Lesson 4.2
Investigating System Failure
Lesson Overview

Students reread one article from Blackout! and then work in small groups to synthesize ideas about the role of parts in the failure of systems. Next, through a teacher-led demonstration, students are introduced to the last part of the electrical system: the electrical grid, or the series of wires that connect the electrical system. Students revisit the Electrical System diagram and trace the pathway of energy transfer from source to electrical device through the system. The class then reviews three pieces of evidence from Ergstown in preparation for further discussion in the following lesson. The purpose of this lesson is for students to visualize the energy transfer that takes place in electrical systems and to begin thinking about what might cause the system to stop transferring energy.

**Anchor Phenomenon:** Ergstown has frequent blackouts.

**Investigative Phenomenon:** Historical examples of real blackouts

**Students learn:**

- Wires can transfer electrical energy from place to place.
- The electrical grid is the wires that transfer electrical energy from many sources to many other places.
- The parts of a system need to interact correctly to make it work.
Synthesizing Ideas About System Failure

Pairs reread one assigned article in Blackout! and think about the source of system failure.

Instructional Guide

1. **Review the Investigation Question.** Point out the Investigation Question on the board, *Why might a system fail?*, and remind students that they are trying to answer this question. Have students briefly share ideas they have so far. Inform students that they will reread and discuss Blackout! in order to answer this question.

2. **Project notebook.** Have students turn to page 71, *Parts of the System That Failed: Blackout!*, in their notebooks. Read the directions and explain the activity.

3. **Distribute student books.** Provide one copy of Blackout! to each pair of students.

4. **Reread pages 6–7 in Blackout!** Have students follow along in their books as you reread “Runaway Truck Causes Huge Blackout.”

5. **Model completing notebook page 71.** Use information from the article to model how to record information about the article.

> According to what we read, which part of the electrical system failed?

- Drawing on student input, circle “wires/electrical grid.” Invite students to supply how they knew this from the text. [We read that the truck’s brakes failed and the utility poles and power lines were knocked over by the runaway truck; the photo on page 6 shows a knocked-over utility pole.]

- Explain that students will reread one other article from the book and think about which part of the system failed.

6. **Assign each pair an article.** Instruct students to complete page 71 in the notebook after they have reread their assigned article.
7. Pairs reread an article and complete page 71.

8. Gather students’ attention. Explain that pairs will meet with another pair who read the same article in *Blackout!* Both pairs will discuss what caused the system to fail in the example they read about.

9. Explain what groups will discuss.

   First, you should discuss and agree upon which part of the system failed.

   - Explain that if two pairs happen to disagree about the cause of the blackout in their article, they should each share their evidence and refer back to the article to come to an agreement.

   After that, you will work with your group to synthesize what you read in *Blackout!* with other ideas you have learned in order to come to a new understanding of why a system might fail.

10. Project notebook. Have students turn to page 72, Synthesizing Information About System Failure, in the notebook. Read the instructions. Point out that every student should complete his or her own notebook page.

11. Students work in groups. Join pairs to form discussion groups. Have groups discuss their articles, synthesize information, complete notebook pages 71 and 72, and choose a representative who will share with the class.

12. Project the Electrical System diagram.

   We’ve been building this diagram to show the various parts of the electrical system and what their functions are. Let’s use this diagram as a reference now as we talk about the different causes of system failure you read about.

   - Use the image to help the representative from each group share her ideas. Ask each representative to identify which part of the system failed in the article that they read, and point to the part of the electrical system that failed on the Electrical System diagram.
We’ve talked about different causes of blackouts all over the world. Let’s synthesize what we’ve learned. If we look at the parts of the electrical system in our diagram, what part can cause a system failure?

[Any part of the electrical system can cause the system to fail.]

What this could mean about Ergstown’s blackout problem? What could be causing the blackouts?

[They could be caused by a failure in any part of the system.]

13. Reflect on system failure. Ask students to think about all that they have read and discussed about system failure.

Why do systems fail?

[Because parts of systems stop functioning properly.]

What needs to be in place in order for a system to work?

[All of the parts need to be working correctly.]

14. Post the key concept and link it to prior learning.

- Post the new key concept (The parts of a system need to interact correctly to make it work.) next to the key concept from Lesson 1.3 (A system is a collection of interacting parts that work together. Each part in the system plays a role to perform an overall function.).

- Then have a student read the combined concept to the class. (A system is a collection of interacting parts that work together. Each part in the system plays a role to perform an overall function. The parts of a system need to interact correctly to make it work.)

