Energy Transformation

4.4

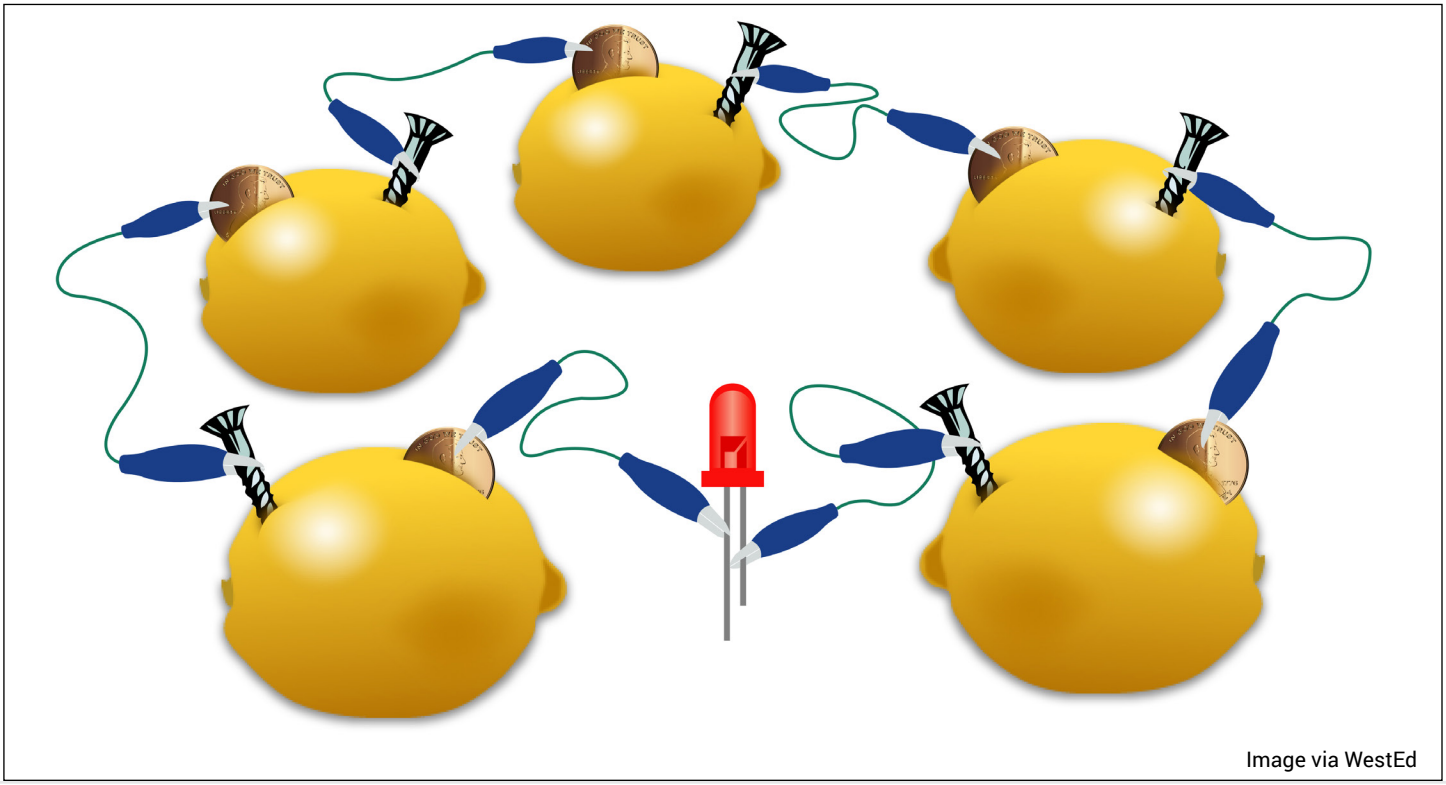


Image via WestEd

Anchoring Phenomenon

A Rube Goldberg® machine stalls.

Lesson Concept

Carry out an investigation to explore how energy moves and can be transformed between objects.

Investigative Phenomenon

Energy transfers can be observed in parts of a Rube Goldberg® machine where energy converts its action to movement, sound, electricity.

Standards

Refer to Appendix 4.4 for NGSS, CCSS (ELA), and California ELD standards.

