Harnessing Human Energy
# Table of Contents

Safety Guidelines for Science Investigations ................................................................. 1

*Harnessing Human Energy* Unit Overview ................................................................. 3

**Chapter 1: What Is Energy?**

Chapter Overview ........................................................................................................... 4

**Lesson 1.1: Welcome to the Energy Research Lab** .................................................... 5
What Has Energy? ........................................................................................................... 6
Using a Simulation to Make the Light Shine ................................................................. 7
Homework: Reflecting on Energy .................................................................................. 8

**Lesson 1.2: Investigating Energy Claims** ................................................................ 9
Warm-Up ....................................................................................................................... 10
Investigating Energy Systems ....................................................................................... 11–12
Homework: Do These Objects Have Energy? ............................................................... 13–14

**Lesson 1.3: Identifying Kinetic Energy and Potential Energy** .................................. 15
Warm-Up ....................................................................................................................... 16
Evidence of Energy ........................................................................................................ 17
Kinetic Energy and Potential Energy Demonstration .................................................... 18
Reflection ....................................................................................................................... 19
Homework: Energy and the Rescue Team .................................................................... 20

**Lesson 1.4: “Energy Inventions”** .......................................................................... 21
Warm-Up ....................................................................................................................... 22
Introducing Active Reading .......................................................................................... 23
Reading “Energy Inventions” ....................................................................................... 24

**Chapter 2: The Rescue Team’s Energy Needs**

Chapter Summary .......................................................................................................... 25

**Lesson 2.1: Investigating Claims About How Objects Get Energy** ......................... 26
Warm-Up ....................................................................................................................... 27
Investigating How Objects Get Energy .......................................................................... 28–29
Homework: Where Does Energy Come From? ............................................................ 30

**Lesson 2.2: Evaluating Energy Sources** ................................................................. 31
Warm-Up ....................................................................................................................... 32
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Read of “Energy Inventions”</td>
<td>33</td>
</tr>
<tr>
<td>Evaluating Energy Sources</td>
<td>34</td>
</tr>
<tr>
<td>Homework: Practice with Energy Transfer Diagrams</td>
<td>35–36</td>
</tr>
<tr>
<td>Homework: “How We Store Energy”</td>
<td>37</td>
</tr>
<tr>
<td><strong>Lesson 2.3: Writing Scientific Explanations</strong></td>
<td>38</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>39</td>
</tr>
<tr>
<td>Word Relationships</td>
<td>40</td>
</tr>
<tr>
<td>Writing a Scientific Explanation for the Rescue Team</td>
<td>41–42</td>
</tr>
<tr>
<td>Homework: Reading About Hand-Crank Flashlights</td>
<td>43</td>
</tr>
<tr>
<td><strong>Chapter 3: Designing an Energy Solution</strong></td>
<td>44</td>
</tr>
<tr>
<td>Chapter Summary</td>
<td>45</td>
</tr>
<tr>
<td><strong>Lesson 3.1: Reading About Energy Systems</strong></td>
<td>46</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>47</td>
</tr>
<tr>
<td>Active Reading: Capturing Human Energy</td>
<td>48</td>
</tr>
<tr>
<td>Discussing Energy Systems</td>
<td>49</td>
</tr>
<tr>
<td>Brainstorming Designs for an Energy System</td>
<td>50</td>
</tr>
<tr>
<td><strong>Lesson 3.2: Designing and Explaining Energy Systems</strong></td>
<td>51</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>52</td>
</tr>
<tr>
<td>Designing Energy Systems</td>
<td>53</td>
</tr>
<tr>
<td>Energy System Sketch</td>
<td>54</td>
</tr>
<tr>
<td>Energy Transfer Diagram</td>
<td>55–56</td>
</tr>
<tr>
<td>Homework: Report for the Rescue Team</td>
<td>57</td>
</tr>
<tr>
<td><strong>Lesson 3.3: Evaluating an Energy Solution</strong></td>
<td>58</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>59</td>
</tr>
<tr>
<td>Evaluating Ed-You-Swivel Evidence</td>
<td>60–61</td>
</tr>
<tr>
<td>Preparing to Write an Argument</td>
<td>62</td>
</tr>
<tr>
<td>Homework: Writing an Argument for the School Principal</td>
<td>63</td>
</tr>
</tbody>
</table>

**Harnessing Human Energy**

**Glossary**
Safety Guidelines for Science Investigations

1. **Follow instructions.** Listen carefully to your teacher’s instructions. Ask questions if you don’t know what to do.

2. **Don’t taste things.** No tasting anything or putting it near your mouth unless your teacher says it is safe to do so.

3. **Smell substances like a chemist.** When you smell a substance, don’t put your nose near it. Instead, gently move the air from above the substance to your nose. This is how chemists smell substances.

4. **Protect your eyes.** Wear safety goggles if something wet could splash into your eyes, if powder or dust might get in your eyes, or if something sharp could fly into your eyes.

5. **Protect your hands.** Wear gloves if you are working with materials or chemicals that could irritate your skin.

6. **Keep your hands away from your face.** Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.

7. **Tell your teacher if you have allergies.** This will keep you safe and comfortable during science class.

8. **Be calm and careful.** Move carefully and slowly around the classroom. Save your outdoor behavior for recess.

9. **Report all spills, accidents, and injuries to your teacher.** Tell your teacher if something spills, if there is an accident, or if someone gets injured.

10. **Avoid anything that could cause a burn.** Allow your teacher to work with hot water or hot equipment.

