Silent Lecture

Introduction to Reaction Rates

Introduction

Students learn in different ways. By varying your teaching style you can help students sharpen their learning skills. Use the technique of the silent lecture to demonstrate the various factors that affect reaction rates.

Concepts

- Kinetics
- Reaction rate
- Single replacement reaction
- Double replacement reaction

Background

In general, the greater the rate of a chemical reaction, the less time is needed for a specific amount of reactants to be converted to products. Therefore, the rate of a reaction can be determined by observing either the disappearance of reactants or the appearance of products as a function of time. Use this set of three "silent lecture" activities to study how the surface area, reactant concentration, and the nature of the reactants affects the rates of chemical reactions.

Materials (for each demonstration)

Chalk, $CaCO_3$, 2 sticks
Copper foil, Cu, 2-cm strip
Magnesium ribbon, Mg, 2-cm pieces, 4
Hydrochloric acid solution, HCl, 0.1 M, 20mL
Hydrochloric acid solution, HCl, 1 M, 50mL
Hydrochloric acid solution, HCl, 3 M, 20mL
Zinc strip, Zn, 2-cm
Forceps
Hammer
Marking pen
Overhead projector
Petri dishes, disposable, 2-partitions
Petri dishes, disposable, 3-partitions, 2
Weighing dish, small

Safety Precautions

Hydrochloric acid solutions are toxic and corrosive. Avoid contact with skin and eyes. Magnesium is a flammable metal. Magnesium burns with an intense flame. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please consult current Material Safety Data Sheets for additional safety, handling, and disposal information.

Silent Demo #1 – The Effect of Surface Area on Reaction Rate

In this activity the effect of surface area on reaction rate will be observed in the reaction of solid calcium carbonate with a hydrochloric acid solution.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CO_2(g) + CaCl_2(aq) + H_2O(l) \qquad \textit{Equation 1}$$

Equal masses of two forms of calcium carbonate—2-cm length of chalk (large surface area) and powder (smaller surface area)—will be added to separate sections of a partitioned Petri dish containing identical volumes of 1 M hydrochloric acid. The relative rates of the two reactions will be compared by observing the rate of formation of the gas bubbles (CO_2).

Procedure

1. Place a two-partition Petri dish on the overhead projector. Using a graduated cylinder, add approximately15 mL of 1

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M hydrochloric acid to each side.

2. Break the piece of chalk in half. Tap one half with a hammer until a powder is formed. Place this powder in a small weighing dish.
3. Simultaneously add the two chalk samples (stick and powder) to the HCl solution in the separate partitions of the Petri dish. Allow the students to observe the relative rates of reaction in each partition.

Silent Demo #2 – The Effect of Reactant Concentration on Reaction Rate

In this second activity, the effect of reactant concentration on reaction rate will be observed in the reaction of solid magnesium with a hydrochloric acid solution.

$$Mg(s) + 2HCl(aq) \rightarrow H_2(g) + MgCl_2(aq)$$ *Equation 2*

Equal masses of magnesium ribbon will be added to separate sections of a partitioned Petri dish containing identical volumes of 3 M hydrochloric acid, 1 M hydrochloric acid, and 0.1 M hydrochloric acid. The relative rates of the three reactions will be compared by observing the rate of formation of the gas bubbles (H_2).

Procedure

1. Use a marking pen to label the three areas of a 3-patrition Petri dish 3 M HCl, 1 M HCl, and 0.1 M HCl.
2. Place the Petri dish on the overhead projector. Using a graduated cylinder, add approximately 10 mL of 3 M hydrochloric acid to area labeled 3 M, add 10 mL of 1 M hydrochloric acid to area labeled 1 M, and add 10 mL of 0.1 M hydrochloric acid to area labeled 0.1 M.
3. Simultaneously add the 2-cm magnesium samples to the HCl solutions in the separate partitions of the Petri dish. Allow the students to observe the relative rates of reaction in each partition.

Silent Demo #3–The Effect of the Nature of the Reactant on Reaction Rate

In this final activity, the effect of the nature of the reactant on reaction rate will be observed in the reaction of three solid metals with a hydrochloric acid solution.

$$M(s) + 2HCl(aq) \rightarrow H_2(g) + MCl_2(aq)$$ *Equation 2*

Equal masses of copper, zinc, and magnesium will be added to separate sections of a partitioned Petri dish containing identical volumes of 1 M hydrochloric acid. The relative rates of the three reactions will be compared by observing the rate of formation of the gas bubbles (H_2).

Procedure

1. Use a marking pen to label the three areas of a 3-patrition Petri dish Cu, Zn, and Mg.
2. Place the Petri dish on the overhead projector. Using a graduated cylinder, add approximately 10 mL of 1 M hydrochloric acid to each compartment.
3. Simultaneously add the 2-cm metal samples to the HCl solutions in the corresponding separate partitions of the Petri dish. Allow the students to observe the relative rates of reaction in each partition.

Tips

For effective silent demos:

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- Keep them short, less than 20 minutes.
- Limit the topic as much as possible.
- Follow up the demo with a discussion of the observations and what they mean. Interpret the evidence!
- Limit the number of silent demos.
- Be sure everything is clearly visible. The overhead projector is a valuable tool here.

Disposal

The waste solutions may be neutralized with a base and rinsed down the drain with excess water according to Flinn Suggested Disposal Method #24b. Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Silent Lecture* activity, presented by Bob Lewis, is available in *Introduction to Reaction Rates* and in *Silent Demonstrations*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Silent Lecture* are available from Flinn Scientific, Inc.

Catalog No.	Description
H0034	Hydrochloric Acid, 3 M
H0013	Hydrochloric Acid, 1 M
H0014	Hydrochloric Acid, 0.1 M
M0139	Magnesium Ribbon
C0182	Copper Strips
Z0024	Zinc Strips
AB1471	Petri Dish, Disposable, 2-partition
AB1472	Petri Dish, Disposable, 3-partition

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

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