A project of CA NGSS K–8 Early Implementation Initiative.

Storyline Link

In the prior lesson, students planned and conducted investigations to explore the speed of objects during collisions in relation to the amount of energy the object possesses.

In this lesson, students test various devices that transform energy, i.e., convert its actions. They make observations to produce data that they analyze for trends or patterns that they use as evidence to construct an explanation. They also learn to refine their arguments based on an evaluation of the evidence. They continue to recognize that energy can be transferred in various ways and between objects. They also continue to define the system to describe its components and interactions.

In the next lesson, students apply what they learned in this learning sequence to design a Rube Goldberg® machine that includes energy transfers and transformations.

Throughout the unit, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.

Time

330 minutes (5 hours 30 minutes)

Part I	75 minutes	
	30 minutes	Engage
	45 minutes	Explore 1
Part II		
	60 minutes	Explore 2
Part III		
	90 minutes	Explain
Part IV		
	45 minutes	Elaborate
Part V		
	60 minutes	Evaluate

Materials

Whole Class

- ❑ Chart paper
- ❑ Markers
- ❑ 4.2.C1: Energy Questions (from Lesson 2: Oops!)
- ❑ 4.4.C1: Sentence Frames for Analyzing Our Data: Station 1
- ❑ *3M Rube Goldberg Machine* video (https://www.youtube.com/watch?v=GEzcO3nfjZk)
- ❑ *Audri's Rube Goldberg Monster Trap* video (https://www.waimeaelementary.org/apps/video/watch.jsp?v=111342)

Per Station (For Part II: Explore 2)

TEACHER NOTE

There are 4 possible stations for students to explore. It is recommended that they do at least 2 or 3 of the stations to experience a variety of transformations (sound, movement, and light). Decide which stations to use and obtain materials for those.

Station 1: Bean/rice with speaker

- ❑ Speaker, (see sample: https://www.amazon.com/Sylvania-SP328-Black-Portable-Bluetooth-Speaker/dp/B00YO2T6ZA/ref=sr_1_22?s=electronics&ie=UTF8&qid=1496357318&sr=1-22&keywords=speaker)
- ❑ Handful of dried beans or rice
- ❑ 4.4.R1: Station Directions: Station 1 Rice/Beans with Speaker

Station 2: Circuit With Motor and Battery

- ❑ Motor with flag or marker to see when turned on (see sample: https://shop.miniscience.com/navigation/detail.asp)
- ❑ AA Battery
- ❑ Wires (2 in each station)
- ❑ 4.4.R1: Station Directions: Circuit with Motor and Battery

Station 3: Circuit with Buzzer and Solar Panel

- ❑ Buzzer (see sample: https://shop.miniscience.com/navigation/detail.asp?id=SSS64104)
- ❑ Solar panel (see sample: http://store.sundancesolar.com/small-solar-panels/)
- ❑ Wires (2 in each station)
- ❑ 4.4.R1: Station Directions: Station 3 Circuit with Buzzer and Solar Panel

Station 4: Circuit with Light Bulb and Hand Generator

- ❑ Light bulb
- ❑ Light bulb holder
- ❑ Hand generator (See sample: https://www.amazon.com/American-Educational-7-1853-Generator-Length/dp/B00657NH7K)
- ❑ Wires (2 in each station)
- ❑ 4.4.R1: Station Directions: Station 4 Circuit with Light Bulb and Hand Generator

Per Station for Elaborate (For Part IV: Elaborate)

> **TEACHER NOTE**
>
> The four stations listed above can be used by changing the source of energy. In addition, the Lemon Light Bulb Circuit could be used. Select the Elaborate stations and obtain materials for those.

