Energy Conversions Coherence Flowchart

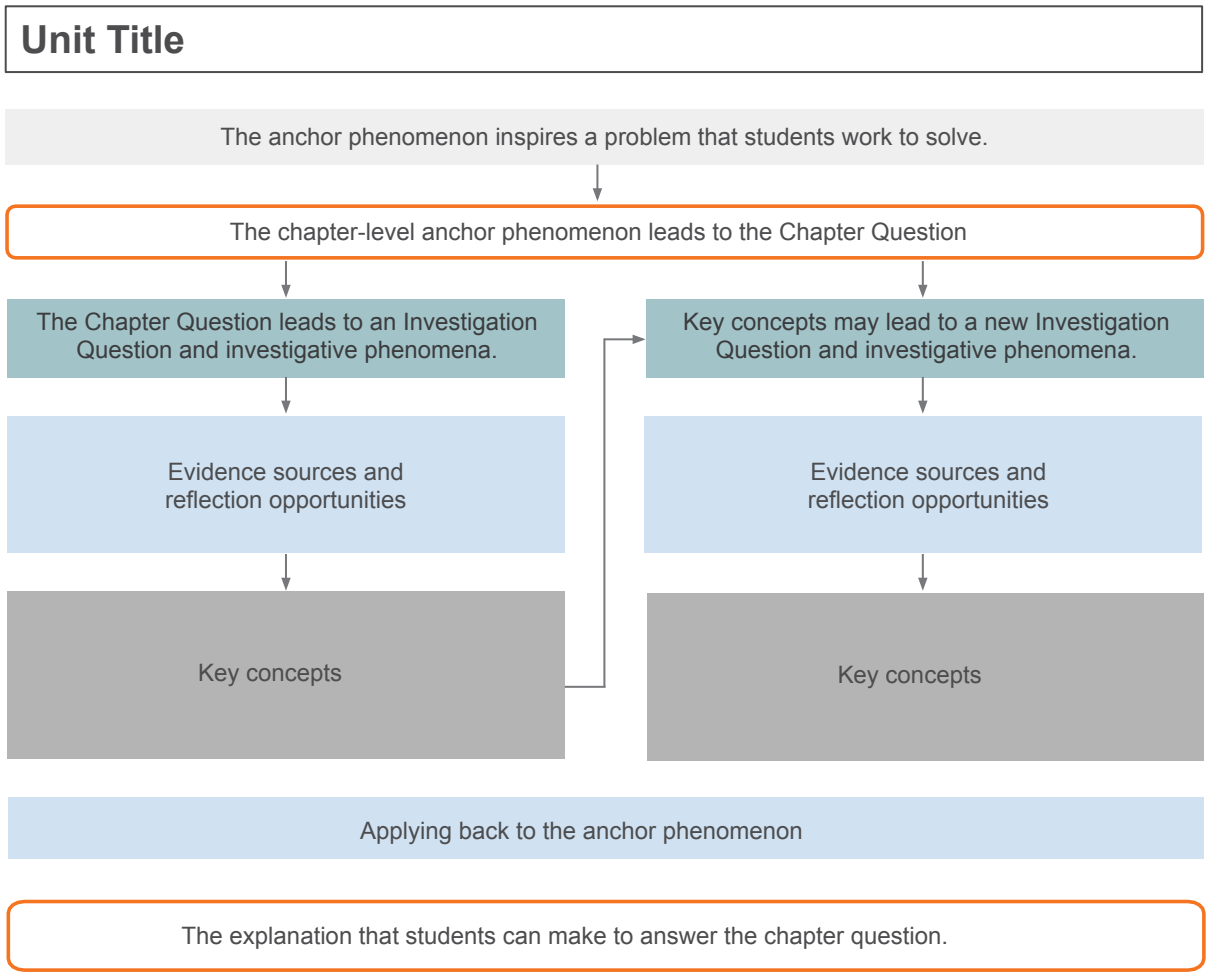
The storyline of the unit

In each Amplify Science unit, students figure out a phenomenon by asking questions, gathering evidence, and coming up with an explanation of how the phenomenon works. The Coherence Flowchart visually represents the storyline of the unit, showing the coherent flow of questions based on phenomena, evidence, and ideas that support students as they build complex explanations of the unit's anchor phenomenon. The Coherence Flowchart on the following pages (one chapter per page) can be used to see the connections between the phenomena and questions that drive students' experiences, the evidence they gather, the ideas they figure out, and the new questions that those ideas generate. The diagram to the right explains the structure of a chapter in the Coherence Flowchart.

