore all the items in</td>
<td>I know that the marble has energy because I saw it moving down the ramp. My evidence is that the marble is moving.</td>
</tr>
</tbody>
</table>

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
		Ask questions to probe student ideas and predictions. Engage students in communicating in scientific ways.	*the bag and complete their data table. Tell them you will call each group when it is their turn to come up to explore the electrical device. Once students are finished observing their objects and recording their evidence, bring the class back together.* So, what did your exploration yield? **What do you think? Can any of the objects you explored have energy? What was your evidence?** ***NOTE TO TEACHER:*** *Call on students to respond. Hold up one object at a time. When they say "yes, an object can have energy" or "no, an object cannot have energy", probe their ideas to find out why they think that way or what their evidence is that the object does or doesn't have energy. As you hear students share what they observed that showed them the object had energy, ask them to demonstrate with the object what they saw, felt, or heard. Ask the class if they agree or disagree that the observation is evidence for energy. Probe the students' thinking about why they agree or disagree.*	We felt heat coming from the projector or monitor. **What do others think, is that evidence of energy changes?** Yes, we used our sense of touch to feel the heat. **Did you use any other senses to detect changes in the objects?** We used our sense of hearing to hear the sound from the noisemaker.
		Engage students in using content representations and models. Make explicit links between science ideas and activities.	Now that we have discussed how to detect changes in the energy of an object, we can draw a system diagram, similar to the one we drew earlier for the ruler-marble-Styrofoam system, for the objects we just explored from the bag. Remember to include all key components of a good system diagram. ***NOTE TO TEACHER*:** *Assign each group one item from the bag for which to draw a system diagram. At least 2 groups should be assigned the same item. Give groups about 10 minutes to draw on chart paper the system diagram for their assigned item. Remind students of the components that their system diagram should include*	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			from the ruler-marble-Styrofoam block system example in their notebook. *Circulate among the groups as they make their system diagram, asking elicit, probe, and challenge questions. Use questions to help focus them on the key system diagram components.*	
10 min	**Follow-up to Activity** <u>Synopsis</u>: Pairs of groups drawing system diagrams for the same object provide feedback based on the System Diagram Key Components criteria (energy lens questions) introduced in the set up for the activity. Students revise their system diagram based on the feedback. <u>Main science ideas</u> Energy flows in and out of systems (CCC 5). Energy changes can be tracked with an energy flow system diagram. We can use system diagrams to construct an explanation of observed relationships in energy changes (SEP 6).	Engage students in using content representations and models. Engage students in communicating in scientific ways.	I saw some interesting system diagrams and heard good conversation as you worked on your diagram. Now the two groups that worked on the same object will come together, trade their diagrams, and provide feedback. Refer to our System Diagram Key Components list up here and use those as guidelines for your feedback. Also make sure to give useful feedback to the other group. An example of useful feedback would be something like, "You did not include all the observable changes on your diagram" or "Where the energy comes from and goes is not shown." An example of feedback that is not as useful would be something like, "Your handwriting looks very nice." ***NOTE TO TEACHER:*** *Give students 5 minutes to use sticky notes to give feedback on the system diagram drawing. Instruct students to give one piece of feedback per sticky note. An example and a nonexample of useful feedback has been provided above to help guide them appropriately.* System Diagram Key Components • The parts of the system with labels • Observable changes taking place • Where in the system energy changes are occurring • Where the energy in the system comes from	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			• Where the energy in the system goes—where it is transferred or transformed Now that you have your group's diagram back with sticky note feedback, it is time to use it to revise your diagram. ***NOTE TO TEACHER:*** *Instruct groups to use the feedback they received by sorting and grouping the sticky notes and discussing if they will accept or reject each piece of feedback. Have them then make their revisions by drawing a single line through changes and using a different color for added information. Give students about 5 minutes to use the feedback to revise their system diagram.*	
5 min	**Summarize and Synthesize** <u>Synopsis</u>: Students add to and revise their response to the Lesson Focus Question. The class summarizes the science ideas and how system diagrams can be used to represent changes in energy within a system. <u>Main science ideas</u> Evidence from our senses help to determine the energy present (light, sound, heat, motion) in a system and any energy changes that occur. System diagrams can be	Engage students in making connections by synthesizing and summarizing key science ideas.	Let's add the new evidence of energy changes that we observed today—feeling heat, seeing light, or hearing sound—to the Science Ideas We've Figured Out chart. **Do any of these new ideas connect to our car launcher system? What do you think?** ***NOTE TO TEACHER:*** *Students should make the connection that the sound they heard when the launcher arm hit the car is motion (kinetic) energy that changed, or transformed, into sound energy. This is a good time to help students understand that sometimes some of the energy actually leaves the system and goes to the surrounding air.*	I heard a sound when the launcher hit the car. **Interesting. Where did this sound energy come from?** Maybe the launcher? It had motion energy, so maybe it transformed some to sound from the collision. **OK, so now where does that sound energy go?** We heard it so it had to get to our ears.

