#9654

CARBON DIOXIDE/ CHEMICAL REACTION RATES

LANDMARK MEDIA, 2001
Grade Levels: 10-12
15 minutes
1 Instructional Graphic Enclosed

DESCRIPTION

Experiments show the production and properties of carbon dioxide and its use as a fire extinguisher. The second part demonstrates the effect of surface area, temperature, and concentration on chemical reaction rates.

ACADEMIC STANDARDS

Subject Area: Science – Physical Sciences

★ Standard: Understands the structure and properties of matter

- Benchmark: Knows that substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties (See Instructional Goals #1 and 3.)
- Benchmark: Knows factors that influence reaction rates (e.g., types of substances involved, temperature, concentration of reactant molecules, amount of contact between reactant molecules) (See Instructional Goal #5.)

Subject Area: Science – Nature of Science

★ Standard: Understands the nature of scientific inquiry

- Benchmark: Designs and conducts a scientific investigation (e.g., formulates hypotheses, designs and executes investigations, interprets data, synthesizes evidence into explanations, propose alternative explanations for observations, critiques explanations and procedures) (See Instructional Goals #1, 3, and 5.)
- Benchmark: Establishes relationships based on evidence and logical argument (e.g., provides causes for effects) (See Instructional Goals #2 and 5.)

INSTRUCTIONAL GOALS

1. To demonstrate how carbon dioxide is formed when hydrochloric acid reacts with calcium carbonate.
2. To show how indicators are used to determine if a solution is acidic or basic.
3. To demonstrate the reaction between carbon dioxide and a solution of calcium hydroxide (limewater).

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4. To point out what carbon dioxide is used for.
5. To demonstrate three ways to increase the rate of a chemical reaction.

VOCABULARY

1. limestone
2. hydrochloric acid
3. apparatus
4. properties
5. nonmetallic oxide
6. indicator
7. carbonic acid
8. calcium hydroxide
9. calcium carbonate
10. calcium hydrogen carbonate
11. nitric acid
12. copper
13. reaction rate
14. surface area
15. concentration

BEFORE SHOWING

1. Review the properties of carbon dioxide gas: color, odor, density, solubility, reactivity.
2. Display the following: a can of carbonated beverage, bread, Alka-Seltzer, baking soda, and washing soda.
3. What gas is needed to produce these substances?
4. What properties of carbon dioxide make it ideal to produce these substances?
5. What are some other substances that are made from carbon dioxide gas?
6. Review acids and bases and the use of indicators to identify their solutions.

DURING SHOWING

1. View the video more than once, with one showing uninterrupted.
2. Pause after the experiment showing calcium carbonate changing into calcium hydrogen carbonate. Discuss why the solution became clear again.
3. Pause after the experiment comparing air with carbon dioxide. Which of the two gases has the higher density? Because of this property, what is a practical use of carbon dioxide?
4. Pause at the start of each of the three sections on chemical reaction rates. Predict which test tube will show the fastest reaction. Give a reason.

AFTER SHOWING

► Discussion Items and Questions

1. Which acid is used in the video to test for limestone? What is the chemical equation for this reaction? Could any acid be used for this test?
2. Carbon dioxide is a nonmetallic oxide. What does this mean?
3. Liquid litmus was used to test to see if the solution was acidic or basic. What did the slow change to red indicate?
4. What happens if carbon dioxide is bubbled into a solution of calcium hydroxide? What is the chemical equation for this reaction?
5. What happens to the cloudy mixture if the carbon dioxide is left bubbling for a long time?
6. How can it be determined if carbon dioxide is more dense than air?
7. Discuss possible explanations for the different reaction rates of copper with nitric acid.

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a. Why did the copper with the larger surface area react faster than the copper that was folded?
b. What would happen if the piece of copper was not folded, but broken down into smaller pieces?
c. What explanation could be given for the reaction to occur faster at a higher temperature than a lower temperature?

8. When the nitric acid was diluted, the acid was poured slowly into the water. Why is water never poured into an acid to make a dilution?
9. What could be the reason why the reaction occurred faster in the concentrated acid than in the diluted acid?

► Applications and Activities

1. Perform an experiment to test substances for carbonates or limestone.
   a. Use a variety of substances such as chalk, marble chips, granite, shells, quartz, antacids, table salt, baking soda, Epsom salts, and borax.
   b. Place a small piece of each substance into individual small plastic cups.
   c. Pour a small amount of vinegar into each cup. Observe and record the observations.
   d. Determine which of the substances tested gave off a gas. What do these substances have in common?
2. Liquid litmus was the indicator used in the video. Research other indicators that could be used. Note which colors identify the solution as acidic or basic.
3. Perform an experiment similar to the one in the video that produces solid calcium carbonate.
   a. Make some limewater by putting some solid carbon hydroxide in water and let it stand overnight. Filter off the solid.
   b. Using a drinking straw, blow carbon dioxide from the lungs into the limewater until a cloudy mixture appears.
   c. Continue to blow and see if the cloudy mixture becomes clear again.
4. Perform an experiment showing that carbon dioxide puts out fire. (See Instructional Graphic.)
5. Report on how information about reactions rates can be applied to manufacturers of chemicals and practical life situations. (Producing chemicals faster is more profitable, storing chemicals in cooler places is safer.)
6. Research and report on the various types of fire extinguishers, how they are rated, and how they put out fires.
7. Research the history of carbonated drinks. Draw a time line to indicate when different brands were invented.
8. Obtain a piece of dry ice (solid carbon dioxide). Discuss its properties and practical uses.
9. Prepare a slide show with graphics about carbon dioxide. Include information such as:
   a. physical and chemical properties

