

Properties of Materials: Designing Glue

Problem students work to solve

How can we design a glue mixture that is better than what the school uses now?

Chapter 1 Question

How can you make a sticky glue? (introduced in 1.3)

Investigation Questions

What can be noticed about different materials? (1.2-1.3)

How can you tell if substances are different? (1.4)

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

Evidence sources and reflection opportunities

- 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)

- 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)

- 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)

Key concepts

- 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)

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

- 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)

Investigation Questions

Which ingredients should we use (or not use) in our glue? (1.8-1.9)*

Application of key concepts to problem

- 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)

Explanation that students can make to answer the Chapter 1 Question

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.

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Chapter 2 Question

Can heating a substance (and returning it to its original temperature) make a better glue?

Investigation Question

What can happen after a substance has been heated or cooled and returns to its original temperature? (2.1-2.2)

Evidence sources and reflection opportunities

- 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)

Key concepts

- 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)

Application of key concepts to problem

- 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)

Explanation that students can make to answer the Chapter 2 Question

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.

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Chapter 3 Question

What ingredients can be used to make a glue that is sticky and strong?

Investigation Question

How can mixtures be designed to have certain properties? (3.2-3.5)

Evidence sources and reflection opportunities

- 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)

Key concepts

- 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)

Application of key concepts to problem

- 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)

Explanation that students can make to answer the Chapter 3 Question

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.

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Chapter 4 Question

What is the glue recipe that best meets our design goals?

Opportunities to engage in practices and apply key concepts

- 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)

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

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