

The Sodium Spectrum

Acid–Base Indicators



Introduction

No chemistry class is complete without the spectacular demonstration of alkali metals reacting with water. The Sodium Spectrum is a novel variation that is much safer to perform than the standard sodium demonstration of simply dropping a small piece of alkali metal into a beaker of water. It also demonstrates the colorful spectrum of colors possible with acid–base indicators.

Concepts

- Alkali metals—reaction with water
- Density
- Acid–base indicators

Materials

Sodium metal, Na, 5 small pieces

Mineral oil, 1000 mL

Phenolphthalein, 0.5% solution, 1 mL

Thymolphthalein, 0.5% solution, 1 mL

m-Nitrophenol, 1.0% solution, 1 mL

Water, 1000 mL

Glass cylinders, approximately 500-mL, 5

Ring stands and clamps (optional), 5

Safety Precautions

Sodium metal is a flammable, corrosive solid; dangerous when exposed to heat or flame; dangerous by reaction with moist air, water, or any oxidizer. Purchasing pre-cut pieces for performing this demo greatly reduces the potential hazard of the material. Sodium reacts with water to produce flammable hydrogen gas and a solution of corrosive sodium hydroxide. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review your current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. Clamp a hydrometer cylinder or large graduated cylinder to a ring stand for support (optional).
2. Add about 200 mL of water to each cylinder.
3. Add 8 drops of phenolphthalein and 2 drops of *m*-nitrophenol to the first cylinder (red).
4. Add 10–15 drops of *m*-nitrophenol to the second cylinder (yellow).
5. Add 2 drops of thymolphthalein and 12 drops of *m*-nitrophenol to the third cylinder (green).
6. Add 10 drops of thymolphthalein to the fourth cylinder (blue).
7. Add 8 drops of phenolphthalein and 2 drops of thymolphthalein to the fifth cylinder (violet).
8. Add 200 mL of mineral oil to each cylinder to form a layer above the water.

Procedure

1. Drop a piece of sodium, about the size of a small kernel of corn, into each cylinder and observe the reaction.
2. Wait about 2–3 minutes for all five indicator colors to fully develop as the aqueous solutions become basic.

Disposal

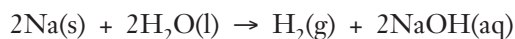
Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Do not dispose of anything until the sodium has completely reacted. The mineral oil can be stored and reused for future demonstrations and labs. The aqueous solution can be flushed down the drain with excess water according to Flinn Suggested Disposal Method #26b.

Tips

- This is a very safe method for demonstrating the reactivity of sodium metal with water. Do not attempt this demonstration with potassium.
- Make sure all the cylinders are stable and secure so they cannot tip over. Glass 500-mL graduated cylinders or large hydrometer cylinders work very well.
- This demonstration works well with very small pieces of sodium. Flinn sells a bottle with 5 small pieces of sodium metal that can actually be cut in half for this demonstration.
- Make sure the mineral oil is dry. If it is wet, the sodium may react more violently and form a less dense piece that will float on top of the mineral oil layer.

Discussion

When added to the cylinder, sodium will sink until it reaches the interface between the two layers, at which time it reacts with water, forming hydrogen gas and the base, NaOH:



The evolution of hydrogen gas is evident, and hydrogen bubbles adhering to the sodium will carry it into the hydrocarbon layer, temporarily stopping the reaction. The amount of hydrogen and heat evolved is kept under control by this swimming behavior, making this demonstration quite safe. The piece of sodium repeatedly dives down to the water-hydrocarbon interface, reacts, then “swims” back up into the hydrocarbon layer until the reaction is complete. During the reaction, the piece of sodium is largely devoid of corrosion, allowing the students to view its gray, metallic appearance.

Density is an important physical property that can be used to separate materials or control reactions. Sodium has a density of 0.97 g/mL and sits at the interface of water and a hydrocarbon. The interface between two immiscible solvents is an effective site for controlling chemical reactions. Many industrial processes use this concept to react aqueous salts with nonpolar hydrocarbons.

Connecting to the National Standards

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

Unifying Concepts and Processes: Grades K–12

Constancy, change, and measurement

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 of atoms, structure and properties of matter, chemical reactions

Acknowledgment

Special thanks to John Little, St. Mary's High School, Stockton, CA, for bringing this demonstration to our attention.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *The Sodium Spectrum* activity, presented by John Little, is available in *Acid-Base Indicators*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *The Sodium Spectrum* are available from Flinn Scientific, Inc.

Catalog No.	Description
S0329	Sodium, Bottle of 5 Small Pieces for Demonstration
M0064	Mineral Oil, Light, 500 mL
P0115	Phenolphthalein Indicator Solution, 0.5%, 100 mL
AP8599	Hydrometer Cylinder, 600-mL
N0088	<i>meta</i> -Nitrophenol, 25 g
T0073	Thymolphthalein, 5 g

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