Carbon Snake

A Carolina Essentials™ Demonstration

Overview

During this teacher-directed demonstration of an exothermic reaction, students observe the dehydration of a carbohydrate using concentrated sulfuric acid. Use the demonstration to illustrate topics such as reaction kinetics, organic reaction types, and energy or heat flow.

Physical Science, Chemistry and Life Science, Biology

Grades: 8–12

Essential Question

What is the energy or heat flow through an exothermic reaction?

Demonstration Objectives

1. Predict what will happen during the demonstration.
2. Observe an exothermic reaction.
3. Trace the flow of energy through the reaction.

Next Generation Science Standards* (NGSS)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations • Students will apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena.	**Physical Science: PS1 and PS3** • PS3.B: Energy transfer—energy is transferred during an exothermic chemical reaction from the reaction vessel (system) to the environment. • PS1.B: Chemical reactions—water can be removed from carbohydrates through a dehydration reaction.	**Cause and Effect** • Students will suggest cause and effect relationships to explain and predict behaviors in complex natural systems like chemical reactions.

Safety Procedures and Precautions

Concentrated sulfuric acid is extremely corrosive and causes severe burns. Avoid acid contact with skin, eyes, and clothing.

The reaction performed in this demonstration produces dangerous sulfur dioxide fumes. It should be performed in a fume hood with adequate ventilation.

Preparation

Know and follow all federal, state, and local regulations as well as school district guidelines for the disposal of laboratory wastes.

Continued on the next page.

TIME REQUIREMENTS

PREP	ACTIVITY
15 min	10-15 min

Teacher Prep: 15 min
Demonstration: 10-15 min

SAFETY REQUIREMENTS

MATERIALS

Concentrated sulfuric acid (H_2SO_4), 30 mL
Sucrose ($C_{12}H_{22}O_{11}$), 30.0 g
Tap water
Glass stirring rod
Pipet
Digital centigram balance
600-mL beaker (or larger)
150-mL reaction beaker (tall form preferred)
100-mL graduated cylinder
Acid-resistant gloves
Weigh boat
Fume hood

HELPFUL LINKS

Carolina Science Online

REFERENCE KITS

Carolina Chemonstrations®: Carbon Snake Kit

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Teacher Procedure

1. Weigh 30 grams of sucrose and place it into the 150-mL reaction beaker.
2. Add 1 mL of water to dampen the sugar.
3. Stir it with the glass stirring rod.
4. Place the beaker on a heat-resistant surface.
5. Put on acid-resistant gloves before handling the concentrated sulfuric acid.
6. Measure 30 mL of sulfuric acid and pour the concentrated sulfuric acid into the reaction beaker.
7. Place the empty graduated cylinder in the beaker of water to dilute any residual acid.
8. Stir the contents with the glass stirring rod until the acid is distributed throughout the sugar.
9. Remove the glass stirring rod and place it in the beaker of water. Stand back from the reaction so students can observe it.

Note: *It might take several minutes for the reaction to begin.*

10. Leave the reaction beaker in the fume hood to cool. The carbon tower may have residual sulfuric acid on it. It should never be handled without acid-resistant gloves and other appropriate PPE.

Teacher Preparation and Tips

Ask students what they expect to happen.

Ask students to define the word dehydrate *and give examples of dehydration.*

If in a biology class, review the reactions for making glucose and using glucose as an energy source. Discuss the differences between glucose and sucrose.

Make sure students can see the reaction but are not exposed to the sulfuric acid fumes or any SO_2 that may be produced.

Consider asking chemistry students to explain the results based on bond energies. A discussion of entropy would also be appropriate.

Data and Observations

A carbon snake grows from the beaker and releases steam or a gas. The beaker appears to get hot since steam was released.

The carbon snake looks dry and crusty and has holes where gas could have been trapped.

Analysis and Discussion

1. What evidence did you observe that a chemical reaction took place during the demonstration?

   The formation of the carbon tube and steam being released

2. Was heat released or absorbed by the overall reaction during the demonstration? Explain the flow of heat during the reaction. (Consider asking chemistry students to explain the results based on bond energies. A discussion of entropy would also be appropriate.)

   Heat was released. The contents of the beaker got hot and turned the water to steam. Heat was transferred to the environment from the reaction beaker. This was an exothermic reaction.

3. The dehydration of sucrose ($C_{12}H_{22}O_{11}$) separates water from the carbohydrate, producing elemental carbon and water. Write a balanced chemical reaction for the dehydration of sucrose.

   $C_{12}H_{22}O_{11} \longrightarrow 12C + 11H_2O$

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TEACHER NOTES

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