11. **Wash your hands after class.** Make sure to wash your hands thoroughly with soap and water after handling plants, animals, or science materials.
Harnessing Human Energy

Unit Overview

How is it possible to charge electrical devices when the power is out? This is the question that you and your classmates will investigate in your role as student energy scientists. Your challenge is to design a way for rescue workers to get energy to their electrical devices (flashlights, cell phones, and radios), even when they are on rescue missions, far from electrical outlets. To do this, you’ll need to learn about possible sources of energy, including energy stored in the bodies of the rescue workers, and figure out a way to capture that human energy. Scientists and engineers have been inventing new ways to solve everyday energy problems; now you and your classmates will have the opportunity to contribute your own valuable ideas.
Welcome to the Energy Research Lab! As a student energy scientist, you will learn about what energy is and how you know whether an object has energy. Answering these questions will help you understand why energy matters to a rescue team.
Welcome to your role as a student energy scientist at the Energy Research Lab. A rescue team needs your help: the team needs to use small electrical devices, such as flashlights, on rescue missions, but these devices often run out of energy. The rescue team needs to find a way to get energy to their flashlights and other devices even when the power is out. Today you will explore what energy is, and you will use a digital simulation to find ways to make a light shine. This will help you begin to solve the rescue team’s problem.

Unit Question
• How is it possible to charge electrical devices when the power is out?

Chapter 1 Question
• What is energy and why does it matter to the rescue team?

Vocabulary
• energy
• system

Digital Tools
• Harnessing Human Energy Sorting Tool activity: What Has Energy?
• Harnessing Human Energy Simulation
What Has Energy?


2. When you have finished sorting the objects, press HAND IN. If you worked with a partner, write his or her name here: ________________________________________________________________________

Goal: Decide whether each object does or does not have energy.

Do:
• Drag objects that you think have energy to the Things That Have Energy bin.
• Drag objects that you think do not have energy to the Things That Don’t Have Energy bin.
• Leave objects you are not sure about in the toolbar.

Tips:
• Make sure to read the object descriptions.
• Scroll down on the toolbar to make sure you see all of the objects.
• You can overlap objects if you need to.
• Remember to press HAND IN when you are done.
Using a Simulation to Make the Light Shine

Part 1
Explore the Harnessing Human Energy Simulation.

• What can you do in the Sim? What do you observe?
• Share what you notice with a partner.
• Later, your teacher will give you a mission to accomplish in the Sim.

Part 2
1. Return to the Simulation and build a system that makes a light shine.
2. After you build a system that makes a light shine, discuss the question below with your partner, and then record your thinking.

Based on your ideas about energy, where do you see examples of energy in the system you built?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

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Homework: Reflecting on Energy

1. Do you think a moving skateboard has energy? Why or why not?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

2. Do you think people used energy before modern times? Why or why not?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

3. How well do you think you understand energy? Use the scale below to rate how well you understand energy (check one).

☐ 1: I don’t understand energy at all.
☐ 2: I know just a little about energy.
☐ 3: I know a fair amount about energy, but there is a lot I don’t know.
☐ 4: I know a lot about energy.
☐ 5: I understand everything there is to know about energy!
Lesson 1.2: Investigating Energy Claims

Today you will learn how to tell if an object has energy. To do this, you will build systems that make a fan spin, and you’ll think carefully about whether the systems have energy. You will also learn how scientists make arguments, and you’ll use the evidence you gathered about energy in systems to support a claim just as a scientist would.

Unit Question
• How is it possible to charge electrical devices when the power is out?

Chapter 1 Question
• What is energy and why does it matter to the rescue team?

Vocabulary
• claim
• energy
• evidence
• reasoning
• scientific argument
• system

Digital Tools
• Harnessing Human Energy Sorting Tool activity: What Has Energy?
Warm-Up

Dear student energy scientists,

People use the word energy to mean a lot of different things. In an everyday sense, energy can mean excitement or having what it takes to run a marathon. In a scientific sense, energy has a specific meaning:

**Energy is the ability to make things move or change.**

Please use this scientific definition of energy to revise your thinking about what has energy.

Sincerely,
Morgan Lewis
Lead Energy Scientist, Energy Research Lab

1. Return to the Sorting Tool activity: What Has Energy? from the previous lesson and revise your work.

2. When you have finished sorting the objects, press HAND IN. If you worked with a partner, write his or her name here: ____________________________________________

3. In the space below, explain what you revised, or why you kept it the same.
   _______________________________________________________________
   _______________________________________________________________
   _______________________________________________________________
   _______________________________________________________________
   _______________________________________________________________
   _______________________________________________________________
Part 1: Do All of the Systems Have Energy?

- Use the materials to build each system with your group.
- After you build each system, use the Reasoning Tool on the next page to record evidence about whether or not each system has energy.
- Remember that energy is the ability to make things move or change.
Part 2: Reasoning Tool

Possible subclaims:

- The Battery System does have energy.
  or
  The Battery System does not have energy.

- The Hand Crank Generator System does have energy.
  or
  The Hand Crank Generator System does not have energy.

- The Solar Cell System does have energy.
  or
  The Solar Cell System does not have energy.

<table>
<thead>
<tr>
<th>Evidence (observations about whether the system does or does not have energy)</th>
<th>This matters because . . . (How does this evidence support the subclaim?)</th>
<th>Therefore, . . . (subclaim)</th>
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Homework: Do These Objects Have Energy?

• Use what you have learned so far about energy to decide whether each of the objects listed below has energy or not.

• Explain your evidence for why you think each object does or doesn’t have energy.