Lemon Light Bulb Circuit

- ❑ 5 Lemons
- ❑ 6 Short electrical wires with alligator clips
- ❑ 5 Pennies
- ❑ Sharp knife
- ❑ 5 Galvanized screws
- ❑ LEDs (at least one color)
- ❑ 4.4.R2: Station 5 How to Make a Lemon Battery

Individual

- ❑ Science notebook
- ❑ Pencils
- ❑ 4.4.H1: Energy Transformation Data Sheet

Advance Preparation

1. Decide which stations to use for the Explore (Part II) and the Elaborate phase (Part IV) and adjust time frames based on those selections.
2. Based on the selected stations, obtain the appropriate materials. Set up stations with appropriate materials and test them. Make sure to charge solar panels in the sun. Duplicate the station instructions for the 4 stations **4.4.R1: Station Directions** and put a direction sheet by each station. If you are going to use the lemon battery as a station, obtain the appropriate materials and duplicate **4.4.R2: Station 5 How to Make a Lemon Battery** for this station.
3. Make a chart titled **Questions about Rube Goldberg® Machines**.
4. Decide how to duplicate **4.4.H1: Energy Transformation Data Sheet**. EITHER provide each student with data sheets for the different stations OR place one handout at each station and have students answer the questions in their science notebook.
5. Preview the *3M Rube Goldberg Machine* video.

Procedure

TEACHER NOTE

Energy is a complex topic. Be aware of possible student misconceptions identified in the NRC Framework. "The idea that there are different forms of energy, such as thermal energy, mechanical energy, and chemical energy, is misleading, as it implies that the nature of the energy in each of these manifestations is distinct when in fact they all are ultimately, at the atomic scale, some mixture of kinetic energy, stored energy, and radiation. It is likewise misleading to call sound or light a form of energy; they are phenomena that, among their other properties, transfer energy from place to place and between objects."[1]

In fourth grade, students are expected to know that energy can be moved from place to place by moving objects or through sound, light, or electric currents. In this lesson, they focus on visible evidence to identify energy transformations: e.g., battery and wires light a light bulb; a collision of moving objects creates sound.

1. A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (pages 120–122).

Part I

Engage (30 minutes)

Communicate information about patterns of energy transfers.

1. Write these words on chart paper: dominoes and marbles colliding; Audri's Rube Goldberg Machine. Ask students with a partner to review their science notebook and discuss what is similar in all the things they have learned.
2. Conduct a discussion about the students' ideas. *ESRs: All involve objects moving. All involve objects hitting something else. All involve energy being transferred from object to object. All involve faster-moving objects having more energy.*
3. Ask the class to collaboratively write a claim about how energy is transferred based on what they know so far. *ESR: Energy is present in moving objects. When they collide, energy can be transferred from one object to another, changing their motion.*

TEACHER NOTE

In the previous lessons, the students focused on energy transfer, where they observed things moving. The energy source was mechanical, and it produced movement of some kind. In this lesson, students explore other ways (e.g., sound, electrical, heat, and light) in which energy is transformed as it moves from object to object.

4. Introduce the *3M Rube Goldberg Machine* video and ask students to observe the actions. Have partners discuss their observations and then conduct a brief class discussion of what they observed.

TEACHER NOTE

Use think-pair-share strategy to get students talking and sharing ideas about their observations.

Use sentence frames to help students engage in partner conversations and a whole group share. Sentence frames can include but are not limited to:

I know that energy _____.

I noticed that _____.

I observed _____.

I agree with _____ because _____.

I want to add that _____.

Focus on energy transformations shown in the video. Prompt students, if needed, to identify where the energy comes from, what the energy does and where it goes to see energy transformation as it moves through the different objects.

5. Ask students if their claims from Step 3 explain everything they observed in the *3M Rube Goldberg Machine* video. If not, what do they still need to figure out? What questions do they have? Chart their questions on the **Questions about Rube Goldberg® Machines** chart.

Explore 1 (45 minutes)

Make observations of patterns to provide evidence that energy can be transformed as it moves from object to object.

6. Write the word transform on the board. Use the student conversation from Step 5 to clarify that **when energy is transformed, its action is converted**. Provide this example: A moving object hits something, and sound is produced.

7. Ask student partner to review their models from Lesson 2: Oops! to find the part of the system where the ball hits the switch. Ask students to discuss what their model shows. Replay the 2:46–3:04 part of the *Audri's Rube Goldberg Monster Trap* video. Ask how students could add to their model in terms of the energy being transformed. *ESR: We could add the word transform to our model. We could say the ball hit the switch, which turned on the electricity to heat up the toaster. When it was hot enough, the lever pushed up.*

8. Tell students to think more about the energy transformations that they observed. Have table groups generate other examples of where energy is transformed in daily live. *ESRs: At night, I turn on the light switch, and the lights go on. My mom turns on the gas to heat the water to make a hard-boiled egg. I flew my kite on a day when the wind made it move; etc.*

9. Facilitate a discussion about how students can get evidence that there is actually energy being transformed in these everyday situations. Ask students to brainstorm ideas, and facilitate a discussion leading to the conclusion that some of these everyday situations could be tested just as they did with the cars and ramps. They could look for patterns where energy is being transferred and transformed.

