IT'S A GAS

Addresses NGSS
Level of Difficulty: 2
Grade Range: 6-8

OVERVIEW

In this activity, students will produce different chemical reactions with yeast. They will observe and measure how balloons inflate during this chemical reaction. They will then create a chart to track their observations and develop hypotheses to explain the reactions.

Topic: **Chemical reactions between yeast and sugar**

Real-World Science Topics

- An exploration of simple chemical reactions
- An exploration of single-celled organisms

Objective

Students will gain an understanding of the ways yeast, a single-celled organism, feeds on sugar and produces a chemical reaction.

Materials Needed for Teacher Demonstration

loaf or several pieces of bread

Materials Needed for Student Teams

- three empty water bottles
- three packages of active dry yeast (baker's yeast)
- sugar
- artificial sweetener
- warm water
- funnel (optional)
- tablespoon
- permanent marker
- ruler
- stopwatch or clock

STEPS FOR *IT'S A GAS*

1. **Warm-up Activity:** Introduce the activity by holding a loaf of bread or several slices of bread in front of the class. Ask students if they have ever made bread or watched bread being made. Allow several students to share their descriptions of the bread-making process. Then, ask students to explain how bread dough can grow (what bakers call "rising"). Ask if students have observed bread in the oven, where it again grows larger. Allow students to guess or explain what causes this change. Rip pieces of the bread apart and pass them around the class. Have students look closely at the bread. Ask them if they observe the tiny holes in the bread. Ask them what they think causes the holes in the bread. Explain that you will return to this question at the end of the lesson. Tell students that in this activity, they will experiment with different variables to measure and observe the effects of yeast in warm water.
2. Break the class into small groups, and hand out the materials to each group. Instruct students to fill each bottle half-full with warm water. Students should then use their permanent marker to label each bottle with the numbers 1, 2, and 3.
3. Instruct students to add one package of yeast to each bottle. If you are using a larger jar of yeast rather than individual packages, they should add one tablespoon of yeast to each jar. Students may find it helpful to use a funnel (or a creased piece of paper) to add the yeast to the bottle.
4. Next, instruct students to add two tablespoons of sugar (glucose) to Bottle 2. Again, the funnel may make the addition of sugar easier. Then, students should add two tablespoons of artificial sweetener to Bottle 3 (about 8 small packets).
5. Instruct students to place balloons on the tops of each bottle, as shown in the photo below. They should work quickly to cap each bottle with a balloon so that little to no gas is allowed to escape.

6. Students should then use a stopwatch or clock to take measured observations at five-minute intervals. They should observe how the balloons are changing, and they should discuss these changes within their groups. Have students use the ruler to measure the diameters of the balloons at each five-minute interval, as shown in the photo on below.

Instruct students to take at least four measurements (over a twenty-minute time period). Have students record their observations and measurements in the chart on their **Student Handouts**.

7. **Wrap-up Activity:** Bring the class together and have students share their results. Which balloon inflated the most and which inflated the least? Why did this happen? What does this investigation tell you about how yeast reacts with sugar? Students should note that when the yeast reacts with sugar, it releases gas. Have students relate this to the holes in the bread that they observed at the beginning of the activity. Have students try to explain why the bread has holes in it, based on what they learned in this activity. Prompt students by reminding them that flour in bread has sugars in it. Students should note that the yeast reacts with the sugars in the flour to release gas. This gas causes the bread to rise, and it creates gas pockets in the bread that we see as "holes." If possible, revisit the bottles and balloons after one hour, and allow students to make one final observation about the balloons and the reactions within the bottles.

It's a Gas! Extension Activity

Challenge students to brainstorm at least three different variables they could introduce to extend this activity. Students can then select one option and repeat the activity with a modified variable. Sample ideas include:

- Instead of using water, use a liquid such as milk or soda. Compare the results with the original experiment.
- Place the bottles in a hot and sunny window to encourage evaporation of the water. What happens to the balloons in this environment?
- Place salt in one of the bottles and sugar in another bottle. Monitor the changes.
- Alter the variables already used in this activity. For example, students could vary the temperature of the water, change the amount of yeast, or change the amount of sugar. Students then compare the results with the original experiment.

IT'S A GAS BACKGROUND INFORMATION

What is yeast?

