A Catalyzed Reaction: Elephant Toothpaste

A Carolina Essentials™ Demonstration

Student Worksheet

Overview

Every chemical reaction proceeds at a certain reaction rate. Reaction rates can be altered by changing temperature, pressure (if gases are involved), concentration of reactants, or particle size (if solids are involved). When a reaction time is relatively slow and needs to be faster, a catalyst can be added. A catalyzed reaction has a shorter reaction time because the addition of a catalyst lowers activation energy.

SAFETY REQUIREMENTS

Hydrogen peroxide (H_2O_2) is stable for at least a year if stored in an airtight opaque container at room temperature. Common in first aid kits, a 3% H_2O_2 solution can be applied to minor cuts and abrasions. When the solution contacts tissue and blood, it rapidly decomposes into water (H_2O) and oxygen gas (O_2) .

$$2H_2O_{2\,(l)} \rightarrow 2H_2O_{(l)} + O_{2\,(g)}$$

The oxygen gas creates a foam that lifts and washes contaminants out of the wound.

This rapid decomposition can only happen in the presence of a catalyst. In the human body that catalyst is catalase, a biological catalyst in blood and tissue. Catalase can lower the activation energy from 75 kJ/mol to about 8 kJ/mol.

In this demonstration, solid potassium iodide (KI) dissolves in aqueous H_2O_2, forming an aqueous iodide ion (I^-) and catalyzing the reaction of aqueous H_2O_2. The steps of the reaction mechanism are as follows:

Step 1	$H_2O_{2(aq)} + I^-_{(aq)} \rightarrow H_2O_{(l)} + IO^-_{(aq)}$	Slow Reaction
Step 2	$IO^-_{(aq)} + H_2O_{2\,(aq)} \rightarrow H2O_{(l)} + O_{2(g)} + I^-_{(aq)}$	Fast Reaction
	$2H_2O_{2(aq)} \rightarrow 2H_2O_{(l)} + O_{2(g)}$ $\Delta H = -196.1$ kJ/mol	Overall Net Reaction

Phenomenon

Observe the starting chemicals your teacher is using. Predict what will happen.

Essential Question

How does the addition of a catalyst affect reaction rate?

Demonstration Objectives

1. Observe a catalyzed decomposition reaction.
2. Compare the reaction rates of catalyzed and uncatalyzed reactions.

Key Materials

Identify the materials that were used in the demonstration.

Procedure

Summarize the demonstration steps.

Continued on the next page.

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Data and Observations

Reaction	Time (s)	Observations
Uncatalyzed Reaction		
Catalyzed Reaction		

Analysis and Discussion

1. What evidence indicates that a reaction took place?

2. Explain why dishwashing detergent was added to the hydrogen peroxide.

3. Explain why the solid potassium iodide was added to one of the bottles.

4. Compare the times for the 2 reactions. Using the time data and observations, write a statement explaining what catalysis is.

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