10. Explain that students have several stations they will go to try to answer their questions about energy transformations.

11. Review **4.4.H1: Energy Transformation Data Sheet**, and explain how students should record their data.

12. Divide students into groups of 3 or 4 and assign them to their station. Explain that they will do one station today and three tomorrow.

TEACHER NOTE

Modify the directions and the timing based on the number of stations you have selected for the students to explore. **These directions are based on having students explore 4 stations, spending 20 minutes at each station. Each stations should have a resources sheet at the station, which provides directions to the students.**

In Part I, preview the stations and explain the materials (about 10–15 minutes); leaving time for 1 station. In Part II, students complete the other 3 stations using a rotation system. There are instructions and guiding questions at each station.

Station 1: Rice/Beans with Speaker
Students place a handful of rice or dried beans on top of the speaker (where the sound is produced). Students observe the rice/beans moving due to the sound produced by the speaker. Energy source: speakers. Energy receiver: rice/beans. Transformation: Observable phenomenon: sound from speaker (electrical) to observable phenomenon motion of rice/beans (mechanical).

Station 2: Circuit with Motor and Battery
Students connect wires from the motor to each side of the battery to create a circuit. Students observe the motor spinning when the circuit is connected. Energy source: battery. Energy receiver: motor. Transformation: observation battery with + and - sides indicating chemical inside (chemical) to observation of wires (electrical current) to observable phenomenon motion of motor. Note: Students may not recognize chemical energy, and that is OK. **If students have never worked with complete circuits, allow extra time for them to figure out how the connections are made.**

Station 3: Circuit with Buzzer and Solar Panel
Students connect a solar panel to wires from the buzzer to create a complete circuit. Students observe the buzzer making a noise when the circuit is connected. Energy source: solar panel. Energy receiver: buzzer. Transformation: solar to electrical to sound. Note: Students may not recognize the solar energy; so ask probing questions as to how the panel was 'powered'.

TEACHER NOTE (continued)

Station 4: Circuit with Light Bulb and Hand Generator
Students place a light bulb in the light bulb holder making sure that the bottom of light bulb is touching the metal plates. Students connect the light bulb with wires and the hand generator to create a complete circuit. Students observe the light bulb turning on when the hand generator is cranked. Energy source: hand generator. Energy receiver: light bulb. Transformation: motion (mechanical) to electrical to light. Note: Students many not recognize that their hand motion (mechanical) transfers the energy to electricity, and that is OK.

13. Have students engage in the exploration at each station by the following directions on **4.4.R1: Station Directions**. Provide about 20 minutes for students to complete their station and record their observations on the **4.4.H1: Energy Transformation Data Sheet** or in their science notebook. Note that stations that involve setting up circuits might take students a little longer to do.

14. Ask students to return to their desks and clean up or revise any of their observation notes.

Part II

Explore 2 (60 minutes)

Make observations of patterns to provide evidence that energy can be transformed as it moves from object to object.

15. Explain that students will continue their station rotations from yesterday. Re-orient students to the expectations and their beginning station for today.

16. Start the investigations. At the end of 20 minutes, ask students to rotate to their next station.

17. At the end of 20 minutes, ask students to rotate to their last station.

18. At the end of 20 minutes, ask students to return to their desk and clean up or add to any of their observation notes in their science notebook. Students should have completed **4.4.H1: Energy Transformation Data Sheet** at the end of the station rotation.

Part III

Explain (90 minutes)

Analyze and use trends in data (patterns) to provide evidence that energy can be transformed between objects as sound, light, or motion.

> **TEACHER NOTE**
>
> Students will share their data in their groups and look for trends (patterns) that can be used as evidence that energy can be transformed.
>
> Discussion of results from Station 1 will be conducted in a "fishbowl." A fishbowl is a way to have a group process their ideas in front of a larger group who listens to the fishbowl group's conversations. The fishbowl can be used as a way to model the kinds of discussion the other groups should be having when given the opportunity to discuss.
>
> Then groups will conduct their discussions, and finally the class will be brought together to summarize what their results indicate. This is a good time to discuss how what they noticed in one station was similar to what they noticed in another, establishing patterns, and that these patterns can be used as evidence to support an explanation.
>
> Depending on student discussion, this part may take 60–90 minutes and can be broken into two sections by having students discuss data from two stations during one period and then the other two stations in another period.

19. Have students form new groups of 4 students who did not do the rotations together.
20. Remind students that they are going to look at their data to see what can be used as evidence that energy can be transformed. Conduct a brief conversation about the difference between data and evidence.

> **TEACHER NOTE**
>
> If your students are familiar with data and evidence, this conversation should just be a review. If this is new to them, spend more time helping them see that raw data has little meaning. It has to be organized and analyzed (e.g., finding trends, deciding if it is appropriate to the claim, and if it is sufficient to make the claim) to become evidence to support or refute a claim.

21. Tell students that they are going to share their data from each station.
    a. Explain that they will use their ideas that they recorded on **4.4.H1: Energy Transformation Data Sheet** and the questions on the chart made from **4.2.C1: Energy Questions** to guide their discussions.
    b. Select a group and conduct a "fishbowl" to model how the discussions might go for Station 1.

c. Display **4.4:C1: Sentence Frames for Analyzing Our Data: Station 1**. Ask students in the group to take turns sharing their data using the prompts.

d. Encourage students to identify the patterns in the cause and effect relationship of what they observed.

e. Continue the "fishbowl" until students have made their claim.

f. Ask the class to discuss briefly in their groups if they agree with the fishbowl group's evidence and claim. Have the groups share and discuss.

22. Ask the groups to use the process they observed in the fishbowl with their own data from Stations 2, 3 and 4.

23. For each station select a group to share its claim. Help students recognize that their data from one station might be similar to that from another station. This sets up patterns that can be used as evidence to support an explanation.

24. Ask students if they think their claim would be supported by another investigation. How would they find out?

Part IV

Elaborate (45 minutes)

Make observations of a new system to provide evidence that energy can be transformed.

> **TEACHER NOTE**
>
> There are two options for Part IV. Choose to do one or both.
>
> Option 1 uses materials from Stations 1–4 to have students engage in additional exploration of energy transformation by switching sources and receivers.
>
> Option 2 extends students' learning with a different type of transformation: chemical to electrical. Use **4.4.R2: Station 5 How to Make a Lemon Battery** One setup is suggested for each group of 4 or 5 students.

25. Tell students they now have an opportunity to continue to extend their data with another exploration in which they can answer their questions about energy transformation.

a. Option 1: Have students, in small groups, continue to explore energy transformation by switching different energy sources (e.g., battery, hand generator, speaker, and solar panel) with different energy receivers (e.g., light bulb, buzzer, oobleck, and motor). Provide students with materials and have students try different pairings of energy sources and energy receivers (e.g., battery with buzzer, solar panel with light bulb, etc.).

b. Option 2: Have students explore the **4.4.R2: Station 5 How to Make a Lemon Battery** in small groups. Provide the group with the appropriate materials and instructions.

26. Whichever option is selected, have students write their observations in their science notebook and use the questions on **4.2.C1: Energy Questions** to analyze their data.

27. Have several groups share evidence that energy can be transformed.

28. Focus on the **Our Thinking So Far** chart from Lesson 1: What's Going On? and add to or refine their thinking

Part V

Evaluate (60 minutes)

Make a claim supported with evidence from several investigations that energy can be converted or transformed into sound, light, or motion.

29. Collect exit slips. Ask students to work in groups of 4 to respond to this prompt: Based on your observations at the four Explore stations and the Elaborate stations, what claim can you make about energy transformations? What evidence did you gather that supports your claim? How can you use the evidence to support your argument?

> **TEACHER NOTE**
>
> If necessary, use sentence frames to help students guide their conversation. For example:
>
> Energy is _____ because _____.
>
> Energy can_____ because_____.
>
> Energy can _____. My evidence is _____.
>
> I observed _____, _____, _____ and _____. Therefore, I think _____.

30. Distribute poster paper and markers. Ask groups to write their claim and list their evidence to support their claim. "What patterns or trends did they notice in the different explorations? How can these patterns be used as evidence to support their claim?"

31. Select a few of the posters and have groups share. Ask other student groups to evaluate the evidence: "How strong do they think the reporting group's evidence is to support the claim? What could be done to make it stronger?"

32. ▶ Play the *3M Rube Goldberg Machine* video from 0:56-1:22. Have students discuss how their claim and evidence statements can help them to explain the flow of energy in the Rube Goldberg® machine.

TEACHER NOTE

▶ An example of a claim with supporting evidence might be:

Energy can be transferred from place to place. Sometimes when that happens the energy can be used locally to produce motion, sound, heat or light. In each station we explored, the energy that came into the system produced a different action. This pattern occurred in each station. For example, the energy in the battery made the motor turn. In another case, the energy in the solar panel made a buzzer make a sound, and in another case, the energy in cranking the hand generator made the light bulb go on. The energy in the speakers made the rice/beans move.

In a Rube Goldberg® machine, the energy of movement produced sound which then produced movement.

References

3M. (2015, August 3) *3M Brand Rube Goldberg Machine.* https://www.youtube.com/watch?v=GEzcO3nfjZk

A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. DOI: https://doi.org/10.17226/13165. National Research Council; Division of Behavioral and Social Sciences and Education; Board on Science Education; Committee on a Conceptual Framework for New K-12 Science Education Standards. National Academies Press, Washington, DC.

Waimea Elementary School. (2016, April 25). *Audri's Rube Goldberg Monster Trap*. Retrieved from https://www.waimeaelementary.org/apps/video/watch.jsp?v=111342.

Toolbox Table of Contents

Energy Transformation Data Sheet

Name: _____

Station 1: Rice/Beans with Speaker

1. What is happening? Draw a picture of your system and label the parts of the system.

2. Where does the energy come from? How do you know?

3. What observable changes are taking place?

4. Was there an energy transformation? How do you know?

Energy Transformation Data Sheet

Name: _____

Station 2: Circuit with Motor and Battery

1. What is happening? Draw a picture of your system and label the parts of the system.

2. Where does the energy come from? How do you know?

3. What observable changes are taking place?

4. Was there an energy transformation? How do you know?

Energy Transformation Data Sheet

Name: _____

Station 3: Circuit with Buzzer and Solar Panel

1. What is happening? Draw a picture of your system and label the parts of the system.

2. Where does the energy come from? How do you know?

3. What observable changes are taking place?

4. Was there an energy transformation? How do you know?

Energy Transformation Data Sheet

Name: _____

Station 4: Circuit with Light Bulb and Hand Generator

1. What is happening? Draw a picture of your system and label the parts of the system.

2. Where does the energy come from? How do you know?

3. What observable changes are taking place?

4. Was there an energy transformation? How do you know?

Station Directions

Station 1: Rice/Beans with Speaker

Instructions:

1. Turn on the speaker.
2. Observe what happens to the rice/beans.
3. Review and discuss with a partner the prompts on the Energy Transformation Data Sheet for Station 1.
4. Write your answers in your science notebook or on the data sheet.

Station Directions

Station 2: Circuit with Motor and Battery

Instructions:

1. Connect the battery with the wires and motor. Hold the wires from the motor onto both ends of the battery.
2. Observe what happens to the motor.
3. Review and discuss with a partner the prompts on the Energy Transformation Data Sheet for Station 2.
4. Write your answers in your science notebook or on the data sheet.

Station Directions

Station 3: Circuit with Buzzer and Solar Panel

Instructions:

1. Connect the solar panel with the wires and buzzer.
2. Observe what happens to the buzzer.
3. Review and discuss with a partner the prompts on the Energy Transformation Data Sheet for Station 3.
4. Write your answers in your science notebook or on the data sheet.

Station Directions

Station 4: Circuit with Light Bulb and Hand Generator

Instructions:

1. Connect the hand generator with wire and light bulb.
2. Turn the generator.
3. Observe what happens to the light bulb.
4. Review and discuss with a partner the prompts on the Energy Transformation Data Sheet for Station 4.
5. Write your answers in your science notebook or on the data sheet.

