

Properties of Materials Coherence Flowchart

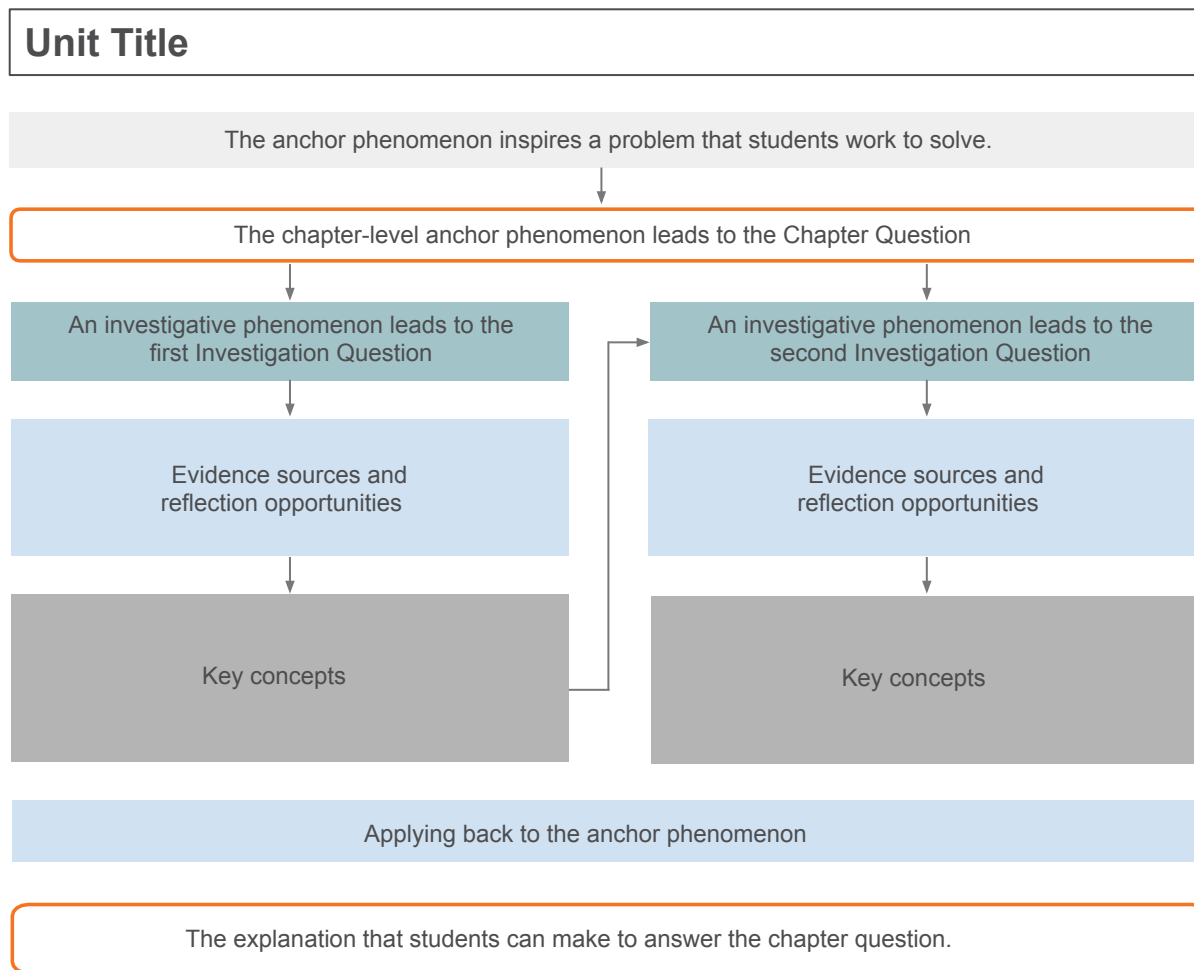
The storyline of the unit

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.

Unit Design Problem

Problem students work to solve

Chapter-level Anchor Phenomenon Chapter 1 Question

Investigative Phenomena Investigation Questions

Evidence sources and reflection opportunities

Key concepts

Investigative Phenomena Investigation Questions

Application of key concepts to problem

Explanation that students can make to answer the Chapter 1 Question

Properties of Materials: Designing Glue

We want to make a glue mixture that is better than what the school uses now.
How can we design a glue mixture that is better than what the school uses now?

Different glue mixtures have different properties. Some are stickier than others.
How can you make a sticky glue? (introduced in 1.3)

There are different materials in the world with different properties.
What can be noticed about different materials? (1.2-1.3)

- Read *What If Rain Boots Were Made of Paper?* (1.2)
- Reflect on materials and properties (1.3)
- Brainstorm uses and properties of a good glue (1.3)
- Observe mystery glues (1.3)

- Properties include how materials smell, look, taste, feel, and sound. (1.2)
- Different materials have different properties. (1.3)
- You can tell if materials and substances are different by observing their properties. (1.3)

Different materials and substances act differently from each other when tested.
How can you tell if substances are different? (1.4)

- Observe properties of dry mystery glues and analyze results of mystery glue sticky tests (1.4)
- Write arguments about whether mystery glues are the same or different (1.4)

- You can tell if materials and substances are different by observing their properties or by testing them. (1.4)

Properties of mixtures can change.
How can the properties of a mixture change? (1.5-1.7)

- Observe dry glue ingredients (1.5)
- Make and observe mixtures (1.5)
- Graph and analyze sticky tests results (1.6)
- Read *Jelly Bean Engineer* (1.7)

- Properties of mixtures can change when other ingredients are added. (1.5)
- Properties of substances are the same whether you have a small amount or a large amount. (1.7)
- Engineers test their designs to find out whether they meet their design goals. (1.7)

Different ingredients result in different properties of a mixture
*Which ingredients should we use (or not use) in our glue? (1.8-1.9)**

- Write design arguments for the ingredients that make the best glues (1.8)
- Make Glue #1 (1.9)
- Write a comparison of partners' glues (1.9)

Glue is a mixture of several ingredients such as flour, water, and cornstarch, and depending on the properties of those ingredients and how they are combined, you can create different glues. Some glues might be stickier or stronger than others. By understanding materials and observing and testing different recipes, you can choose the ingredients that provide the properties you are seeking.

