The Chef

Preparation and Application

Introduction

When water is added to calcium oxide, the amount of heat produced is enough to fry an egg. This is an ideal demonstration when discussing exothermic reactions and enthalpy change (ΔH), but is also a fun attention-getter to use anytime.

Concepts

- Exothermic reactions
- Heat of formation

Materials

Calcium oxide lump, CaO, 100–200 g

Water, distilled, 25–100 mL

Cooking oil

Stirring rod

Small aluminum pans, the same size, 2 (small round square cake pans or disposable aluminum foil pans)

Egg, small, 1-(medium or large eggs do not work as well)

Spatula

Chef's hat (optional)ßßß

Safety Precautions

Calcium oxide is a corrosive material and a severe body tissue irritant. Avoid all body tissue contact. Reaction of calcium oxide and water will produce large amounts of heat and skin burns are possible. A lump of calcium oxide may disintegrate violently and splatter when water is added. Wash hands thoroughly when finished. This should be a teacher demonstration only. Do not allow students to perform this procedure. Do not eat the egg. Any items brought into the lab are no longer considered food grade and should never be eaten. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

In a 1-L Erlenmeyer flask, dissolve 4 g of sodium carbonate in approximately 600 mL of distilled water. Add 0.2 g of luminol, stir to dissolve. Add 24 g of sodium bicarbonate, 0.5 g of ammonium carbonate and 0.4 g of cupric sulfate. Stir to dissolve. Dilute to 1000 mL with distilled water. Stir. This is Solution A.

In a second 1-L flask, add 25 mL of 6% hydrogen peroxide. Dilute to 1000 mL with distilled water and mix well. This is Solution B.

Procedure

1. Place 100 to 200 grams of calcium oxide lumps in one of the aluminum pans. The amount depends on the size of the pan. The calcium oxide should form a single, tight layer on the bottom of the pan.
2. Add 25–100 mL of water to the calcium oxide (a little practice will help determine the right amount of water).
3. Stir the calcium oxide and water with a stirring rod.
4. Add a small amount of cooking oil to the second pan and place it directly on top of the calcium oxide in the first pan.
5. When the second pan and cooking oil seem to be getting hot, break open a small egg into the top pan.
6. Cook the egg to order.
7. See if your students can answer these questions based on the following table:

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Chemical	Heat of Formation (kJ/mole)
CaO(s)	– 635.1
$Ca(OH)_2$(s)	– 986.1
$Ca(OH)_2$(aq)	– 1002.8
H_2O(1)	– 285.8

a. If the only product is Ca(OH)2(s), calculate the heat released per mole.

b. If the only product is Ca(OH)2(aq), calculate the heat released per mole.

Solid calcium hydroxide is the main product since its solubility is only 0.0218 moles/1000 grams of water at 20 °C and decreases to 0.0090 moles/1000 grams of water at 100 °C.

Disposal

Please consult your current Flinn Scientific Catalog/Reference Manual for general guidelines and specific procedures governing the disposal of laboratory waste. The calcium oxide solution (calcium hydroxide after the demonstration) should be diluted with excess water, neutralized with a hydrochloric acid solution, and then flushed down the drain with excess water according to Flinn Suggested Disposal Method #10.

Discussion

Please consult your current Flinn Scientific Catalog/Reference Manual for general guidelines and specific procedures governing the disposal of laboratory waste. The calcium oxide solution (calcium hydroxide after the demonstration) should be diluted with excess water, neutralized with a hydrochloric acid solution, and then flushed down the drain with excess water according to Flinn Suggested Disposal Method #10.

Calcium oxide is also known as lime or quicklime and is used to make plaster, mortar, bricks, and many other construction materials. Calcium oxide is produced by heating limestone (calcium carbonate) in air. Calcium oxide readily absorbs and reacts with carbon dioxide and water to form calcium carbonate (CaCO3) and calcium hydroxide [Ca(OH)2], respectively. When calcium oxide is added to water, an exothermic reaction occurs, producing calcium hydroxide and a large amount of heat. Calcium hydroxide is used to treat acidic soils, soften water, and in the preparation of many building materials such as plaster, mortar, and bricks. The solubility of calcium hydroxide is very low, about 1.6 g/L so the product is Ca(OH)2(s), not Ca(OH)2(aq).

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s) + \text{heat}$$

$$\Delta H = \Delta H_f(\text{products}) - \Delta H_f(\text{reactants})$$

$$\Delta H = \Delta H_f[Ca(OH)_2(s)] - \{\Delta H_f[CaO(s)] + \Delta H_f[H_2O(l)]\}$$

$$\Delta H = -986.1 \text{ kJ/mole} - [-635.1 \text{ kJ/mole} + -285.8 \text{ kJ/mole}] = -65.2 \text{ kJ/mole}$$

Connecting to the National Standards

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

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
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

In a second 1-L flask, add 25 mL of 6% hydrogen peroxide. Dilute to 1000 mL with distilled water and mix well. This is Solution B.

References

Shakhashiri, B. Z. Chemical Demonstrations; University of Wisconsin: Madison, 1983; Vol. 1, p 19.

Materials for the *Chef—A Chemical Demonstration* are available from Flinn Scientific, Inc.

Catalog No.	Description
C0264	Calcium Oxide, Lump, 100 g
C0028	Calcium Oxide, Lump, 500 g

Consult the Flinn Scientific website for current prices.