1. Food (check one)
   🔢 has energy
   🔳 does not have energy

What is your evidence for why you think food has energy or does not have energy?
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

2. Soccer ball flying through the air (check one)
   🔢 has energy
   🔳 does not have energy

What is your evidence for why you think this object has energy or does not have energy?
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
Homework: Do These Objects Have Energy? (continued)

3. Soccer ball not moving (check one)
   □ has energy
   □ does not have energy

What is your evidence for why you think this object has energy or does not have energy?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

4. Fan spinning (check one)
   □ has energy
   □ does not have energy

What is your evidence for why you think this object has energy or does not have energy?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

5. Fan not spinning (check one)
   □ has energy
   □ does not have energy

What is your evidence for why you think this object has energy or does not have energy?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
Lesson 1.3: Identifying Kinetic Energy and Potential Energy

Welcome back to the Energy Research Lab! In today’s lesson, you will continue your research on energy, focusing on how to recognize when things have energy. You will learn about different types of energy today—first through the use of the Sorting Tool, and then through a demonstration by your teacher.

Unit Question

• How is it possible to charge electrical devices when the power is out?

Chapter 1 Question

• What is energy and why does it matter to the rescue team?

Key Concept

• Whenever something moves or changes, it is because of energy.

Vocabulary

• energy
• evidence
• kinetic energy
• potential energy

Digital Tools

• Harnessing Human Energy Sorting Tool activity: Evidence of Energy
Warm-Up

The lead energy scientist has forwarded you an email from an Energy Research Lab client. Read the email and decide how you would respond to the client.

Dear student energy scientists,

Now that you have been learning about energy, I would like your help responding to some questions we receive here at the Energy Research Lab. Please see the email I’ve included below.

Sincerely,
Morgan Lewis
Lead Energy Scientist, Energy Research Lab

Email from client:
Dear Energy Research Lab,
My friend drives around in her electric car, and she has to charge the car’s batteries every night. However, I never need to plug in my bike! Therefore, I think I can get from place to place without using energy at all.
What do you think? Is riding a bike a way to travel that doesn’t use energy?

Sincerely,
Sasha (Energy Research Lab client)

1. Which of the following statements would you include in your response to the client? (check one)
   - Riding a bike doesn’t use energy.
   - Riding a bike does use energy.
   - I’m not sure if riding a bike uses energy or not.

2. Explain the statement you selected in the space below.

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
Evidence of Energy

1. Launch the Sorting Tool activity: Evidence of Energy and follow the instructions below. Talk to a partner about your ideas as you work.

2. When you have finished sorting the objects, press HAND IN. If you worked with a partner, write his or her name here: _____________________________________________

Goal: Look at each object and decide whether you can see evidence of energy.

Do:
• Think about the definition of energy as you look at each object. Do you see evidence of energy?
• If you can’t see evidence of energy, drag the object to the bin on the left.
• If you can see evidence of energy, drag the object to the bin on the right.
• Leave objects you are not sure about in the toolbar.

Tips:
• Scroll down on the toolbar to make sure you see all of the objects.
• Remember that energy is the ability to make things move or change.
Kinetic Energy and Potential Energy Demonstration

Before your teacher begins the demonstration, answer the following questions by selecting the option that best completes each sentence.

1. A wind-up toy that is not wound up... (check one)
   □ does not have energy.
   □ has kinetic energy.
   □ has potential energy.
   □ has both kinetic and potential energy.

2. A wind-up toy that is wound up but not moving... (check one)
   □ does not have energy.
   □ has kinetic energy.
   □ has potential energy.
   □ has both kinetic and potential energy.

3. A wind-up toy that is wound up and moving... (check one)
   □ does not have energy.
   □ has kinetic energy.
   □ has potential energy.
   □ has both kinetic and potential energy.
Reflection

How do you know whether an object has potential energy?

- Circle one object from the choices below that you think has potential energy.
- Explain why you think the object you selected has potential energy.

<table>
<thead>
<tr>
<th>skateboard at top of ramp</th>
<th>charged battery</th>
<th>food</th>
<th>stretched bow and arrow</th>
</tr>
</thead>
</table>

Why do you think this object has potential energy?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
Homework: Energy and the Rescue Team

You have been investigating why energy matters to the rescue team, and now you’ve learned about two different categories of energy.

1. What is one way that kinetic energy might be involved in rescue team missions?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

2. What is one way that potential energy might be involved in rescue team missions?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
Lesson 1.4: “Energy Inventions”

Scientists around the world are working to solve the world’s energy problems in creative ways. Some of these solutions were designed by people not much older than you. Today you’ll read an article about some of these energy inventions and the scientists who designed them. You will practice reading like a scientist: carefully and actively, making sure that you understand the text and images. You will record your questions and ideas as you read, and you’ll have a chance to discuss your thoughts about the article with others.

Unit Question
• How is it possible to charge electrical devices when the power is out?

Chapter 1 Question
• What is energy and why does it matter to the rescue team?

Key Concepts
• Whenever something moves or changes, it is because of energy.
• When something is moving, it has kinetic energy.
• When something has the ability to make things move or change in the future, it has potential energy, even if it is not moving or changing now.

Vocabulary
• energy
• kinetic energy
• potential energy

Digital Tools
• *Harnessing Human Energy* Sorting Tool activity: Kinetic or Potential Energy?
Warm-Up

1. Launch the Sorting Tool activity: Kinetic or Potential Energy? and follow the instructions below.
2. When you have finished sorting the objects, press HAND IN. If you worked with a partner, write his or her name here: _____________________________________________

Goal: Decide whether each object has kinetic energy or potential energy.

Do:
• If you think an object has potential energy, drag it to the Potential Energy bin.
• If you think an object has kinetic energy, drag it to the Kinetic Energy bin.

Tips:
• Kinetic energy is the energy that an object has because it is moving.
• Potential energy is the energy that is stored in an object or system.
Introducing Active Reading

- What do you notice about this student’s annotations?
- How do you know that she was thinking carefully while reading and trying to understand the article?
Reading “Energy Inventions”

1. Read and annotate the article “Energy Inventions.”
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

As I read, I paid attention to my own understanding and recorded my thoughts and questions.

☐ Never
☐ Almost never
☐ Sometimes
☐ Frequently/often
☐ All the time

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.
Chapter 2: The Rescue Team’s Energy Needs
Chapter Summary

What do you do when your flashlight runs out of energy? What about when the power is out? In Chapter 2, you will investigate how objects get energy. This will help you learn how the rescue team can charge electrical devices, even when the power is out.
Lesson 2.1: Investigating Claims About How Objects Get Energy

The work you’ve done so far as a student energy scientist has helped you build an understanding of what energy is, and why it matters to the rescue team. You know that the rescue team needs energy to operate electrical devices, but how do devices and other objects get energy? Today you will gather evidence from the Simulation to help answer this question.

Unit Question
• How is it possible to charge electrical devices when the power is out?

Chapter 2 Question
• How can the rescue workers get energy to the batteries in their equipment during rescue missions?

Vocabulary
• energy
• evidence
• kinetic energy
• potential energy
• system
• transfer

Digital Tools
• Harnessing Human Energy Simulation
Warm-Up

Dear student energy scientists,

Rescue workers need to have working equipment, such as flashlights, at all times. But they can’t always just charge their equipment by plugging it in. As student energy scientists, your assignment is to make sure the rescue team’s equipment works in any emergency situation. To prepare to help the rescue team, reflect on these questions and record your ideas.

Sincerely,
Morgan Lewis
Lead Energy Scientist, Energy Research Lab

1. What types of emergency situations could rescue workers be in that would make it difficult for them to get energy to their electrical devices?

_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________

2. What’s one idea you have about how rescue workers can get energy to their electrical devices in these situations?

_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
Investigating How Objects Get Energy

How do objects get energy?

• With your partner, decide which claim you will investigate in the Simulation, and select it below.
• Talk to your partner about how you plan to get evidence for or against your claim in the Simulation.
• Use the Reasoning Tool below to record your evidence and explain how the evidence supports or goes against the claim you selected.

The claim we are investigating is (check one)

☐ Claim 1: Objects can make their own energy.
☐ Claim 2: Objects get energy from other objects that have energy.
☐ Claim 3: Only living things have energy.

Reasoning Tool

<table>
<thead>
<tr>
<th>Evidence (observations from the Simulation)</th>
<th>This matters because . . . (How does this evidence support or go against the claim)</th>
<th>Therefore, . . . (the claim that the evidence supports or goes against) is/is not supported.</th>
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Investigating How Objects Get Energy (continued)

Describe the energy system you built in the Sim that provided evidence for or against your claim:

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
Homework: Where Does Energy Come From?

- Use the Simulation to build two different systems that can launch a ball.
- Describe each system you built.
- Answer the question about each system.

System 1 description:

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

In your first system, where did the ball get the energy that it needed in order to move?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

System 2 description:

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________

In your second system, where did the ball get the energy that it needed in order to move?

___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
Lesson 2.2: Evaluating Energy Sources

Does everything have energy? And where does it come from anyway? Today you will revisit the “Energy Inventions” article to get more evidence about how objects get energy. You will also learn about and discuss many different energy sources and decide which energy sources are the best and worst options for the rescue team.

Unit Question
• How is it possible to charge electrical devices when the power is out?

Chapter 2 Question
• How can the rescue workers get energy to the batteries in their equipment during rescue missions?

Vocabulary
• convert
• energy
• kinetic energy
• potential energy
• system
• transfer

Digital Tools
• Harnessing Human Energy Sorting Tool activities: Energy from the Sun, Energy from Gasoline, and Energy from Food
• Harnessing Human Energy Simulation
Warm-Up

It’s important for energy scientists to be able to understand and describe how energy systems work. Look closely at the energy system below and answer the questions.

1. On the lines below, write where each object gets its energy from: the flywheel, the person turning the crank, the battery, or the generator.
   - The light gets its energy from the _______________________.
   - The battery gets its energy from the _______________________.
   - The generator gets its energy from the _______________________.
   - The flywheel gets its energy from the _______________________.

2. Someone needs to turn the crank to make the flywheel spin. Is this person creating energy? If not, where do you think the person’s energy comes from?
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
Reread the last two paragraphs of the “Energy Inventions” article and highlight evidence that supports or goes against the claims:

- **Claim 1**: Objects can make their own energy.
- **Claim 2**: Objects get energy from other objects that have energy.

Which claim do you think is most convincing based on the evidence you have gathered so far? (check one)

- [ ] Claim 1
- [ ] Claim 2
Evaluating Energy Sources

- Read each Energy Source Card carefully and discuss your questions and ideas about each energy source with your partner.
- Next, arrange the cards in order of best to worst energy source options for the rescue team. Place the cards in a line with the best option on the left and the worst option on the right.
- When you are finished sorting the cards on your desk, answer the questions below.

Energy Sources
- nuclear power plant
- wind turbine
- combustion engine
- human-powered generator
- hydroelectric power plant
- fuel-burning power plant
- solar cell

1. Which energy source did you rank as the best option for the rescue team?

2. Which energy source did you rank as the worst option for the rescue team?
Homework: Practice with Energy Transfer Diagrams

Energy from the Sun
1. Launch the Sorting Tool activity: Energy from the Sun, and follow the instructions below.
2. When you are finished, press HAND IN.
3. Optional: Build the system described below in the Simulation.

Goal: Make an Energy Transfer Diagram that shows how energy from the sun can be used to make a flashlight shine.

Do:
• Drag the battery and the sun shining on a solar cell to the correct bins.
• Add more objects and arrows to show how energy from the sun can be transferred and converted to make a flashlight shine.

Tips:
• You can change the direction of the arrow by selecting it and dragging the purple dot.

Energy from Gasoline
1. Launch the Sorting Tool activity: Energy from Gasoline, and follow the instructions below.
2. When you are finished, press HAND IN.
3. Optional: Build the system described below in the Simulation.

Goal: Make an Energy Transfer Diagram that shows how energy from gasoline can be used to make a flashlight shine.

Do:
• Drag the battery and gasoline to the correct bins.
• Add more objects and arrows to show how energy from gasoline can be transferred and converted to make a flashlight shine.

Tips:
• You can change the direction of the arrow by selecting it and dragging the purple dot.
Homework: Practice with Energy Transfer Diagrams (continued)

Energy from Food
1. Launch the Sorting Tool activity: Energy from Food, and follow the instructions below.
2. When you are finished, press HAND IN.
3. Optional: Build the system described below in the Simulation.

Goal: Make an Energy Transfer Diagram that shows how energy from food can be used to make a flashlight shine.

Do:
  • Drag the battery and food to the correct bins.
  • Add more objects and arrows to show how energy from food can be transferred and converted to make a flashlight shine.

Tips:
  • You can change the direction of the arrow by selecting it and dragging the purple dot.
Homework: “How We Store Energy”

In this lesson, you evaluated different energy sources, including renewable energy sources such as solar and wind power. One of the big challenges humans face is how to store energy. To learn more about this challenge, read and annotate the “How We Store Energy” article. Then, answer the questions below.

1. How have batteries gotten better over time?

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2. Why is it important for scientists to find better ways to store solar and wind energy?

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________________________________________________________________________________________
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Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.

2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.

3. Examine all visual representations carefully. Consider how they go together with the text.

4. After you read, discuss what you have read with others to help you better understand the text.
Lesson 2.3: Writing Scientific Explanations

The lead energy scientist at the Energy Research Lab is eagerly awaiting your response on how you can solve the rescue team’s energy problem. Today you will decide on the best energy source for the rescue team. Once this decision is made, you will work with some of your fellow student energy scientists to develop a detailed explanation of how the rescue workers can use this energy source to get energy to the batteries in their flashlights during rescue missions.

Unit Question
• How is it possible to charge electrical devices when the power is out?

Chapter 2 Question
• How can the rescue workers get energy to the batteries in their equipment during rescue missions?

Vocabulary
• convert
• energy
• generator
• kinetic energy
• potential energy
• system
• transfer

Key Concepts
• Nothing creates energy. If something has energy, the energy must have been transferred from something else.

• Energy can be transferred from one object to another, and energy can be converted from one type to another.

Digital Tools
• Harnessing Human Energy Sorting Tool activity: Energy Transfer Diagram
One of the rescue workers has a special flashlight; it has a crank, and the light shines when the crank is turned. Since the rescue worker has never had to replace the batteries or plug in the flashlight, she thinks this flashlight works without an energy source.
Do you agree or disagree?

☐ I think the flashlight does work without an energy source.

☐ I think the flashlight does not work without an energy source.

I think this because . . .
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___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
___________________________________________________________________________________________
Word Relationships

1. With a partner, use the words on the Word Relationships Cards to create sentences that answer the Chapter 2 Question: How can the rescue workers get energy to the batteries in their equipment during rescue missions?

2. Use at least two words from the Word Relationships Cards in each sentence. You don’t have to use all the words.

3. There are many different ways to answer the Chapter 2 Question, so try to create as many sentences as you can. You can also use multiple sentences to express your ideas.

4. When you have created your sentences, join another pair of students and share your responses.

Word Bank

<table>
<thead>
<tr>
<th>energy</th>
<th>convert</th>
<th>transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>potential energy</td>
<td>kinetic energy</td>
<td></td>
</tr>
</tbody>
</table>
Part 1

Chapter 2 Question: How can the rescue workers get energy to the batteries in their equipment during rescue missions?

Dear student energy scientists,

The rescue workers are very interested in solar cells, wind turbines, combustion engines, and human-powered generators as possible ways to get energy to their batteries. Please write a report for the rescue workers with a recommendation of an energy source they can use that will help ensure that they never run out of energy in emergency situations. Make sure the rescue workers understand how they can use this source to get energy to the batteries in their flashlights during rescue missions.

Sincerely,
Morgan Lewis
Lead Energy Scientist, Energy Research Lab

1. Which energy source do you think is the best choice for the rescue team? (check one)
   - [ ] sun (solar cell)
   - [ ] wind (wind turbine)
   - [ ] fuel (combustion engine)
   - [ ] human-powered generator

2. Why do you think this is the best choice for the rescue team?

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___________________________________________________________________________________________
___________________________________________________________________________________________
Writing a Scientific Explanation for the Rescue Team (continued)

Part 2

1. Launch the Sorting Tool activity: Energy Transfer Diagram to show how the energy source you chose could be used to make a flashlight shine.

2. When you have finished, press HAND IN. If you worked with a partner, write his or her name here:

_________________________________________________________________________________________

3. Write an explanation of how the rescue workers can use the energy source you chose to get energy to their equipment.

Goal: Make an Energy Transfer Diagram that shows how the energy source you chose could be used to make a flashlight shine.

Do:

• Drag the flashlight and the energy source you chose to the correct bins.
• Add more objects and arrows to show how energy from the energy source can be transferred and converted to make a flashlight shine.

Tips:

• You can change the direction of the arrow by selecting it and dragging the purple dot.

Word Bank

<table>
<thead>
<tr>
<th>energy</th>
<th>convert</th>
<th>transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>potential energy</td>
<td>kinetic energy</td>
<td></td>
</tr>
</tbody>
</table>

How can the rescue workers use the energy source you chose to get energy to their equipment?

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Dear student energy scientists,

To help you design a system that solves the rescue team’s problem, I would like you to learn about some human-powered devices that already exist. I hope learning about these devices will give you ideas that will help you design an original solution to the rescue team’s problem.

Sincerely,
Morgan Lewis
Lead Energy Scientist, Energy Research Lab

1. Read and annotate the “Hand-Crank Flashlight” article. The first time you read, record your questions and connections.

2. Reread the “Hand-Crank Flashlight” article. While reading the article a second time, make highlights and add annotations that help you answer the question: How does the hand-crank get energy to a battery?
Chapter 3: Designing an Energy Solution
Chapter Summary

All over the world, energy scientists and engineers are inventing ways to capture energy from the human body’s motion to charge electrical devices. In Chapter 3, you will learn about some of these inventions, and you will design a system that captures energy from rescue workers’ motion to charge the batteries in their electrical devices.
Lesson 3.1: Reading About Energy Systems

Based on your research and the research of other student energy scientists, the rescue workers have decided that they would like to use kinetic energy from their bodies to power their flashlights. Your task is to design a system that allows them to do this. Before you begin to design your energy system, you will learn about some interesting systems that capture energy from the body's motion.

Unit Question
• How is it possible to charge electrical devices when the power is out?

Chapter 3 Question
• What is the best way for the rescue workers to capture energy from their bodies’ motion during rescue missions?

Key Concepts
• Whenever something moves or changes, it is because of energy.
• When something is moving, it has kinetic energy.
• When something has the ability to make things move or change in the future, it has potential energy, even if it is not moving or changing now.
• Nothing creates energy. If something has energy, the energy must have been transferred from something else.
• Energy can be transferred from one object to another, and energy can be converted from one type to another.

Vocabulary
• convert
• energy
• kinetic energy
• potential energy
• system
• transfer
Warm-Up

You read about hand-crank flashlights. Do you think a hand-crank flashlight would be a good energy system for the rescue workers? Why or why not? You can review the “Hand-Crank Flashlight” article, if needed.

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Active Reading: Capturing Human Energy

Part 1: First Read
• Choose one of the articles from the Capturing Human Energy article set. Record the title of the article you selected here: __________________________________________________________
• Read and annotate the article, using your Active Reading strategies. You can refer to the Active Reading Guidelines below.

Part 2: Second Read
• Read the same Capturing Human Energy article again. Highlight information and add annotations that help answer these questions:
  • How does the system you read about transfer and convert energy to make a generator move?
  • Do you think this system would be a good solution for the rescue team? Why or why not?
• Be prepared to share what you learned with the members of your group.

Active Reading Guidelines
1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.
Discussing Energy Systems

- Group members should take turns to explain the energy system they read about.
  - How does the system transfer and convert energy to make a generator move?
  - Do you think this system would be a good solution for the rescue team? Why or why not?
- As each group member explains an energy system, record brief notes about that energy system in the table below.

<table>
<thead>
<tr>
<th>Energy system</th>
<th>How does this system make a generator move?</th>
<th>Would the system be a good solution for the rescue team? Why or why not?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand-crank flashlight</td>
<td>When a person turns the crank, the generator spins.</td>
<td>No, the rescue workers would need to stop what they are doing to turn the crank.</td>
</tr>
<tr>
<td>Energy-capturing backpack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy-capturing bike</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy-capturing rocking chair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy-capturing knee brace</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Brainstorming Designs for an Energy System

The rescue workers need a way to get energy to their equipment anytime and anywhere. **What is the best way for the rescue workers to capture energy from their bodies’ motion during rescue missions?**

Brainstorm some ideas for a system that captures energy from rescue workers’ motion. Make sure your energy system

- transfers energy from the body’s motion to a battery;
- is easy for the rescue team to use during rescue missions; and
- is original (your group’s own design).

Record your ideas for energy systems in the space below.

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Lesson 3.2: Designing and Explaining Energy Systems

What do you think is the best way for the rescue workers to capture energy from their bodies’ motion during rescue missions? Today you will work with your group to design an original energy system to accomplish this important job! You will document your energy system and use physical materials to make a model of your design so that the rescue team can understand how it works.

Unit Question
• How is it possible to charge electrical devices when the power is out?

Chapter 3 Question
• What is the best way for the rescue workers to capture energy from their bodies’ motion during rescue missions?

Key Concepts
• Whenever something moves or changes, it is because of energy.
• When something is moving, it has kinetic energy.
• When something has the ability to make things move or change in the future, it has potential energy, even if it is not moving or changing now.
• Nothing creates energy. If something has energy, the energy must have been transferred from something else.
• Energy can be transferred from one object to another, and energy can be converted from one type to another.

Vocabulary
• convert
• energy
• kinetic energy
• potential energy
• system
• transfer

Digital Tools
• Harnessing Human Energy Simulation
Warm-Up

Dear student energy scientists,

I would like you to read about one more system that captures human energy. This might give you more ideas for a system that could work for the rescue team.

Sincerely,
Morgan Lewis
Lead Energy Scientist, Energy Research Lab

How Energy-Harvesting Floor Tiles Work

Energy-harvesting floor tiles work by compressing a tiny amount when stepped on. A special generator converts this squeezing motion to electrical energy. With each footstep, one tile provides enough energy to power a standard lightbulb for just a fraction of a second.

Stepping on the energy-harvesting floor tiles makes the generator move...

...which charges the battery...

...which can power a light or other device.

How could the rescue workers use squeezing or compressing to get energy to their flashlights during rescue missions?

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Designing Energy Systems

Remember that the rescue workers need a way to easily get energy to their equipment anytime and anywhere. **What is the best way for the rescue workers to capture energy from their bodies' motion during rescue missions?**

1. Work with your group to design an original energy system for the rescue team. All group members should participate in designing the system.

2. Share ideas for energy systems. As a group, decide on one energy system to design.

3. Use the Energy System Sketch sheet on the next page to show what your system might look like.

4. Complete the Energy Transfer Diagram sheet on page 54 to show how your energy system captures energy from the body’s motion.

5. Use the provided materials to make a model of your energy system. Your system should include
   
   - a film canister or binder clip to represent a generator; and
   
   - a penny to represent a battery.
Energy System Sketch

In the space below, sketch your energy system. Add labels and captions that help explain how your energy system works. You can use the Word Bank to help you label your sketch. You do not need to use all of the words.

Word Bank

<table>
<thead>
<tr>
<th>potential energy</th>
<th>transfer</th>
<th>generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>kinetic energy</td>
<td>convert</td>
<td></td>
</tr>
</tbody>
</table>
Energy Transfer Diagram

Make an Energy Transfer Diagram, using labels and arrows, to show how your system captured energy from the rescue worker’s motion in order to power a flashlight.

Potential Energy

Kinetic Energy

Light Energy
Homework: Report for the Rescue Team

Your homework has two parts. First, write a report to the rescue workers about the energy system you designed for them. Then, read the message from the lead energy scientist about designing a new energy system to solve a different problem.

Part 1
Write a report to the rescue team explaining how your energy system works. Make sure to explain how your system captures energy from rescue workers’ bodies to power equipment during rescue missions. Try to use the words in the Word Bank below.

Word Bank

| kinetic energy | potential energy | transfer | convert | generator |

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Dear student energy scientists,

One of our clients is interested in ways to power lights and other small electronics using energy sources that are available in his environment. This client lives in a sunny, windy, dry environment. I’d like you to use the Simulation to design an energy system for this client and record your ideas below. I look forward to seeing what you come up with!

Sincerely,
Morgan Lewis
Lead Energy Scientist, Energy Research Lab

Part 2

1. Launch the Simulation and create an energy system that can meet the needs of the Energy Research Lab client.

2. In the space below, describe the parts of your energy system and explain how energy is transferred and converted in the system to power lights or small electronics.

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Lesson 3.3: Evaluating an Energy Solution

The Energy Research Lab was impressed with your energy system designs for the rescue team and would like your help with another client’s energy problem. A school principal is interested in saving money on her school’s energy costs by capturing energy from students’ physical activities while they are at school. She wants to know whether or not the Ed-You-Swivel chair, a new energy-harnessing product, is a good energy solution for her school. In this lesson, you will evaluate evidence about the Ed-You-Swivel to make a recommendation to the principal.

Unit Question
- How is it possible to charge electrical devices when the power is out?

Chapter 3 Question
- What is the best way for the rescue workers to capture energy from their bodies’ motion during rescue missions?

Key Concepts
- Whenever something moves or changes, it is because of energy.
- When something is moving, it has kinetic energy.
- When something has the ability to make things move or change in the future, it has potential energy, even if it is not moving or changing now.
- Nothing creates energy. If something has energy, the energy must have been transferred from something else.
- Energy can be transferred from one object to another, and energy can be converted from one type to another.

Vocabulary
- claim
- energy
- evidence
- kinetic energy
- potential energy
- reasoning
- transfer
Warm-Up

The Energy Research Lab has received a request from a new client. A school principal is interested in saving money on her school’s energy costs by capturing energy from students’ physical activities while they are at school. She has learned about the Ed-You-Swivel chair, a new energy-harnessing product, and wants to know whether it is a good energy solution for her school.

Read the Ed-You-Swivel brochure below. Use your Active Reading annotation strategies to record questions and connections as you read.

Ed-You-Energy

...helping schools save energy since 2013

About our company: At Ed-You-Energy, we are in the business of helping students generate electricity for their schools! We design state-of-the-art furniture and other equipment for schools like yours.

At first glance, you can see that our products are designed with comfort and quality in mind. What you can’t see is that each and every Ed-You-Energy product has a built-in electrical generator! These generators convert energy from students’ movements to electrical energy and store it in a battery. Schools can use these batteries to power computers, tablets, lights, and more. Think of how much energy YOUR school could save with Ed-You-Energy products!

About the Ed-You-Swivel: The Ed-You-Swivel chair is designed so that students can turn in any direction during class. Students can talk to their partners or look at a chalkboard behind them without wasting time dragging their desks across the floor. Every time students swivel their seats, their movements turn a generator. The generator converts kinetic energy to potential energy that is stored in a battery.
Evaluating Ed-You-Swivel Evidence

Part 1: Evaluating Evidence Based on Reliability of Source
Follow the steps below to evaluate the Ed-You-Swivel evidence with your partner.

1. Discuss each piece of evidence with your partner.
   • How reliable is the source of the evidence?
   • What makes you think that? You can use the sentence starter below to discuss the evidence.
     *I think this evidence source is very reliable / reliable / not reliable because . . .*

2. Place each evidence card on the Evidence Gradient based on how reliable you think the evidence source is. Make sure that each evidence card is positioned above cards with less reliable sources and below cards with more reliable sources.

Part 2: Deciding Which Claim the Evidence Supports

3. Place the two Claim Cards side by side at the top of your desk.

4. Discuss each piece of evidence with your partner and decide which claim it supports. Place the Evidence Card under that claim.

5. When you have finished sorting the evidence, select the claim below you think is best supported. Be ready to explain how the evidence supports this claim.

☐ Claim 1: The Ed-You-Swivel chairs will capture enough energy to power the school’s small electronics.

☐ Claim 2: The Ed-You-Swivel chairs will not capture enough energy to power the school’s small electronics.
Preparing to Write an Argument

Part 1
The Reasoning Tool will help you organize your evidence so you can write a clear and convincing argument for the principal. Select the evidence you want to include, and write it in the left-hand column of the table on page 61. Then, in the middle column, explain why this evidence matters. In the right-hand column, you can write the claim or you can explain in more detail what aspect of the claim is supported.

Evidence

- **Evidence Card A:** A commercial paid for by Ed-You-Energy says that the Ed-You-Swivel “creates” enough energy to power an entire school.

- **Evidence Card B:** Data from the electric company shows that the school uses about 15 million (15,000,000) joules of energy every hour.

- **Evidence Card C:** A magazine called *Future-Tech Today* published an article about the Ed-You-Swivel. The article said that after a few minutes of use, the product would be able to fully charge one tablet. *Future-Tech Today* also published an article about a car that “makes more energy than it uses.”

- **Evidence Card D:** Engineers at Product Testing Lab, Inc. found that the Ed-You-Swivel harnesses 4,000 joules in one day of typical use. It would take an Ed-You-Swivel 20 days to charge one tablet. Product Testing Lab, Inc. is a company used by many businesses, schools, and government agencies to make choices about what to buy.

- **Evidence Card E:** Your friend said that his dad uses the Ed-You-Swivel at work, and it captures enough energy to charge his cell phone.

- **Evidence Card F:** Someone who knows the owner of a company that sells basketballs that harness human energy says that the Ed-You-Swivel will not capture enough energy to charge a cell phone, even if it is used for an entire day.

- **Evidence Card G:** For hundreds of years, scientists have observed that energy cannot be created. If something has energy, the energy must have been transferred from something else.

- **Evidence Card H:** The Ed-You-Swivel developers state that the product can save schools money.
Part 2

Question: Can the Ed-You-Swivel chairs capture enough energy to power the school’s small electronics?

Select the claim the evidence supports:

- **Claim 1:** The Ed-You-Swivel chairs will capture enough energy to power the school’s small electronics.
- **Claim 2:** The Ed-You-Swivel chairs will not capture enough energy to power the school’s small electronics.

<table>
<thead>
<tr>
<th>Evidence</th>
<th>This matters because . . . (How does this evidence support the claim?)</th>
<th>Therefore, . . . (claim)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
Homework: Writing an Argument for the School Principal

Write an argument that explains to the school principal why you think the Ed-You-Swivel chairs will or will not help the school save money on energy costs. Try to include the following in your argument:

- your claim (The Ed-You-Swivel chairs will / will not capture enough energy to power the school’s small electronics.)
- an explanation of how the Ed-You-Swivel works
- evidence that supports your claim (Refer to the evidence and ideas you recorded in the Reasoning Tool.)
- vocabulary from the Word Bank

Word Bank

<table>
<thead>
<tr>
<th>kinetic energy</th>
<th>potential energy</th>
<th>transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>convert</td>
<td>evidence</td>
<td>harness</td>
</tr>
</tbody>
</table>

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**Harnessing Human Energy Glossary**

**claim:** a proposed answer to a question about the natural world

*afirmación:* una respuesta propuesta a una pregunta sobre el mundo natural

**convert:** to change from one type to another

*convertir:* cambiar de un tipo a otro

**energy:** the ability to make things move or change

*energía:* la capacidad de hacer que las cosas se muevan o cambien

**evidence:** information about the natural world that is used to support or go against (refute) a claim

*evidencia:* información sobre el mundo natural que se utiliza para respaldar o rechazar (refutar) una afirmación

**generator:** a machine that can convert kinetic energy into electrical energy

*generador:* una máquina que puede convertir energía cinética en energía eléctrica

**kinetic energy:** the energy that an object has because it is moving

*energía cinética:* la energía que tiene un objeto porque se está moviendo

**model:** an object, diagram, or computer program that helps us understand something by making it simpler or easier to see

*modelo:* un objeto, diagrama o programa de computadora que nos ayuda a entender algo haciéndolo más simple o fácil de ver

**potential energy:** the energy that is stored in an object or system

*energía potencial:* la energía que está almacenada en un objeto o sistema

**reasoning:** the process of making clear how your evidence supports your claim

*razonamiento:* el proceso de aclarar cómo tu evidencia respalda tu afirmación

**scientific argument:** a claim supported by evidence

*argumento científico:* una afirmación respaldada por evidencia

**system:** a set of interacting parts forming a complex whole

*sistema:* un conjunto de partes que interactúan formando un todo complejo

**transfer:** to move from one object to another or one place to another

*transferir:* mover de un objeto a otro o de un lugar a otro
Lawrence Hall of Science

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