Teacher Support

Background

Science Practices: Synthesizing Information
Scientists frequently synthesize information from a variety of sources. For instance, in a meta-analysis of data, scientists synthesize evidence from several studies to inform claims that can be supported by a large number of data. In this lesson, students synthesize evidence from several sources such as texts, investigations, and simulations to understand more about systems and how they might fail if one or more of the parts does not work. As students have had several opportunities to practice synthesizing up to this point, they do this independently in this lesson.
Instructional Suggestion

Supporting Discussions: Class Discussion About System Failure
As each group shares which part of the system in their article failed, try to let students run the discussion as much as possible. You may wish to encourage students to follow up on each others’ ideas by using prompts such as the following:

- Do others agree or disagree with this group?
- Can anyone find evidence in the text to support this idea? Where?
- Does anyone have a different idea?

Instructional Suggestion

Providing More Experience: Today’s Daily Written Reflection
Think of a system that includes these parts: the sun, a solar panel, wires, and a lamp. Describe two possible ways that you could make this system fail and explain why each failure would occur. This prompt (on page 70 in the Investigation Notebook) asks students to think about what they already know about system failures and to consider questions they currently have about why systems fail. Encouraging students to respond to this prompt can help them connect what they have already learned about the electrical grid to any lingering ideas or questions they still have. This can help you learn about students’ prior knowledge of system failures. It also serves as an anticipatory activity for rereading Blackout! in this lesson.

Possible Responses

Investigation Notebook
Parts of the System That Failed: Blackout! (page 71)

Article Headline:
Runaway Truck Causes Huge Blackout

The Electrical System
Wires/Electrical Grid circled

What evidence did you see or read about in the article that makes you think this?
The truck knocked over utility poles that held up wires from the electrical grid. The power lines went down, so they’d not transfer energy to people’s homes.
Idea: If power lines break or fall down, that can cause a blackout.
Page: 6

Idea: If too many people use air conditioners, there may not be enough energy in the electrical system.
Page: 9

Idea: Power plants can run out of coal.
Page: 11

Idea: Hydroelectric energy runs power plants—not enough water can cause blackouts.
Page: 14

New understanding: Systems can fail when one part doesn’t work or breaks.
Parts of the System That Failed: *Blackout!*

1. On the line below, record the title of the article you read in *Blackout!*
2. Based on that article, which part or parts of the system failed? Circle that part or parts in the Electrical System below.
3. Explain your response in the space provided below.

Article Headline:

___________________________________________________________________
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What evidence did you see or read about in the article that makes you think this?

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___________________________________________________________________
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___________________________________________________________________

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Synthesizing Ideas About System Failure

1. Read the question below. Talk about it with your group.
2. Record ideas from *Blackout!* and from other sources in the boxes below.
   If you use an idea from *Blackout!*, write the page number where you found that information.
3. Then, connect the ideas together to answer the question. Write your new understanding in the box below the arrow.

**Question:** How might a system fail?

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New understanding:
Synthesizing Ideas About System Failure

Pairs reread one assigned article in *Blackout!* and think about the source of system failure.

**Instructional Guide**

1. **Review the Investigation Question.** Point out the Investigation Question on the board, *Why might a system fail?*, and remind students that they are trying to answer this question. Have students briefly share ideas they have so far. Inform students that they will reread and discuss *Blackout!* in order to answer this question.

2. **Project notebook.** Have students turn to page 71, *Parts of the System That Failed: Blackout!*, in their notebooks. Read the directions and explain the activity.

3. **Distribute student books.** Provide one copy of *Blackout!* to each pair of students.

4. **Reread pages 6–7 in Blackout!** Have students follow along in their books as you reread “Runaway Truck Causes Huge Blackout.”

5. **Model completing notebook page 71.** Use information from the article to model how to record information about the article.

- De acuerdo con lo que leímos, ¿qué parte del sistema eléctrico falló?
  - Drawing on student input, circle “wires/electrical grid.” Invite students to supply how they knew this from the text. [We read that the truck’s brakes failed and the utility poles and power lines were knocked over by the runaway truck; the photo on page 6 shows a knocked-over utility pole.]
  - Explain that students will reread one other article from the book and think about which part of the system failed.

6. **Assign each pair an article.** Instruct students to complete page 71 in the notebook after they have reread their assigned article.
7. Pairs reread an article and complete page 71.

8. Gather students’ attention. Explain that pairs will meet with another pair who read the same article in Blackout! Both pairs will discuss what caused the system to fail in the example they read about.

9. Explain what groups will discuss.

10. Project notebook. Have students turn to page 72, Synthesizing Information About System Failure, in the notebook. Read the instructions. Point out that every student should complete his or her own notebook page.

11. Students work in groups. Join pairs to form discussion groups. Have groups discuss their articles, synthesize information, complete notebook pages 71 and 72, and choose a representative who will share with the class.

12. Project the Electrical System diagram.

Hemos estado construyendo este diagrama para mostrar las diversas partes del sistema eléctrico y cuáles son sus funciones. Usemos este diagrama como referencia ahora, mientras hablamos sobre las diferentes causas de falla del sistema sobre las que leyeron.
13. Reflect on system failure. Ask students to think about all that they have read and discussed about system failure.

- Use the image to help the representative from each group share her ideas. Ask each representative to identify which part of the system failed in the article that they read, and point to the part of the electrical system that failed on the Electrical System diagram.

Hemos hablado sobre diferentes causas de apagones por todo el mundo. Sinteticemos lo que hemos aprendido. Si observamos las partes del sistema eléctrico en nuestro diagrama, ¿qué parte puede causar una falla del sistema?

[Cualquier parte del sistema eléctrico puede causar que falle el sistema.]

¿Qué podría significar esto sobre el problema de apagones de Ergstown? ¿Qué podría estar causando los apagones?

[Podrían ser causados por una falla en cualquier parte del sistema.]

14. Post the key concept and link it to prior learning.

- Post the new key concept (The parts of a system need to interact correctly to make it work.) next to the key concept from Lesson 1.3 (A system is a collection of interacting parts that work together. Each part in the system plays a role to perform an overall function.).

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**Instructional Suggestion**

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As each group shares which part of the system in their article failed, try to let students run the discussion as much as possible. You may wish to encourage students to follow up on each others’ ideas by using prompts such as the following:

- Do others agree or disagree with this group?
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**Instructional Suggestion**

**Providing More Experience: Today’s Daily Written Reflection**

*Think of a system that includes these parts: the sun, a solar panel, wires, and a lamp. Describe two possible ways that you could make this system fail and explain why each failure would occur.* This prompt (on page 70 in the Investigation Notebook) asks students to think about what they already know about system failures and to consider questions they currently have about why systems fail. Encouraging students to respond to this prompt can help them connect what they have already learned about the electrical grid to any lingering ideas or questions they still have. This can help you learn about students’ prior knowledge of system failures. It also serves as an anticipatory activity for rereading *Blackout!* in this lesson.

**Possible Responses**

Investigation Notebook

Parts of the System That Failed: *Blackout!* (page 71)

Article Headline:

Runaway Truck Causes Huge Blackout

The Electrical System

Wires/Electrical Grid circled

What evidence did you see or read about in the article that makes you think this?

The truck knocked over utility poles that held up wires from the electrical grid. The power lines went down, so they’d not transfer energy to people’s homes.
Investigation Notebook
Synthesizing Ideas About System Failure (page 72)

Idea: If power lines break or fall down, that can cause a blackout.
Page: 6

Idea: If too many people use air conditioners, there may not be enough energy in the electrical system.
Page: 9

Idea: Power plants can run out of coal.
Page: 11

Idea: Hydroelectric energy runs power plants—not enough water can cause blackouts.
Page: 14

New understanding: Systems can fail when one part doesn’t work or breaks.
Partes del sistema que fallaron: ¡Apagón!

1. Sobre la línea siguiente, apunta el título del artículo que leíste en ¡Apagón!
2. Con base en ese artículo, ¿qué parte o partes del sistema fallaron? Encierra en un círculo esa parte o esas partes del sistema eléctrico debajo.
3. Explica tu respuesta en las líneas en blanco más debajo.

Título del artículo:

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El sistema eléctrico

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<tr>
<th>Parte: Fuentes</th>
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<th>Parte: Cables/Red eléctrica</th>
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<tr>
<td>Función: Proporcionar energía al sistema</td>
<td>Función: Convertir la energía de las fuentes en energía eléctrica</td>
<td>Función: Transferir energía eléctrica desde muchas fuentes hacia otros lugares</td>
<td>Función: Convertir la energía eléctrica en otras formas de energía</td>
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¿Qué evidencia viste o leíste en el artículo que te hace pensar esto?

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Conversiones de energía—Lección 4.2
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Sintetizar información acerca de las fallas del sistema

1. Lee la pregunta siguiente. Habla acerca de ello con tu grupo.

2. Apunta ideas de ¡Apagón! y de otras fuentes en los cuadros debajo. Si usas una idea de ¡Apagón!, escribe el número de la página donde encontraste esa información.

3. Luego conecta las ideas para responder la pregunta. Escribe algo nuevo que comprendes en el cuadro debajo de la flecha.

**Pregunta:** ¿Cómo podría fallar un sistema?

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Algo nuevo que comprendo: