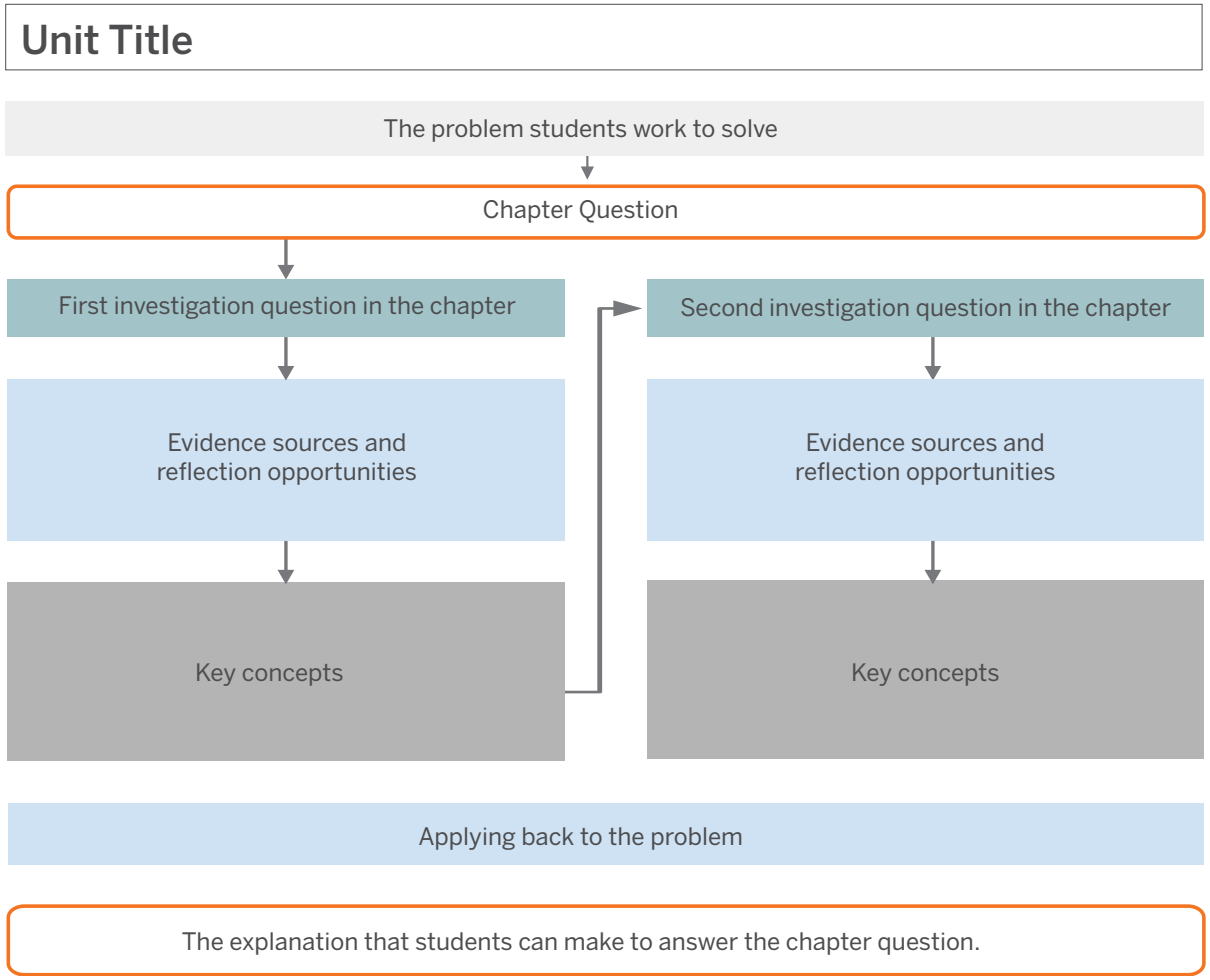
Earth, Moon, and Sun Coherence Flowchart

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, 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 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.

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, Investigation Questions focus students on a manageable piece of content that will help them figure out the Chapter Question. Each question 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 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

Earth, Moon, and Sun: An Astrophotographer's Challenge

The problem students work to solve

How can an astrophotographer plan for the best times to take photos of specific features on the Moon?

Chapter 1 Question

Why is there a border between light and dark on the Moon?

Investigation Question

Where does the Moon get its light? (1.2)

Why is part of the Moon dark? (1.3, 1.4)

Evidence sources and reflection opportunities

- Use the Sim to investigate where the moon gets its light (1.2)

- Use a moon sphere model to observe light and dark on the Moon (1.3)
- Gather evidence in the Sim to explain why part of the moon is dark. (1.4)
- Use the Modeling Tool to show light and dark on the Moon. (1.4)

Key concepts

- The Moon does not make its own light; the sun illuminates the Moon. (1.2)

- When a model is "to scale," object sizes and distances are larger or smaller than in the real world but the same relative to one another. Some models need to be "not to scale" to be useful. (1.3)
- The sun illuminates the half of the Moon that is facing it, and the other half is dark. (1.4)
- Light from the sun travels in straight lines. (1.4)

Application of key concepts to the problem

Discuss if the astrophotographer can take pictures of the three moon features on any night or on some nights. (1.4)

Explanation that students can make to answer the Chapter 1 Question

There is a border between light and dark on the Moon because the Moon always has a light part and a dark part. This is because the sun illuminates the half of the moon that is facing the sun but not the half that is facing away from the sun. The half that is facing away from the sun is dark because outer space is dark and the Moon does not make its own light.

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The problem students work to solve

How can an astrophotographer plan for the best times to take photos of specific features on the Moon?