Station 5: How to Make a Lemon Battery

Things you need

5 lemons 

5 copper pennies 

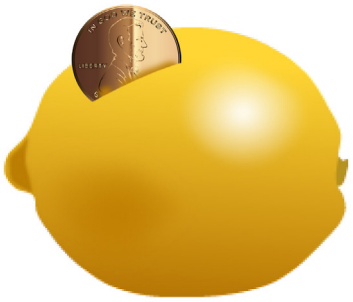
5 galvanized screws 

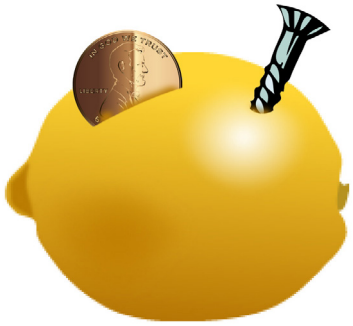
6 short electrical wires with alligator clips 

1 sharp knife 

LEDs 

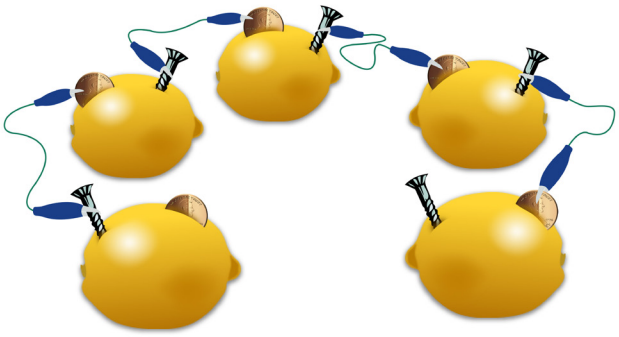
1. Roll each lemon gently on a table to break the cell walls and loosen up the juice inside. The sour juice is needed for the chemical reaction.
2. With your teacher's help, make a cut in a lemon with a knife. Cut a slit about one-half an inch from the center. Make the slit wide enough so the penny will fit and deep enough so that about half of the penny will be in the lemon.
3. Now push a penny firmly into the slit you cut.
4. Repeat Steps 2 and 3 for the other four lemons.
5. Mark a spot one-half an inch from the center on the other side, and insert a galvanized screw. Twist it in, clockwise, to secure it in the lemon flesh. Now repeat with the other four lemons.



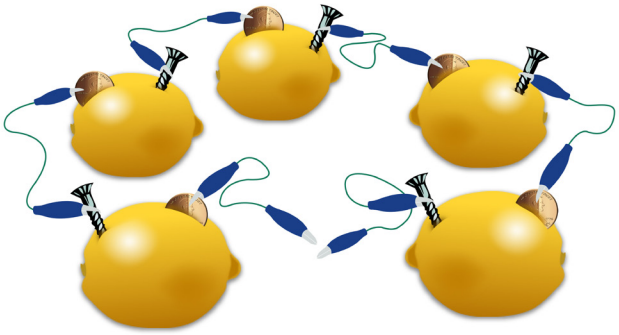


Station 5: How to Make a Lemon Battery (continued)