Yeast is a single-celled organism. Yeast is a type of fungi, and there are thousands of types of yeast. The most common types of yeast are used commercially for baking and fermentation (as in the case of alcoholic beverages). When yeast is used in bread, it metabolizes the glucose in the flour and releases carbon dioxide gas and alcohol. The carbon dioxide gas bubbles cause the bread to rise, and help give bread a light and airy texture.

What is the chemical reaction that occurs between yeast and sugar and why?

Glucose, or sugar, is an excellent food for yeast. Yeast metabolizes glucose, and the by-product of this reaction is carbon dioxide gas and ethanol. In this activity, the water bottle with the yeast and sugar is the only bottle that provides the yeast with sufficient food. The carbon dioxide is the gas that fills the balloon. Students will also notice the gas rising up through the water in bubbles.

Why does the balloon covering the bottle with artificial sweetener inflate a small amount?

Some artificial sweeteners contain modified sugars, while others are composed of synthetic sugars. Because the molecular structure of these sugars is different from that of regular sugar, the reaction between yeast and artificial sweeteners is generally much less than that of regular sugar. Your students may have varying results in the bottle with artificial sweetener, depending on the brand of artificial sweetener you use. You may want to offer students some information on the makeup of artificial sweeteners, and challenge them to discover the connection between carbohydrates, calories, sugars, and yeast. Students can conduct simple Internet searches to learn more about the composition of the artificial sweetener used in the activity.

Key Vocabulary:

glucose: a simple sugar molecule

single-celled organism: a microscopic living thing that comprises only one cell; also called a microorganism

reaction: a change or transformation

yeast: microscopic, single-celled organisms that reproduce when they convert sugar into alcohol and carbon dioxide

TEACHER HANDOUT FOR *IT'S A GAS*

1. Write a prediction about what you think will happen to each of the three bottles in this experiment.

   [Sample answer: I think the bottle with the real sugar will make the balloon blow up. I think the other two balloons will not inflate.]

2. Record your observations and measurements for each of the three bottles in the chart below.

   [Sample chart below.]

	5 MINUTES	10 MINUTES	15 MINUTES	20 MINUTES
BOTTLE 1: Yeast and water	*No change in balloon.*	*No change in balloon.*	*Tiny change in balloon. Expanded to about 1/2 inch thick.*	*No change from 15-minute mark. Balloon is limp, not much pressure.*
BOTTLE 2: Yeast, water, sugar	*At 3-minute mark, balloon was upright. Measures 2 inches across.*	*Balloon grew larger. Measures 3 inches across.*	*Balloon grew a tiny bit more. Measures 3 1/2 inches across.*	*Barely any change from 15-minute mark, but balloon feels more firm. Measures 3 3/4 inches.*
BOTTLE 3: Yeast, water, artificial sweetener	*Balloon slightly inflated. Measures 1/2 inch across.*	*Balloon grew a tiny bit, but still barely inflated. Measures 3/4 inch across.*	*Balloon taking on rounded shape. Still hangs down. Measures 1 1/2 inches.*	*Balloon now upright on bottle, but still feels soft. Measures 2 inches across.*

3. Which balloon changed the most? Which changed the least?

   [Sample answer: The balloon on Bottle 2 changed the most. It expanded quickly and held the most gas. The balloon on Bottle 1 changed the least. It expanded very little.]

4. Describe what you think happened in the bottle that changed the most.

   [Sample answer: I think there is a reaction between sugar and yeast. The sugar caused the yeast to bubble and produce gas, which filled the balloon. It seems like the sugar is feeding the yeast.]

5. Describe why you believe the other two bottles had less change than the bottle you described in the previous question.

   [Sample answer: If it is true that the sugar is feeding the yeast, then it makes sense that the first bottle would not change; there's no "food" in the water. The same might be true of the artificial sweetener. I noticed that the packet said "Zero Calories," so maybe that means there's no way for it to feed the yeast.]

STUDENT HANDOUT FOR *IT'S A GAS*

Name:

Date:

1. Write a prediction about what you think will happen to each of the three bottles in this experiment.

2. Record your observations and measurements for each of the three bottles in the chart below.

	5 MINUTES	10 MINUTES	15 MINUTES	20 MINUTES
BOTTLE 1: Yeast and water				
BOTTLE 2: Yeast, water, sugar				
BOTTLE 3: Yeast, water, artificial sweetener				

3. Which balloon changed the most? Which changed the least?

4. Describe what you think happened in this bottle to cause the balloon to change.

5. Describe why you believe the other two bottles had less change than the bottle you described in the previous question.