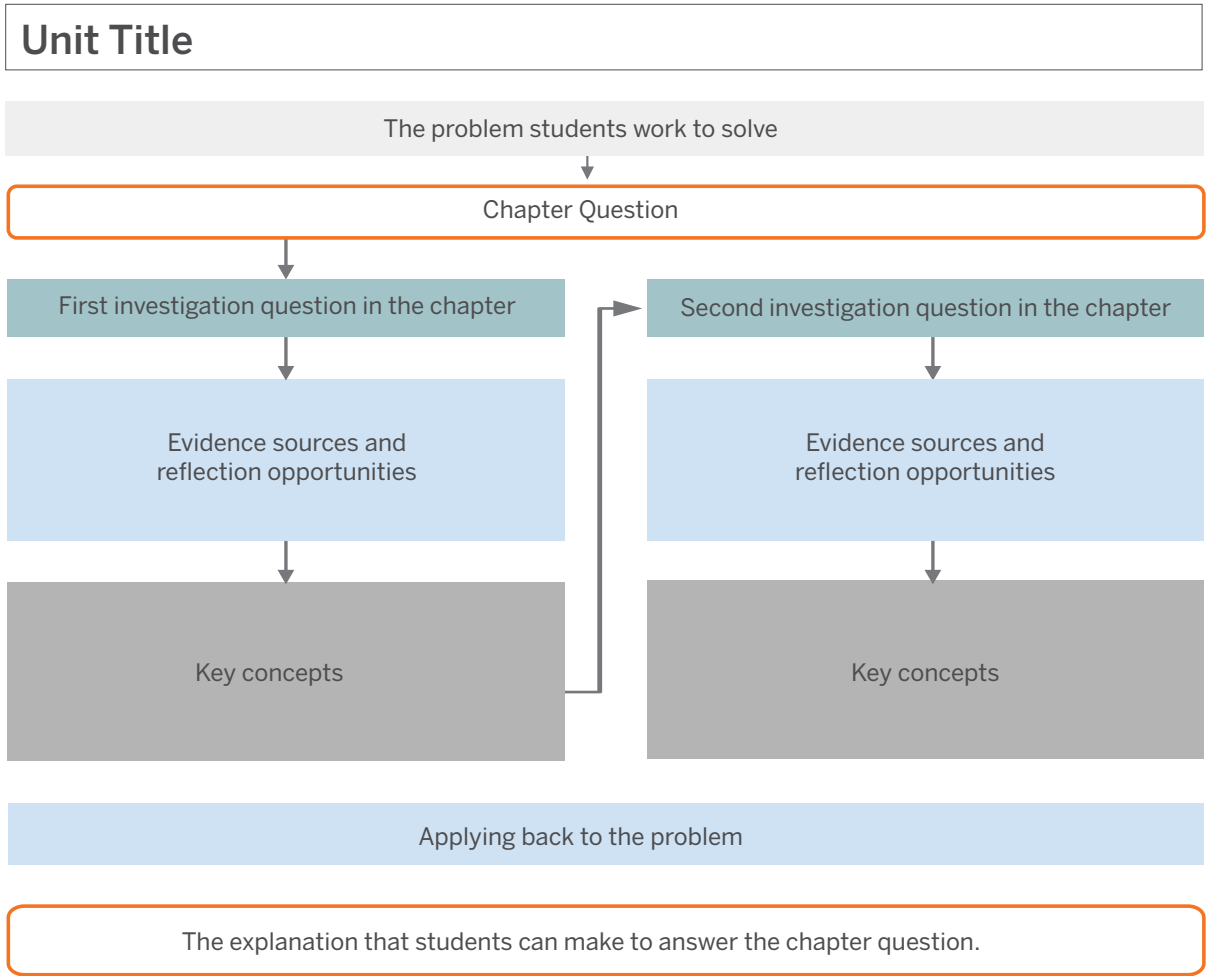
# *Chemical Reactions* Coherence Flowchart

## 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.

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# Chemical Reactions: Mysterious Substance in Westfield's Water

**Problem students work to solve**

Why is there a mysterious reddish-brown substance in the tap water of Westfield?

**Chapter 1 Question**

What is the reddish-brown substance in the water?

**Investigation Questions**

- How can you tell one substance from another? (1.3)
- Why do different substances have different properties? (1.4, 1.5, 1.6)

**Evidence sources and reflection opportunities**

- Observe different substances to gather evidence about the identity of the reddish-brown substance (1.2)
- Make detailed observations of four samples to predict whether or not any of them are the same substance (1.3)

- Watch a video to visualize the atoms that make up everything (1.4)
- Read "Atomic Zoom-In" (1.4)
- Use the Sim to investigate the properties of substances and relate the properties to atomic-scale models of the substances (1.5)
- Revisit "Atomic Zoom-In" (1.5)
- Use unit vocabulary to answer the investigation question. (1.6)

**Key Concepts**

- Different substances have different properties. (1.3)

- Things that are too small (or too large) to see can be studied with models. (1.5)
- Substances have different properties because they are made of different groups of atoms. These groups vary in the type or number of atoms that make up the group. (1.6)
- Groups of atoms repeat to make up a substance.(1.6)

**Application of Key Concepts to problem**

Write an argument about whether the reddish-brown substance is the same as the substance that makes up the pipes, the same as the fertilizer, or a different substance (1.6)

**The explanation that students can make to answer the Chapter 1 Question**

The reddish-brown substance is different from the pipe substance and the fertilizer. The reddish-brown substance is a different color than the fertilizer, which is white, and the substance that makes up the pipe, which is gray. This means that they cannot be the same substance because they do not have the same properties. The atomic models show that the reddish-brown substance is made up of different repeating groups of atoms than the fertilizer and the pipe substance. The difference in atoms caused the difference in properties.



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# Chemical Reactions: Mysterious Substance in Westfield's Water

**Problem students work to solve**

Why is there a mysterious reddish-brown substance in the tap water of Westfield?

**Chapter 2 Question**

How did the rust form?

**Investigation Questions**

- Can substances change into different substances? (2.1)
- How do substances change into different substances during chemical reactions? (2.2, 2.3)

**Evidence sources and reflection opportunities**

- Observe what happens when two substances are mixed (2.1)
- Mix substances in the Sim and observe what happens at atomic scale (2.1)
- Use the Sim to find and observe substances that do and do not react when mixed. (2.2)
- Use a token model to explain how a chemical reaction changes reactants into products. (2.2)

**Key Concepts**

- During a chemical reaction, one or more starting substances (reactants) change into one or more different substances (products). (2.1)
- During a chemical reaction, atoms do not change from one type to another. (2.2)
- During a chemical reaction, atoms rearrange themselves from different groups of atoms. (2.2)

**Application of Key Concepts to problem**

- Use a token model to test if the iron pipes turned into rust, the fertilizer turned into ruse, or both. (2.3)
- Model how the iron pipes

**The explanation that students can make to answer the Chapter 2 Question**

The rust formed from a chemical reaction between the iron pipes and the fertilizer. During a chemical reaction, the atoms from the reactants rearrange to form the repeating groups of atoms of the products, which means the atoms in the products must be present in the reactants. Iron atoms from the pipe rearranged with the oxygen atoms from the fertilizer to make the repeating groups of atoms that make up rust.



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# Chemical Reactions: Mysterious Substance in Westfield's Water

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|---|---|
| The problem students work to solve | Why is there a mysterious reddish-brown substance in the tap water of Westfield? |
| Chapter 3 Question | What was produced during the reaction between the iron pipes and the fertilizer? |
| Investigation Question | • What happens to atoms during a chemical reaction? (3.1, 3.2, 3.3) |
| Evidence sources and reflection opportunities | • Watch and discuss a video showing paper burning. (3.1)<br>• Read "What Happens When Fuels Burn?"(3.1)<br>• Use the Sim to analyze what happens at the atomic scale when fuel burns. (3.2)<br>• Revisit "What Happens When Fuels Burn?"(3.2)<br>• Use a token model to investigate possible reactants that produce sulfur and hydrogen chloride. (3.3)<br>• Use unit vocabulary to explain what happened in a reaction that formed sulfur and hydrogen chloride. (3.3) |
| Key Concepts | • During a chemical reaction, all of the atoms that make up the reactants rearrange to form the products. (3.2)<br>• During a chemical reaction, atoms cannot be created or destroyed. (3.3) |
| Application of key concepts to the problem | • Use Explanation Cards to discuss the Chapter 2 Question (2.5)<br>• Write explanations to answer the Chapter 2 Question (2.5) |
| Explanation that students can make to answer the Chapter 3 Question | Rust and sodium nitrite were produced during the reaction between the iron pipes and the fertilizer. In a chemical reaction atoms cannot be destroyed, therefore, all of the atoms must rearrange to form products. Some of the atoms rearranged to form rust and the remaining atoms must have rearranged to form another product. Sodium nitrite is made out of one sodium atom, one nitrogen atom, and two oxygen atoms. These are the same type of atoms that made up the fertilizer. |



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# Chemical Reactions: Mysterious Substance in Westfield's Water

Problem students work to solve and the Chapter 4 Question

Who might have used the unknown substance to steal the diamond?

Application of Key Concepts to new problem

- Evaluate the quality of evidence (4.1)
- Analyze and sort evidence based on claims (4.2)
- Model possible reactions using the paper Modeling Tool (4.2)
- Participate in the Science Seminar (4.3)
- Write an argument to support a claim (4.3)
- Mix substances in the Sim and observe what happens at atomic scale (2.1)

The explanation that students can make to answer the Chapter 4 Question

One possible explanation students can make:

Pat is most likely to have made the hydrofluoric acid. My first piece of evidence is that the chemical supply company delivered sulfuric acid and calcium fluoride to Pat's house However, these substances were not found at Pat's house. This could mean that Pat used these substances in a chemical reaction. This evidence supports my claim because a chemical reaction between sulfuric acid and calcium fluoride could cause the atoms to rearrange to form hydrofluoric acid as one of the products. This is because sulfuric acid contains hydrogen atoms, and calcium fluoride contains fluorine atoms, which are the two types of atoms that repeat to make up hydrofluoric acid.

My next piece of evidence is that the police found calcium sulfate at Pat's house. This evidence supports my claim because if Pat mixed the sulfuric acid and the calcium fluoride to make hydrofluoric acid, then the other product of this reaction could be calcium sulfate. This is because only the hydrogen and fluorine atoms would rearrange to form hydrofluoric acid. The rest of the atoms of the reactants would have to rearrange to form another substance. Calcium sulfate is probably the other product that would form because its atom group contains all the atoms that did not rearrange to form hydrofluoric acid. This evidence suggests that Pat mixed sulfuric acid and calcium fluoride to make the hydrofluoric acid.