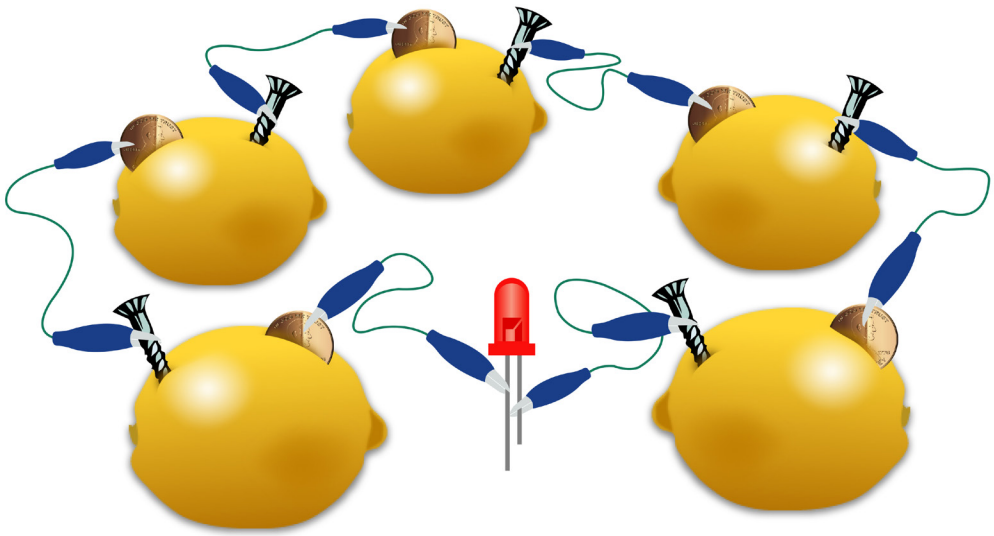
6. Now using the alligator clip wire, connect the screw in one lemon to the penny in the next lemon. Use four alligator clip wires to connect the five lemons. Arrange the lemons in a circle as shown.



7. Attached the additional two alligator clip wires to the penny in the first lemon and the galvanized screw in last lemon.



8. The LED has two legs that are slightly different lengths. With the free wire that is attached to the penny, fix the clip to the slightly longer leg of the LED. Connect the free wire from last lemon to the other leg of the LED. If the light does not come on, check all your connections (alligator clips) or try a different LED.



Sentence Frames for Analyzing Our Data

Station 1

The system we observed was _____. It had these parts _____.
They worked together to _____.

I observed that the rice/beans _____ when the speaker _____.
This means that the _____ caused the _____ to _____.

I agree/disagree because I noticed _____.

I think the source of energy for Station 1 was _____ because _____.

I agree/disagree because I noticed _____.

I think the energy stayed the same/changed because I noticed _____.

I agree/disagree because I noticed _____.

Our observations are evidence that energy transformed from _____ to _____ as it moved from _____ to _____.

OR

Our observations do not support the idea that energy can be transformed because _____.

Appendix 4.4

Energy Transformation

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
4-PS3-2	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electrical currents. [*Assessment Boundary: Assessment does not include quantitative measurements of energy.*]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Planning and Carrying Out Investigations
• Make observations ~~and/or measurements~~ to produce data to serve as the basis for evidence for an explanation of a phenomenon ~~or test a design solution~~.
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.
Engaging in Argument from Evidence
• Compare and refine arguments based on an evaluation of the evidence presented. • Construct and/or support an argument with evidence, data, ~~and/or a model~~.
Obtaining, Evaluating, and Communicating Information
• Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.
Analyzing and Interpreting Data
• Analyze and interpret data to make sense of phenomena, using logical reasoning, ~~mathematics, and or/computation~~. • Compare and contrast data collected by different groups to discuss similarities and differences in their findings.

Appendix 4.4

DISCIPLINARY CORE IDEAS (DCI)
PS3.B: Conservation of Energy and Energy Transfer
• 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.~~
• Energy can also be transferred from place to place by electrical currents which can then be used to locally produce motion, sound, heat, or light.

CROSSCUTTING CONCEPTS (CCC)
Energy and Matter
• Energy can be transferred in various ways and between objects.
Systems and System Models
• A system can be described in terms of its components and their interactions.
Cause and Effect
• Cause and effect relationships are routinely identified, tested, and used to explain change.

Common Core State Standards (CCSS)

CCSS ELA WRITING
CCSS.ELA-LITERACY.W.4.7
Conduct short research projects that build knowledge through investigation of different aspects of a topic.

Appendix 4.4

California English Language Development (ELD) Standards

CA ELD		
Part 1.4.5 Listening actively to spoken English in a range of social and academic contexts		
EMERGING	**EXPANDING**	**BRIDGING**
Demonstrate active listening of read-alouds and oral presentations by asking and answering basic questions with prompting and substantial support.	Demonstrate active listening of read-alouds and oral presentations by asking and answering detailed questions with occasional prompting and moderate support.	Demonstrate active listening of read-alouds and oral presentations by asking and answering detailed questions with minimal prompting and light support.
In addition to the standard above, you may find that you touch on the following standard as well: **P1.4.1** Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics		