

Factors That Affect Reaction Rate

A Carolina Essentials™ Demonstration

Student Worksheet



Overview

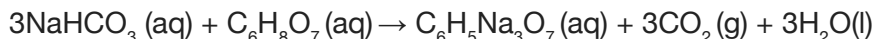
Why do pennies tarnish as they age but nickels don't? Why can a single match light a wooden splint but not a log? How quickly or slowly a reaction takes place is called **reaction rate**. Reaction rate is measured in a lab setting by observing changes in concentrations of either reactants decreasing or products increasing over time. For reactions that have highly visible changes between reactants and products, like color changes or the production of bubbles, concentration changes are inferred, so you record the times for the visible changes.

Phenomenon

1. Identify a few common reactions that you are familiar with. Think about reactions in the kitchen, laundry, or bathroom.
2. Can the rate (how fast or slow the reaction is happening) be changed?
3. What may be able to change the reaction rate?

You are going to determine the reaction rate of a common reaction today and examine ways the rate of reaction can be manipulated. The materials used, Alka-Seltzer® and water, are probably familiar to you. Time measurements are made using the disappearance of the antacid and the appearance of carbon dioxide bubbles. In a quantitative lab, change in concentration of either a reactant (disappearance) or product (appearance) would be measured over time.

The Alka-Seltzer® tablet is a mixture of sodium hydrogen carbonate (sodium bicarbonate) and citric acid. It reacts with water to produce carbon dioxide as bubbles. You can use the disappearance of the tablet as an indicator of reactants being consumed and the carbon dioxide bubbles as evidence of product being formed.



Essential Question

Can the rate at which a reaction occurs be changed?

Demonstration Objectives

1. Collect evidence to determine if reaction rates can be manipulated.
2. Collect evidence of the affect concentration, temperature, and particle size have on reaction rate.

Safety

Wear safety goggles to prevent splash hazards.

Disposal

Pour the Alka-Seltzer® water down the sink. Wash the jars with soap and water and return them to the designated space.

SAFETY REQUIREMENTS



MATERIALS

- 5 individual Alka-Seltzer® tablets
- 3 specimen jars, 4 oz
- 3 jar caps, 58 mm
- Mortar and pestle, 60 mL
- Timer or smartphone
- Hot plate or access to a microwave
- 3 beakers, 1000 mL
- Warm water, 1000 mL (40–50° C)
- Tap water, 1000 mL (20–25° C)
- Cold water, 1000 mL (5–15° C)

Procedure

1. If doing a demo, fill in the times for each reaction in the data table. If doing the activity in groups, your teacher may assign you 1 variable to investigate, or you may do all 3.
2. Temperature
 - A. Break 2 tablets into equal halves. Keep unused halves in the foil package to minimize a reaction with water in the air.
 - B. Label the jar caps as tap, warm, and cold.
 - C. Fill each jar $\frac{3}{4}$ full of water at the appropriate temperature and cap it.
 - D. Place a half tablet in the jar labeled "Warm" and immediately begin timing. Record when bubbles are first observed and when the tablet is completely reacted.
 - E. Complete the reaction with tap water and cold water and record the same information.
3. Concentration
 - A. Break a tablet into equal halves. Break a half into halves ($\frac{1}{4}$ tablet). Keep the pieces in the foil package to minimize a reaction with water in the air.
 - B. Label the jar caps as whole, $\frac{1}{2}$, and $\frac{1}{4}$.
 - C. Fill each jar $\frac{3}{4}$ full of tap water and cap it.
 - D. Place the whole tablet in the jar labeled "Whole" and immediately begin timing. Record when bubbles are first observed and when the tablet is completely reacted.
 - E. Complete the reaction with the $\frac{1}{2}$ tablet and tap water and the reaction with the $\frac{1}{4}$ tablet and tap water. Record the same information.
4. Particle Size
 - A. Break 2 tablets into equal halves. Keep the pieces in the foil package to minimize a reaction with water in the air.
 - B. Label the jar caps as whole, chunks, and powder.
 - C. Fill each jar $\frac{3}{4}$ full of tap water and cap it.
 - D. Place the unbroken $\frac{1}{2}$ tablet in the jar labeled "Whole" and immediately begin timing. Record when bubbles are first observed and when the tablet is completely reacted.
 - E. Break $\frac{1}{2}$ of a tablet into chunks. Complete the reaction with the chunks and tap water. Record the same information.
 - F. Crush $\frac{1}{2}$ of a tablet into powder using the mortar and pestle. Complete the reaction with the tablet powder and tap water. Record the same information.

Data and Observations

Group Data

Temperature and Time (s)	Concentration and Time (s)	Particle Size and Time (s)
Room	Whole	Whole
Warm	Half	Chunks
Cold	Quarter	Powder

Class Data

Temperature and Time (s)	Concentration and Time (s)	Particle Size and Time (s)
Room	Whole	Whole
Warm	Half	Chunks
Cold	Quarter	Powder

Analysis and Discussion

1. State the relationship between each variable and reaction time.
2. Use a series of particle diagrams to illustrate the variable you were assigned and the relationship between the variable and reaction rate you discovered. Use a single symbol for Alka-Seltzer[®] and a single symbol for carbon dioxide. You do not have to show every atom. Color or symbol code the particles.

Particle Diagrams