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
	used to represent energy changes within a system.		Those are two important points to remember. First, the evidence we use to detect energy changes must be something we actually observe. And second, sometimes some energy leaves the system and goes into the surrounding air. Now, let's revisit our Lesson Focus Question: **How do we detect and represent energy changes in a system?** Please reread your response to our initial sentence starter. After you have done that, use these sentence stems to add to your thinking:	**Interesting, so does it stay in the system like the motion energy did?** Oh, if our system is only the parts we labeled, then no. It went to the air, then our ears. **Good. Are there any other ideas about energy in the launching system?** I know when a rubber band is stretched it can get warm, so heat. **Do others agree or disagree?** I think that might be true, but we didn't actually feel the heat so we can't say that, right? **What do others think about this?** I think ___ is right. We have to have evidence to say it happened.

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			I can detect changes in energy within a system by ... *I can represent the energy changes in a system by ...* ***NOTE TO TEACHER:*** *Give students time to write their ideas in their notebook. Remind them to make any edits or changes in a different color. If time allows, call on students to share their ideas. As each one shares an idea, probe student ideas to connect their evidence for energy to what they did in the activity that demonstrated changes in energy. For example, if students say, "An object has energy if I see light", ask what object or objects they observed in the activity gave off light.*	I know that the energy of an object or system has changed because it produced light. **What objects did you observe in the activity that gave off light?** The flashlight. **What did you do to get the flashlight to produce light?** I turned the crank. **How did the energy of the flashlight system change?** I put in motion energy, and it was changed to light energy. **Can someone summarize the flashlight system energy changes using our new science words?** I'll try—my hand transferred motion energy to the flashlight. Then the motion energy was transformed to light energy. And the light went into the air around it. **Good! Now, how can you represent energy changes like that?**

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
				We can draw a system diagram like we just did today. Oh, or could we do something like the card sort to match up the energy and the evidence?
5 min	**Link to Next Lesson** Synopsis: Students review the ideas from previous lessons to identify what they have figured out and to think about whether we can use everything we've figured out to explain all the energy changes in the car launcher system.	Link science ideas to other science ideas (next lesson).	***NOTE TO TEACHER:*** *Refer students to their notebook to review what they have figured out in all the lessons so far. Provide a few moments of individual think time.* In the next lesson, we'll build on the explanation of the car launcher system we began in the last lesson and combine it with what we learned with our system diagrams from today's lesson to develop a complete explanation of all the energy changes in the car launcher system.	

BSCS Science Learning
Transforming Science Education Through Research-Driven Innovation

Energy: Every Day, Everywhere Lesson 4

Keeping Track of Energy

1

Important Science Ideas We Have Figured Out

- (Add important science ideas about energy that are not already listed.)
-
-
-
-

2

Lesson 4: Focus Question

How do we detect and represent energy changes in a system?

I know that the energy of an object or system has changed ...

BSCS Science Learning

3

Energy System Diagram

- Can anyone name a system that we have investigated in this unit?
- What do you think is meant by a "system"?

BSCS Science Learning

4

Energy System Diagram

System diagram key components

- The parts of the system
- Observable changes taking place
- Where in the system are energy changes occurring?
- Where does the energy come from?
- Where does the energy go?

BSCS Science Learning

5

Energy System Diagram

Identify the parts of the marble-ramp system or other system we have investigated in this unit.

Think about

- where in the system you observed changes occurring.
- where energy changes are happening.

BSCS Science Learning

6

Investigation: How do we know if something has energy?

