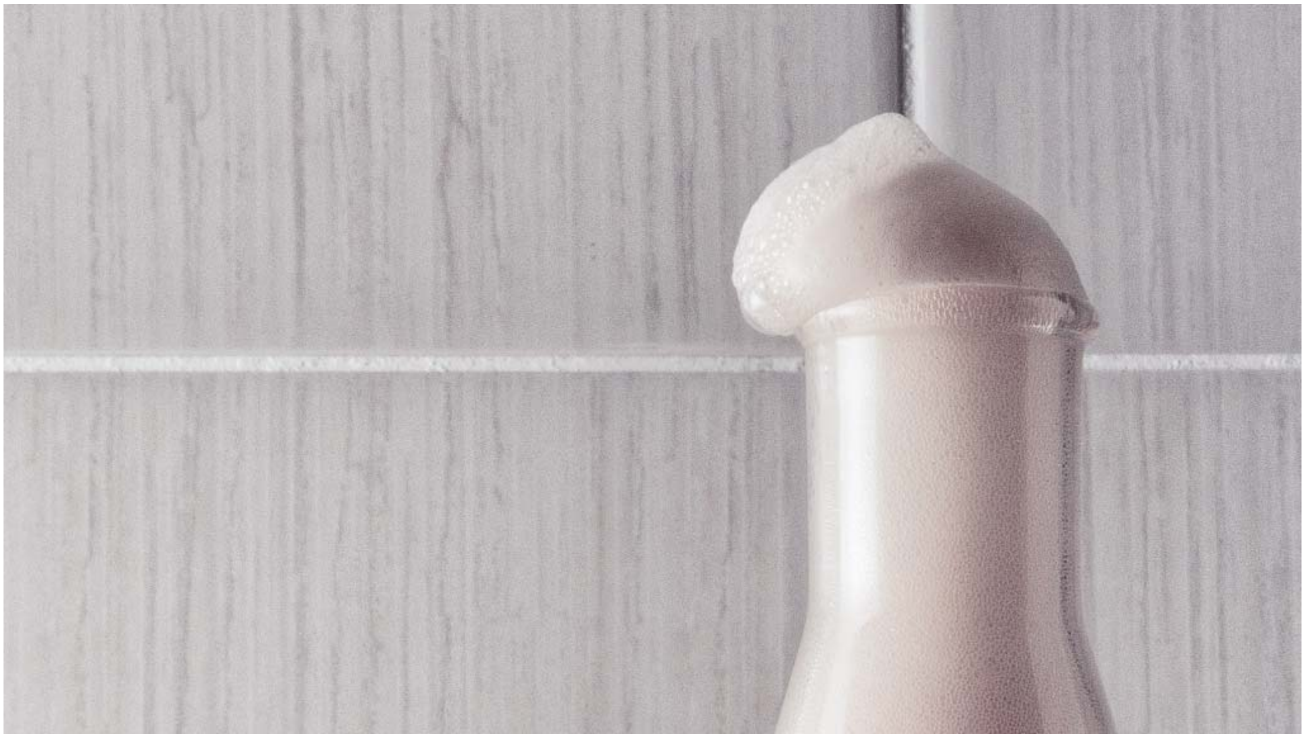
# Why Did the Reaction Happen So Fast?



## Welcome to NSTA's Daily Do

Teachers and families across the country are facing a new reality of providing opportunities for students to ***do*** science through distance and home learning. The **Daily Do** is one of the ways NSTA is supporting teachers and families with this endeavor. Each weekday, NSTA will share a sensemaking task teachers and families can use to engage their students in authentic, relevant science learning. We encourage families to make time for family science learning (science is a social process!) and are dedicated to helping students and their families find balance between learning science and the day-to-day responsibilities they have to stay healthy and safe.

## What is Sensemaking?

Sensemaking is actively trying to figure out how the world works (science) or how to design solutions to problems (engineering). Students ***do*** science and engineering through the science and engineering practices. Engaging in these practices necessitates students be part of a learning community to be able to share ideas, evaluate competing ideas, give and receive critique, and reach consensus. Whether this community of learners is made up of classmates or family members, students and adults build and refine science and engineering knowledge together.

# Introduction

Elephant toothpaste! You may have seen the elephant toothpaste demonstration performed anywhere from your local science center to the local news or morning program (a quick search of YouTube confirms this). But what is elephant toothpaste? How does it work?

In today's Daily Do, students and families observe the elephant toothpaste phenomenon (be ready to observe this phenomenon more than once). Engaging in science and engineering practices and using the thinking tool of cause and effect, families make sense of science ideas about chemical reactions at an elementary, middles school or high school level. Keep younger siblings nearby -once the reaction stops, the foam is safe to touch.

# Elephant Toothpaste

In the video, the rectangular tub on the table contains a mixture of hydrogen peroxide and liquid dish soap. The cups the teacher and students are holding contain a mixture of warm water and active dry yeast. What happens when they empty their cups into the tub?

**PREPARATION**

You might choose to do this a demonstration first and then let students investigate with their own materials. This is a student-friendly version of the famous (infamous?) "Elephant Toothpaste" chemical reaction - students can touch the foam that results from the reaction. Students should wear protective eye wear and avoid getting the foam on their clothes as it can discolor fabric.

**Materials**

- clear 20-oz plastic bottle (try to find ones with the least textured-sides to make it easier to view what's happening inside)
- 3% hydrogen peroxide solution (available at grocery stores and pharmacies)
- active dry yeast
- liquid dish soap
- warm water
- tray or tub (to catch "toothpaste" from bottle)
- measuring spoons
- liquid measuring cups
- funnel (helpful, but not required)
- safety glasses
- infrared thermometer or temperature probe (optional)

**Getting Ready**

Measure the hydrogen peroxide, liquid dish soap, and warm water and set aside

- 1/2 cup hydrogen peroxide
- 1/4 cup dish soap
- 1/4 warm water

Five minutes before the demonstration, add 1 tablespoon yeast to the warm water. Stir and set aside.

When you're ready to do the demonstration, add the substances to the bottle in this order:

1. hydrogen peroxide
2. dish soap (swirl to mix)
3. water-yeast mixture

But don't do it yet!

**NOTICE AND WONDER**

Tell your students you have a weird and puzzling phenomenon you want to share with them. Ask students to create a t-chart and label on column *notice* and the other *wonder*. Show the video clip above several times; allow time in between each viewing for students to record their observations and questions.

*This is a good opportunity to mix the yeast with warm water.*

Next, tell students you want them to observe the phenomenon more closely. You might want to let students know this will be a smaller version of the phenomenon they observed in the video (to avoid disappointment). If students are standing close to you, ask them to wear safety glasses to protect their eyes from splashes of hydrogen peroxide.

Identify the substances as you add them to the bottle. Pause briefly between each addition so students can observe what is happening inside the bottle. As the chemical reaction continues, remind students to continue to make and record observations, If students ask questions out loud, acknowledge the question and ask students to record in their t-chart.

Ask students to turn to a partner and share their observations. Then ask students to share their observations and compile a class list of observations. Observations will likely include, it happened fast, there is a lot of foam, the foam is bubbly (trapped bubbles), there is liquid still inside the bottle, there is brown stuff on top of the bubbles (yeast), nothing happened until yeast was added, it makes steam, and the foam is warm.

Ask students, "How does the elephant toothpaste phenomenon occur?" Give students time to think independently and record their ideas. Encourage them to use words, pictures and symbols. As you walk around the room, ask students questions like,

- What are your ideas about how to explain this phenomenon?
- Have you observed or experienced something like this before? How does that experience help you think about the elephant toothpaste phenomenon? (How are they alike? How are they different?)
- Which observation(s) support the idea you are representing here?

Ask student to turn and share their explanation with a partner. Consider using partner conversational supports (sentence stems). Choose **one or two** stems for both speaker and responder that are most appropriate for your students (based on discussion experience and grade-level):

Speaker

- I think____because _____.
- *Share an analogy that relates to your idea.*
- I think this relates to the science idea of _____.

Responder

- One difference between my idea and your idea is ____.
- What do you mean when you say ____.
- I heard you say ____. What evidence is that based on?

Make sure you give students opportunities to switch roles. Remind students to continue to record new questions they have about the elephant toothpaste phenomenon.

Ask students to look at the questions they have recorded and choose the one they are most curious about to share with the class. Ask student to write their question on a stick note or paper square that can be posted on a class question board.

**NEXT STEPS**

**Elementary students.** Elementary students may ask questions around how each ingredient "works" in creating elephant toothpaste.

- Does adding more yeast make it bigger or faster or hotter?
- Why is the yeast in the water? Will it work if you don't put the yeast in water?
- What would happen if you used more dish soap? What would happen if you didn't use any dish soap?
- What's the liquid left in the bottle?
- What's in the bubbles?

You might allow students to work in small groups to collaboratively design an investigation to answer one question and then have the groups report their findings. You might navigate the students to use the data to figure out if new substances with different properties are formed when hydrogen peroxide, liquid dish soap and yeast are mixed. Which substances are new substances? Which substances stayed the same? Which substances aren't we sure are new or the ones we started with?

**Middle school students.** Middle school students may have many of the same questions as elementary students. You might as a class figure out which question to investigate first. For example, why does the reaction stop when there's still liquid in the  bottle? How could we figure out if the liquid is hydrogen peroxide or something new?

You might provide students with a list of substances that are a liquid at room temperature, clear and colorless. Include their physical (and/or chemical) properties such as color, density, boiling point, and viscosity. Students could use these physical properties to design an investigation to determine the identify of the substance in the bottle. (Note: Make sure all the hydrogen peroxide in the bottle has reacted before students begin investigation.)

Using evidence from data collected in the investigation, ask students to make a claim about the identify of the liquid in the bottle. They might use the science idea that pure substances have characteristic physical and chemical properties to connect their evidence to their claim.

Students will likely want to investigate how yeast affects the rate of reaction. They could design another investigation to answer this question.They might notice a pattern that the more yeast they use the faster the reaction occurs. They might also notice the amount of yeast does not appear to change from the start to the end of the chemical reaction.
Consider asking students to create an individual model to explain the elephant toothpaste phenomenon and then work in small groups to create a group consensus model. You might create a scaffold with three panels labeled **right before the reaction starts**, **during the reaction,** and **right after the reaction ends**.

As you move from group to group, you might ask:

- What are the components (parts) of your model?
- How are (point to one component) and (point to another component) interacting? How might you represent the interaction?
- Which substances remain the same from panel to panel. Which substances are new substances (were not present in first panel)? What is your evidence?

Ask student groups to use their models to help create a "must-have" list of what should be included in the models and then create a class consensus model.

**High school students.** High school students will likely have the same questions as elementary and middle school students. You might ask your students to create an initial model to explain the elephant toothpaste phenomenon and then create an initial group model. Some questions you might ask students or student groups as you walk around the room include:

- What are the components (parts) of your model?
- How are (point to one component) and (point to another component) interacting? How might you represent the interaction?
- How does your model explain the change in temperature?
- How could you represent the speed at which the reaction occurred? Could you use your model to predict how to speed up or slow down the reaction?
- Do you think new substances were formed? How are you representing the new substances?

You might have students post their models and then do a gallery walk (visiting at least three different group models). Ask students to notice similarities and differences between their models and the other group models. Then ask,

- What ideas are we in agreement about?
- Are there places where we disagree? Can we clarify these?
- Where should we go next to help us with areas where we are not sure/not in agreement?

Ask students, "What should we investigate next?"

## NSTA Collection of Resources for Today's Daily Do

NSTA has created a *Why did the reaction happen so fast?* collection of resources to support teachers and families using this task. If you're an NSTA member, you can add this collection to your library by clicking ADD TO MY LIBRARY located near the top of the page (at right in the blue box).

## Check Out Previous Daily Dos from NSTA

The NSTA Daily Do is an open educational resource (OER) and can be used by educators and families providing students distance and home science learning. Access the entire collection of NSTA Daily Dos.