*This Investigation Question guides application of key concepts to the problem.

Unit Design Problem

Problem students work to solve

Chapter-level Anchor Phenomenon Chapter 2 Question

Investigative Phenomena Investigation Questions

Evidence sources and reflection opportunities

Key concepts

Application of key concepts to problem

Explanation that students can make to answer the Chapter 2 Question

Properties of Materials: Designing Glue

We want to make a glue mixture that is better than what the school uses now.
How can we design a glue mixture that is better than what the school uses now?

Heating a glue ingredient (and returning it to its original temperature) can result in changing the properties of the glue ingredient.
Can heating a substance (and returning it to its original temperature) make a better glue?

After being heated or cooled, the properties of a substance can change.
What can happen after a substance has been heated or cooled and returns to its original temperature? (2.1-2.2)

- Read *Can You Change It Back?* (2.1)
- Compare heated and unheated mixtures of cornstarch and water (2.2)
- Sort heated/cooled substances in a digital tool (2.2)
- Write about the properties of a substance before and after it was heated or cooled (2.2)

- When a substance is heated or cooled, its properties can change. (2.1)
- Some substances change back to the way they were before they were heated or cooled. (2.2)
- If a substance doesn't change back to the way it was, it has become a different substance. (2.2)

- Graph and analyze sticky test results of heated and unheated cornstarch and water mixtures (2.3)
- Discuss evidence for whether heating the cornstarch and water mixture will make the glue stickier (2.4)
- Write design arguments for whether or not heating the cornstarch and water mixture will help make a stickier glue (2.4)

When water is heated and returned to room temperature, the properties go back to the way they were, but the properties of some other materials change after heating and going back to room temperature. For example, when a mixture of cornstarch and water is heated and then returned to room temperature, it has different properties than it had before.

Unit Design Problem

Problem students work to solve

Chapter-level Anchor Phenomenon Chapter 3 Question

Investigative Phenomena Investigation Questions

Evidence sources and reflection opportunities

Key concepts

Application of key concepts to problem

Explanation that students can make to answer the Chapter 3 Question

Properties of Materials: Designing Glue

We want to make a glue mixture that is better than what the school uses now.
How can we design a glue mixture that is better than what the school uses now?

Different glue mixtures have different properties. Some are stronger than others.
What ingredients can be used to make a glue that is sticky and strong?

Different ingredients result in mixtures with different properties.
How can mixtures be designed to have certain properties? (3.2-3.5)

- Read *Jess Makes Hair Gel* (3.1)
- Graph and analyze results of glue strength tests (3.3)
- Read about strength (and other properties) of ingredients in *Handbook of Interesting Ingredients* (3.3)
- Discuss evidence from tests and text for different glue ingredients (3.3)
- Evaluate and synthesize evidence (3.4)

- Mixtures may have a combination of the properties of their ingredients. (3.2)
- Mixtures may have some of the properties of their ingredients. (3.4)
- Mixtures can be designed for certain purposes by using ingredients with certain properties. (3.4)

- Write design arguments for which ingredients will make a glue that best meets design goals (3.4)
- Make Glue #2 (3.5)
- Reflect on designing mixtures and write about solutions for designing toothpaste (3.5)

Sometimes, the properties of glue are a combination of the properties of the substances that make up that glue, such as a flour-water combination. Ingredients can be combined to create different glues that have different properties. For example, baking soda, which is smooth, and flour, which is sticky, can be combined to make smooth and sticky glue.

Unit Design Problem

Problem students work to solve

Chapter-level Anchor Phenomenon
Chapter 4 Question

Opportunities to engage in practices and apply key concepts

Practice that students can do in response to the Chapter 4 Question

Properties of Materials: Designing Glue

We want to make a glue mixture that is better than what the school uses now.
How can we design a glue mixture that is better than what the school uses now?

We want to pick the glue recipe that best meets our design goals.
What is the glue recipe that best meets our design goals?

- Evaluate Glue #2 test results in terms of design goals (4.1)
- Modify glue recipe and make Glue #3 (4.1)
- Evaluate Glue #3 test results in terms of stickiness, strength, and other design goals (4.2)
- Discuss evidence in support of ingredients for glues (4.2)
- Modify glue recipe and make and use Glue #4 to create a picture frame (4.2)
- Sort ingredient properties in a digital tool (4.3)
- Sort mystery mixtures in a digital tool (4.3)
- Observe effectiveness of glue in holding together picture frame (4.4)
- Write design arguments to the principal recommending a glue recipe (4.4)
- Write a broader reflection on how to design a mixture for a certain purpose (4.4)

Students can conduct tests of their glue recipes and evaluate the results of their tests to determine how well their glues meets the design goals. They can use evidence from their tests to iterate on their glue recipes to better meet design goals.