- How do we know if an object has energy?
- What is your evidence?

7

Investigation: How do we know if something has energy?

- Investigate these objects for **energy**.
  - You will use a data table to record your observations and evidence.
  - Draw this data table in your science notebook. We will complete the first row together.

8

R emhfw	Hylghqfh ri hqhuj|
Marble rolling down the ramp	The marble is moving

9

How do we know if something has energy?

- *I know that something has energy because it ...*
- Share your sentences with the class.
  - You may demonstrate your ideas using the objects you explored.

10

Energy System Diagram

- Draw a system diagram for the object you have been assigned.
- Remember to include the System Diagram Key Components:
  - The parts of the system
  - Observable changes taking place
  - Where in the system are energy changes occurring?
  - Where does the energy come from?
  - Where does the energy go?

11

Energy System Diagram: Feedback

- Use sticky notes to give feedback to the other group with which you traded system diagrams.
- Does the system diagram identify the key components?
  - The parts of the system
  - Observable changes taking place
  - Where in the system are energy changes occurring?
  - Where does the energy come from?
  - Where does the energy go?

12

Energy System Diagram: Revisions

- Use the feedback you received from the other group to revise your energy system diagram.
  - Sort and group the sticky notes.
  - Discuss as a group if you will accept or reject each piece of feedback.
  - Make your revisions by using a single line through changes and using a different color for added information.

13

Lesson Summary: Key Science Ideas

Write in your notebook all the ways we know that something has energy and how the energy of an object has changed.

Do any of these new ideas connect to our car launcher system?

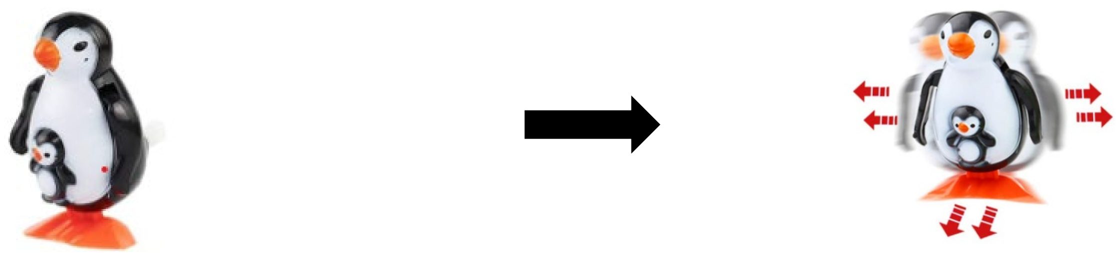
14

System Diagram

Wind-Up Toy

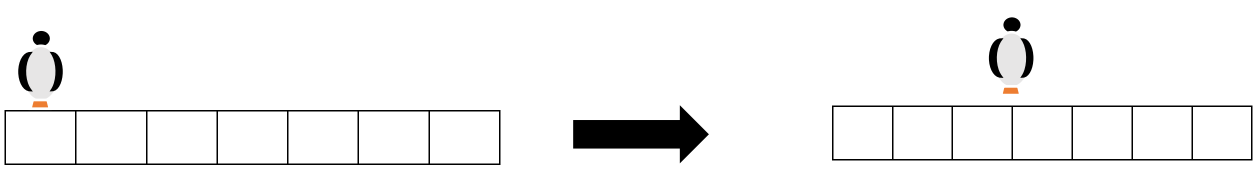
1. The toy is wound up.