Chapter 2 Question

Why does the border between light and dark on the Moon change location?

Investigation Question

If half of the Moon is always illuminated, why does its appearance from Earth change (2.1, 2.2, 2.3)

How can we predict how the Moon will change appearance from day to day? (2.4)

Evidence sources and reflection opportunities

- Read "Phases of the Moon" (2.1)
- Use the Moon sphere model to gather evidence about why the Moon's appearance from Earth changes (2.2)
- Revisit "Phases of the Moon" (2.2)
- Predict and observe the Moon at different positions using the Sim (2.3)
- Use the Modeling Tool to show how the Moon is illuminated at different times.

- Observe how the Moon's phases change with its orbit using the Moon sphere model (2.4)
- Write and share about patterns in the changes to the appearance of the Moon.
- Use the Modeling Tool to show the order of the phases and positions of the moon. (2.4)
- Use a model to show the pattern in the phases of the Moon. (2.5)

Key concepts

- From Earth we can only see the half of the Moon that is facing us. (2.3)
- Because the Moon moves to different positions around Earth, we see different amounts of the illuminated half of the Moon. This is why we see different phases of the Moon. (2.3)

- There is a pattern to the position of the Moon because the Moon orbits around Earth. (2.4)
- It takes about one month for the Moon to orbit Earth, so it takes about one month to see the full pattern of moon phases. This pattern repeats with every orbit of the Moon. (2.4)

Application of key concepts to the problem

- Discuss if the astrophotographer can take pictures of the three moon features on any night or only on some nights. (2.5)

Explanation that students can make to answer the Chapter 2 Question

From Earth we can only see the half of the Moon that is facing us. Because the Moon moves to different positions around Earth, we see different amounts of the illuminated half of the Moon. This is why we see different phases of the Moon.

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Earth, Moon, and Sun: An Astrophotographer's Challenge

The problem students work to solve

How can an astrophotographer plan for the best times to take photos of specific features on the Moon?

Chapter 3 Question

What are the conditions that cause a lunar eclipse?

Investigation Question

What makes the Moon completely dark during a lunar eclipse? (3.1)

Evidence sources and reflection opportunities

- Create a lunar eclipse with the Moon Sphere Model (3.1)
- Explore lunar eclipses in the Sim to figure out how the Earth, the Moon, and the sun must be arranged to cause a lunar eclipse. (3.1)

Key concepts

- During a lunar eclipse, the Moon is completely dark because Earth blocks sunlight from hitting the Moon. (3.1)
- Lunar eclipses can only happen when Earth is in between the sun and the Moon. (3.1)

Why isn't there a lunar eclipse every time Earth is in between the sun and the Moon? (3.2, 3.3)

- Read "An Ancient Machine for Predicting Eclipses"(3.2)
- Use the Sim to gather evidence about when lunar eclipses occur. (3.3)
- Revisit "An Ancient Machine for Predicting Eclipses"(3.3)
- Model the positions of the Earth, the Moon, and the Sun during a lunar eclipse and a full moon with the Modeling Tool (3.3)
- Write and share about what causes a lunar eclipse (3.4)

Lunar eclipses do not happen every time Earth is in between the sun and the Moon. (3.3)
The Moon is only completely dark when the sun, Earth, and the Moon are in a straight line, with Earth in the middle. (3.3)

Application of key concepts to the problem

Use the Reasoning Tool to evaluate claims and then write a scientific argument for the astrophotographer about when a lunar eclipse can be photographed (3.4)

Explanation that students can make to answer the Chapter 3 Question

During a lunar eclipse, the Moon is completely dark because Earth blocks sunlight from hitting the Moon. Lunar eclipses can only happen when Earth is directly in between the sun and the Moon. Lunar eclipses do not happen every time Earth is in between the sun and the Moon. The Moon is only completely dark when the sun, Earth, and the Moon are in a straight line, with Earth in the middle.

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Earth, Moon, and Sun: An Astrophotographer's Challenge

Problem students work to solve and the Chapter 4 Question

What are the conditions that cause a lunar eclipse?

Evidence sources and reflection opportunities

- Analyze and sort evidence based on claims (4.1)
- Participate in the Science Seminar (4.2)
- Use the Reasoning Tool to connect the evidence to the claims (4.3)
- Write an argument to support a claim (4.3)

Explanation that students can make to answer the Chapter 4 Question

One possible explanation students can make:

There probably will be a lunar eclipse of the moon of Kepler-47c during a year. There will be a lunar eclipse if Kepler-47c blocks the light from Stars A and B from hitting the moon. This will happen if Kepler-47c is in between its moon and both stars, and all four objects are in a straight line. The evidence that supports my claim is that there are two positions where Kepler-47c could be in between the moon and both stars and where all four objects are in a straight line. This is important because it means that a lunar eclipse is possible. Another piece of evidence is that the orbit of the moon around Kepler-47c might not be tilted because most moons' orbits have almost no tilt. If the orbit of the moon has no tilt, then anytime Kepler-47c is in between the moon and Stars A and B (in one of the two positions stated above), then all four objects will be in a straight line and there will be a lunar eclipse. So, this would make a lunar eclipse more likely to happen. If there were a tilt, then Kepler-47c might be slightly above or below a direct line to Stars A and B and there would be no lunar eclipse. Another piece of evidence is that the moon of Kepler 47-c might orbit Kepler-47c many times per year, like Deimos. If a moon orbits more times per year, it has more chances for lunar eclipses, so this would make a lunar eclipse even more likely. Although many things about Kepler-47c and its moon are not known, the evidence supports the claim that during a year there will probably be a lunar eclipse.