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b. occurrence in nature
c. commercial uses
d. commercial sources of carbon dioxide
e. common ways to produce it in the school laboratory

RELATED RESOURCES

- Hydrogen #9658
- Oxygen #9664

World Wide Web

The following Web sites complement the contents of this guide; they were selected by professionals who have experience in teaching deaf and hard of hearing students. Every effort was made to select accurate, educationally relevant, and "kid safe" sites. However, teachers should preview them before use. The U.S. Department of Education, the National Association of the Deaf, and the Captioned Media Program do not endorse the sites and are not responsible for their content.

- **CARBON DIOXIDE FROM ALKA-SELTZER**

Explains a procedure for finding out what occurs when Alka-Seltzer tablets are added to water. The experiment is simple enough to be able to perform at home.

http://faculty.dbcc.cc.fl.us/swansoj/Carbon_Dioxide_from_Alka-Seltzer.htm

- **ACIDITY DETERMINATION USING INDICATORS**

http://faculty.dbcc.cc.fl.us/swansoj/Acidity_Determination_Using_Indicators.htm

Outlines an experiment to find the acidity of a variety of common substances by using an indicator. The indicators are prepared from naturally occurring substances.

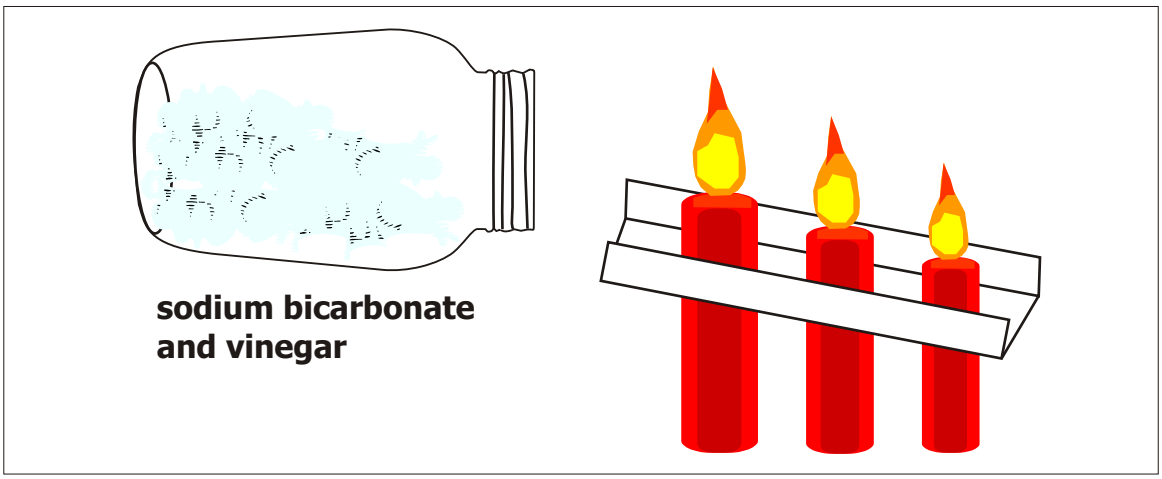
INSTRUCTIONAL GRAPHICS

- DEMONSTRATION OF CO2's ABLILTY TO EXTINGUISH FIRES

Demonstration of CO_2's Ability to Extinguish Fires

Procedure:
Place three candles of different sizes on a piece of cardboard. Make a cardboard trough with three holes, each hole just large enough to hold the candles firmly. Fit the trough over the candles so that it is just below the top of each candle. (See the picture below.) Light the candles.

Obtain a large glass jar. Put some baking soda into the jar, add vinegar, and cover the jar with a piece of cardboard until the bubbling stops. Remove the cardboard and tilt the jar over the higher end of the trough, allowing the gas to flow into the trough and put out the candle flames.



QUESTIONS:

1. What is the name of the gas that was produced?

2. Which candle was extinguished first?

3. What was the purpose of holding the glass jar closer to the end holding the taller candle?

4. What would happen if the glass jar were held closer to the end holding the shorter candle?

5. Predict what would happen if the glass jar were held over a cake that had several birthday candles burning?

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