2. The toy is released.



1. The toy is wound up.

2. The toy is released.

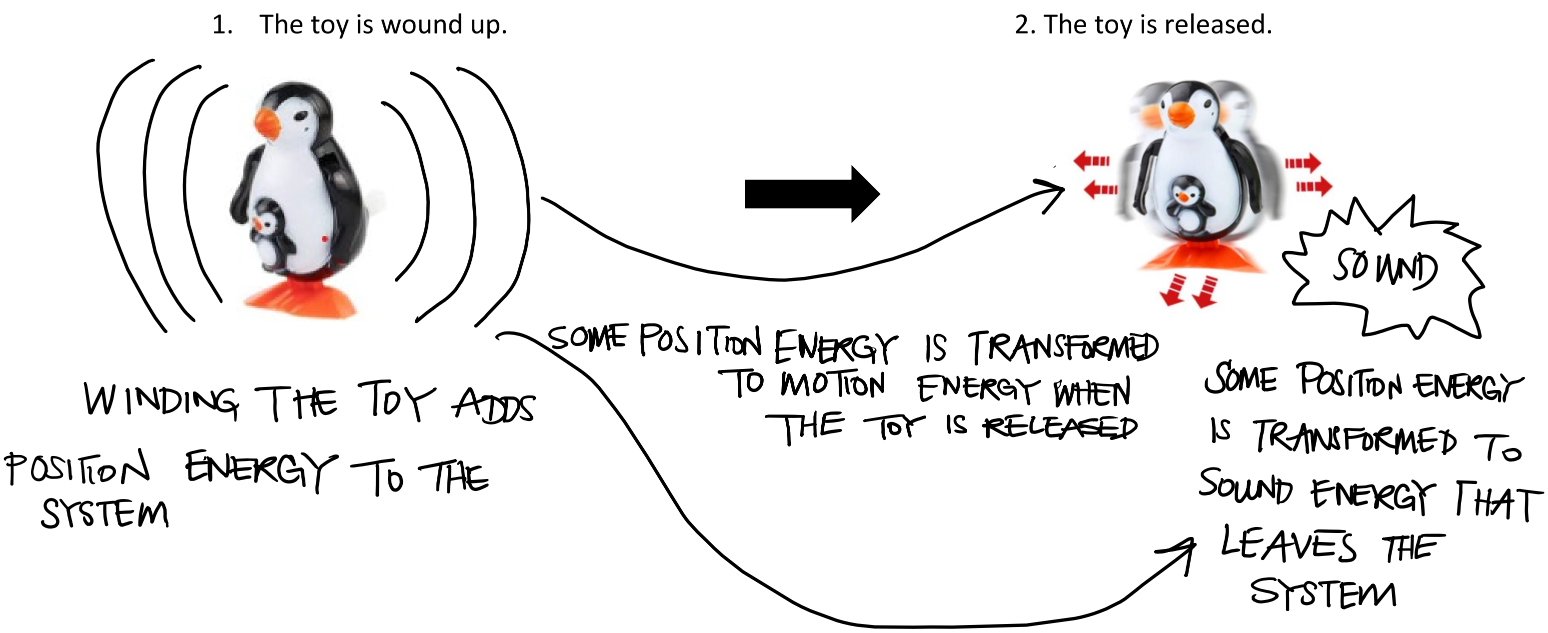


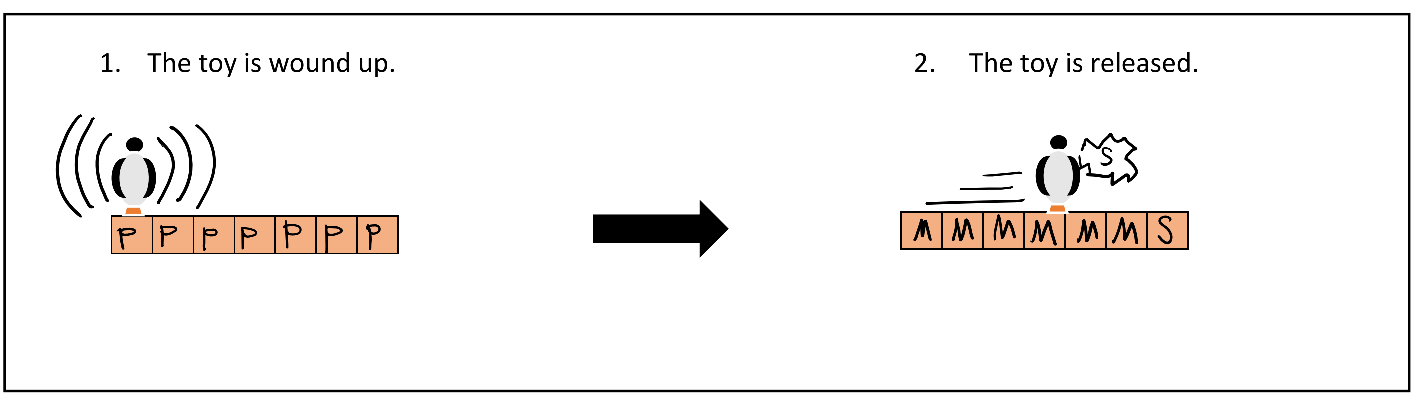
Teacher Key

System Diagram

Wind-Up Toy

OBSERVABLE CHANGES:
THE TOY IS WOUND UP AND PLACED ON THE TABLE. THE TOY BEGINS TO MOVE FORWARD AND WADDLE SIDE TO SIDE. THE TOYS MAKES NOISE AS IT MOVES.





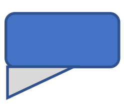
P = POSITION ENERGY

M = MOTION ENERGY

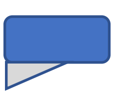
S = SOUND ENERGY

System Diagram

Hand-Crank Flashlight



cranking slowly



cranking fast

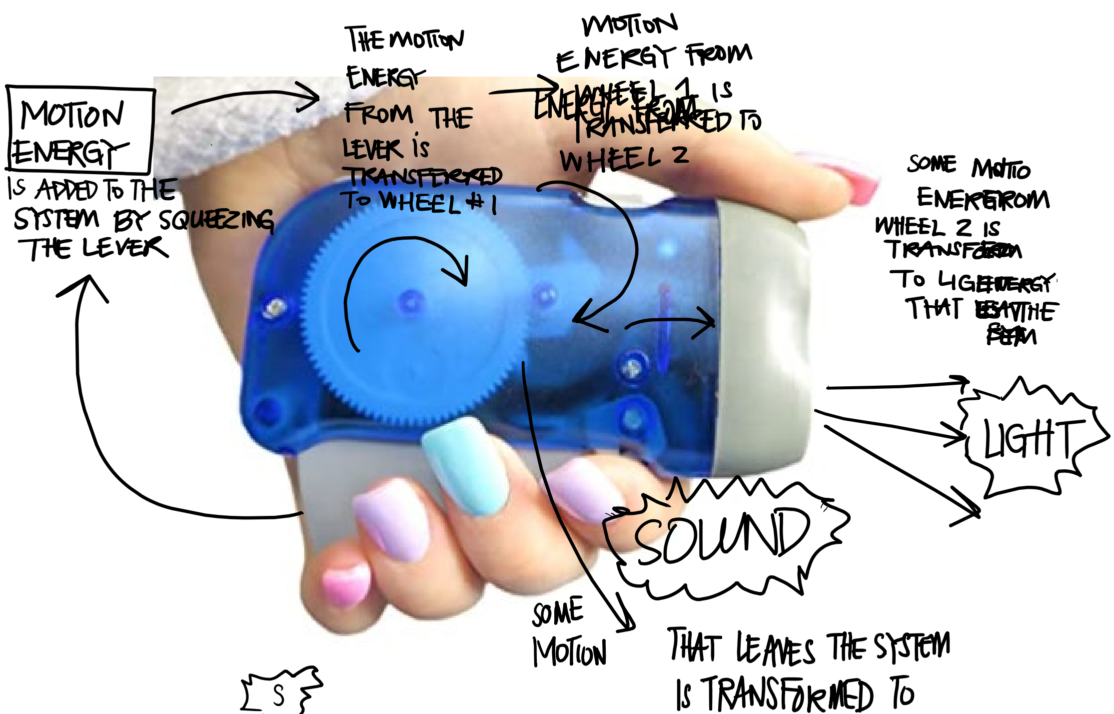
Teacher Key

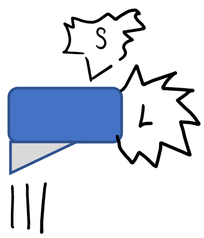
System Diagram

Hand-Crank Flashlight

OBSERVABLE CHANGES

SQUEEZING THE LEVER TURNS THE FIRST WHEEL WHICH TURNS THE SECOND WHEEL WHICH LIGHTS THE BULB. THE FASTER THE LEVER IS SQUEEZED/CRANKED, THE BRIGHTER THE LIGHT BECOMES. WHEN YOU STOP CRANKING THE FLASHLIGHT, THE WHEELS STOP MOVING AND NO MORE LIGHT IS PRODUCED.





M	L	S			

cranking slowly

M	M	L	L	S	S

cranking fast

M= MOTION ENERGY

L= LIGHT ENERGY

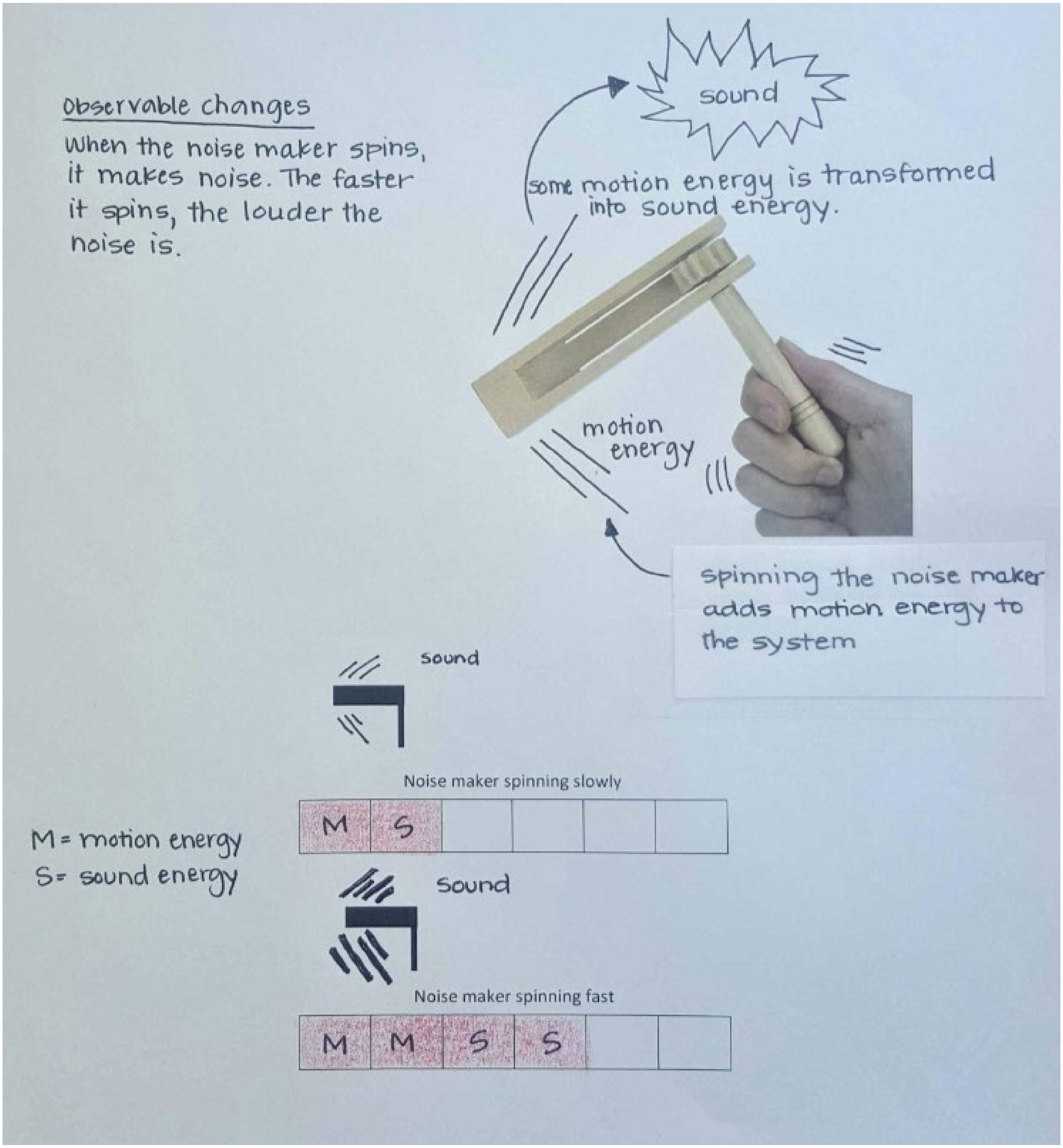
S= SOUND ENERGY

System Diagram
Noisemaker

noisemaker spinning slowly

noisemaker spinning fast

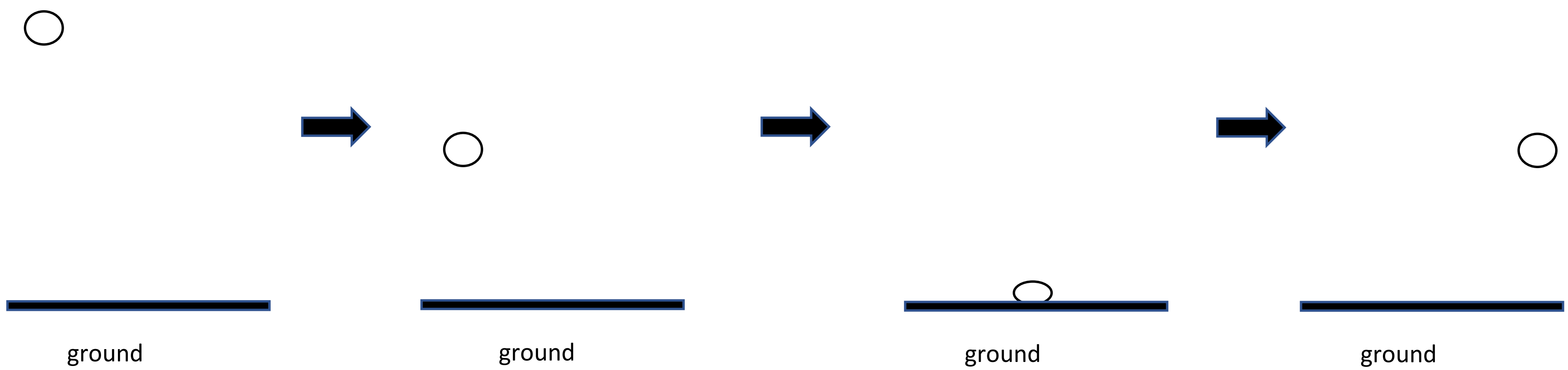
Teacher Key
System Diagram
Noisemaker

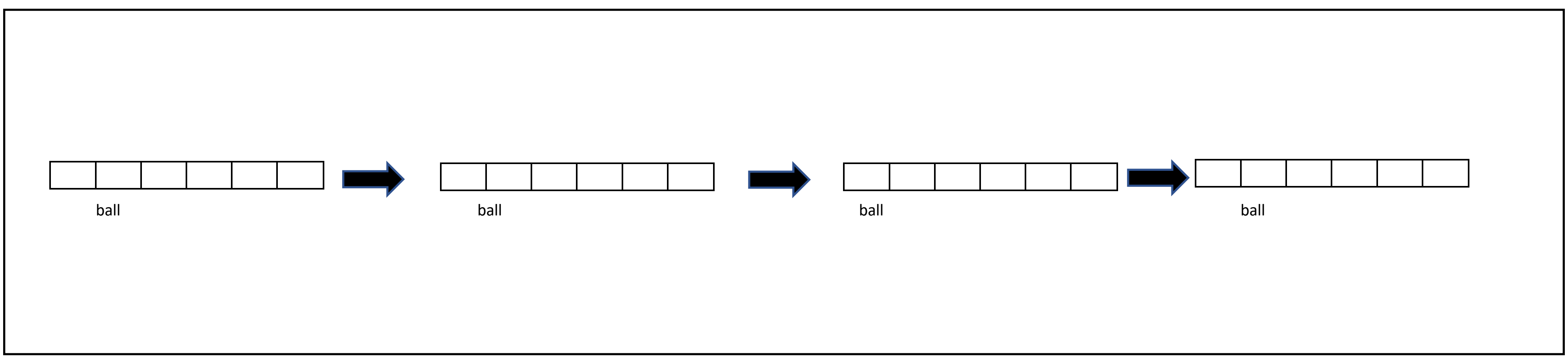


System Diagram

Rubber Ball

1. The ball is being held in the air.
2. The ball falls halfway to the ground.
3. The ball hits the ground.
4. The ball bounces halfway back up.





Teacher Key

System Diagram

Rubber Ball

OBSERVABLE CHANGES: THE BALL IS DROPPED TO THE GROUND AND HITS THE GROUND AND BOUNCES BACK UP.