In some units a design problem drives the investigations of the unit or of specific lessons. In these cases the design problem will be noted in place of the phenomenon.

Note: The Coherence Flowchart is a tool for teachers and is not meant to be distributed to students.

Typical structure of one chapter in a Coherence Flowchart



Instruction is framed by questions about the unit's anchor phenomenon and the related problem students are solving. Chapter Questions then guide students in figuring out the phenomenon, piece by piece. Within each chapter, investigative phenomena lead to Investigation Questions that focus students on a manageable piece of content that will help them figure out the Chapter Question. Each phenomenon leads to a question which motivates activities, and each activity provides specific evidence related to the Investigation Question. Students synthesize the understanding constructed over multiple activities, and this understanding is formalized through key concepts. Often a key concept leads students to an additional investigative phenomenon and Investigation Question students need to pursue to answer the Chapter Question. At the end of the chapter, students' new understanding is applied back to the unit's anchor phenomenon and leads students to a new Chapter Question or a final explanation.

AmplifyScience

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Energy Conversions: Blackout in Ergstown

Unit Anchor Phenomenon

Problem students work to solve

Ergstown has frequent blackouts.
Why does Ergstown keep having blackouts?

Chapter-level Anchor Phenomenon

Chapter 1 Question

There was a blackout in Ergstown.
What happened to the electrical system the night of the Ergstown blackout?

Investigation Questions

What is a system? (1.2, 1.3)
(Note: See Lesson Overviews for lesson-level Investigative Phenomena)

What can electrical energy in a system be used for? (1.4, 1.5)
(Note: See Lesson Overviews for lesson-level Investigative Phenomena)

Evidence sources and reflection opportunities

- Observe a simple system (1.2)
- Read *Systems* (1.2)
- Build a simple electrical system (1.3)
- Discuss parts and functions of a system (1.3)

- Find electrical energy in the Sim (1.4)
- Build simple electrical systems and observe various types of energy outputs (1.5)
- Read about forms of energy in *It's All Energy* (1.5)
- Write about ideas from the reading and hands-on investigation (1.5)

Key concepts

- A system is a collection of interacting parts that work together. Each part in the system plays a role to perform an overall system function. (1.3)

- Light, motion, sound, and thermal energy are all forms of energy. You can observe evidence of these different forms as outputs of electrical devices. (1.5)

Application of key concepts to the problem

- Observe and write about forms of energy in the Ergstown subway (1.6)

Explanation that students can make to answer the Chapter 1 Question

The devices stopped working in Ergstown because they weren't able to get electrical energy from the electrical system. When devices work, they output light, heat, motion, or sound. These are forms of energy. During the blackout, the devices weren't getting electrical energy.

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Chapter-level Anchor Phenomenon

Chapter 2 Question

During the blackout in Ergstown, all the lights and other electrical devices stopped working.
What makes the devices in Ergstown output energy or fail to output energy?

Investigation Questions

How do devices have so many different output energy forms when they are plugged into the same electrical system? (2.1, 2.2)
(Note: See Lesson Overviews for lesson-level Investigative Phenomena)

Why would electrical devices stop converting energy? (2.3, 2.4)
(Note: See Lesson Overviews for lesson-level Investigative Phenomena)

Evidence sources and reflection opportunities

- Read about energy converters in *It's All Energy* (2.1)
- Build electrical systems in the Sim (2.1)
- Use the sorting tool to identify input and output forms (2.2)
- Read *Energy Past and Present* (2.2)
- Write about ideas from the book and the hands-on investigation (2.2)

- Observe an electrical system with too many devices connected for the energy source to power (2.3)
- Observe a physical model of an electrical system (2.3)
- Test energy systems in the Sim (2.4)
- Gather evidence about LED lights from *It's All Energy* (2.4)

Key concepts

- Energy can change from one form to another form. One way energy can change is through an electrical device. (2.2)

- Devices will not have energy to function if they need more energy from the system than is put into the system. (2.3)
- Engineers argue for one solution over others based on how well it meets criteria. (2.4)

Application of key concepts to the problem

- Categorize different possible changes to Ergstown's electrical system 2.3)
- Discuss criteria and solutions for Ergstown (2.3)
- Write a design argument about the best solution for Ergstown (2.4)

Explanation that students can make to answer the Chapter 2 Question

Energy isn't created or destroyed. When devices get electrical energy, they can convert it into light, heat, motion, or sound because these are all forms of energy. When all the devices were running, they caused a blackout. The devices needed more energy from the electrical system than was available. Either the town was using too many devices, or the devices were not energy-efficient enough. If more energy is needed from the electrical system than is available, a blackout can occur.

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Unit Anchor Phenomenon

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Why does Ergstown keep having blackouts?

Chapter-level Anchor Phenomenon

Chapter 3 Question

The devices in Ergstown usually work when they are plugged into the electrical system.
Where does the electrical energy for the devices in Ergstown come from?

Investigation Questions

Where does energy come from? (3.1)
(Note: See Lesson Overviews for lesson-level Investigative Phenomena)

How does energy get from energy sources to the rest of the electrical system? (3.2, 3.3, 3.4)
(Note: See Lesson Overviews for lesson-level Investigative Phenomena)

Evidence sources and reflection opportunities

- Investigate energy sources in the Sim (3.1)
- Read about energy sources in *It's All Energy* (3.1)

- Observe a demonstration of an electrical generator (3.2)
- Sort energy converters with the sorting tool (3.2)
- Read *Sunlight and Showers* (3.3)
- Observe a simple electrical system powered by a generator (3.4)
- Design a wind turbine (3.4)

Key concepts

- Energy never just appears. It comes from a source. (3.1)

- Some energy converters are designed to convert energy from sources to electrical energy that goes into the electrical system. (3.2)

Application of key concepts to the problem

- Examine a photo of the Ergstown hospital to understand where their energy comes from (3.2)
- Discuss solutions for solving Ergstown's blackout problem (3.4)
- Write a design argument about reducing blackouts in Ergstown (3.6)

Explanation that students can make to answer the Chapter 3 Question

Electrical energy that comes through the electrical grid must have a source and a source converter. There are many possible sources, such as fossil fuels, wind, water, and sunlight. Each of these sources has a converter that changes the energy form of the source into electrical energy. More energy use could have caused a blackout in Ergstown if there wasn't enough energy from the source, there weren't enough source converters to convert energy from the source, or the source converters were broken.

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Energy Conversions: Blackout in Ergstown

Unit Anchor Phenomenon

Problem students work to solve

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Why does Ergstown keep having blackouts?

Chapter-level Anchor Phenomenon

Chapter 4 Question

Devices all over Ergstown usually work when they are plugged into the electrical system.
How does energy get to the devices all over Ergstown?

Investigation Questions

Why might a system fail? (4.1, 4.2)
(Note: See Lesson Overviews for lesson-level Investigative Phenomena)

How does energy get from the source to a device? (4.2)
(Note: See Lesson Overviews for lesson-level Investigative Phenomena)

Evidence sources and reflection opportunities

- Revisit section about system failure in *Systems* (4.1)
- Build electrical systems and analyze failures in them (4.1)
- Read *Blackout!* (4.1)
- Revisit *Blackout!* to identify sources of system failure (4.2)

- View a demo of the electrical grid and discuss energy transfer (4.2)

Key concepts

- The parts of a system need to interact correctly to make it work. (4.2)

- Wires can transfer electrical energy from place to place. (4.2)

Application of key concepts to the problem

- Discuss evidence about the blackout in Ergstown (4.2, 4.3)
- Explain the cause of the electrical system failure (4.3)
- Discuss solutions for Ergstown (4.3, 4.4)
- Test systems related to possible solutions in the Sim (4.4)
- Write and share arguments for system improvements (4.5)

Explanation that students can make to answer the Chapter 4 Question

The energy that comes from the source is transferred through the electrical grid. The devices won't function if the wires that connect the source converter and devices are broken. This can happen if the connections between the grid and the converters aren't strong enough, if the wires aren't in a secure location, or if there aren't enough backup wires.

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