Self-Igniting Candle

Introduction

With just a simple touch, a glass stirring rod will ignite a candle!

Concepts

- Thermochemistry
- Decomposition reactions

Materials

Potassium chlorate, $KClO_3$, small scoop with a microspatula
Sucrose, $C_{12}H_{22}O_{11}$, small scoop with a microspatula
Sulfuric acid, H_2SO_4, concentrated, 18 M, 1 drop
Glass stirring rod
Spatula, micro
Watch glass or Petri dish, glass
Wax candle

Safety Precautions

Potassium chlorate is a strong oxidizer and an explosion risk. Never grind with other chemicals. Sulfuric acid is extremely corrosive to skin, eyes and other tissue. Do not scale this reaction up—keep it microscale as written. After adding the drop of sulfuric acid to the candle, quickly step back as the reaction may splatter upon igniting. The light given off by the self-igniting candle may be very bright—do not stare directly at the flame. Observe the flame using peripheral vision and wear goggles with polycarbonate lenses to absorb UV radiation. 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

Shave a small well (¼–½ inch deep) around the wick of the paraffin wax candle using a micro spatula, or burn the candle for a few minutes to create a depression around the wick.

Procedure

1. Obtain a pea-size amount of potassium chlorate and gently break it apart using a micro spatula or a glass stirring rod on a watch glass or Petri dish.
2. Obtain an approximately equal amount of sucrose and mix it with the potassium chlorate in the glass dish by gently swirling the dish. *Caution:* Do NOT grind the potassium chlorate with the sucrose, simply swirl until a consistent mixture is obtained.
3. Using the microspatula, scoop the chemical mixture into the depression around the candlewick.
4. Dip a clean glass stirring rod (if a glass stirring rod was used for step 1, do NOT use the same one for this step) into 18 M sulfuric acid so that one drop of acid is suspended from the tip.
5. Touch the tip of the glass stirring rod to the candle depression containing the chemical mixture and quickly step back from the demonstration. The candlewick should ignite after a few seconds as heat from the reaction is generated.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The candle may be reused for future demonstrations. Wipe the black carbon residue from the depression around the wick using a paper towel. Run the paper towel under the faucet before placing it in the trash. Excess potassium chlorate may be reduced according to Suggested Disposal Method #12a. Sucrose may be placed in the trash according to Flinn Suggested Disposal Method #26b. Sulfuric acid may be neutralized according to Flinn Suggested Disposal Method 24a.

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Tips

- We recommend that students and others observing this demonstration also wear goggles or safety glasses with polycarbonate lenses to absorb any UV radiation given off by the bright flame.
- The bright flame may be similar to that observed with burning magnesium. The teacher may not want to repeat this demonstration multiple times in one day if the eyes become irritated.

Discussion

This demonstration involves a series of chemical reactions. The first reaction is the dehydration of sucrose by sulfuric acid to produce heat, carbon, and water vapor. Concentrated sulfuric acid is a strong dehydrating agent and will literally "pull" the water out of carbohydrates.

$$C_{12}H_{22}O_{11}(s) \xrightarrow{H_2SO_4} C(s) + H_2O\,(g) + \text{heat}$$

The heat produced by the first reaction initiates the decomposition of potassium chlorate, which generates oxygen gas as a product. Carbon produced in the dehydration reaction catalyses this second reaction.

$$\text{Heat} + 2KClO_3(s) \xrightarrow{C} 2KCl(s) + 3O_2(g)$$

A general reaction for the combination of the heat, oxygen, and carbon igniting the paraffin wax and lighting the candlewick:

$$\text{Heat} + C_nH_{2n+2}(s) + O_2(g) \longrightarrow CO_2(g) + H_2O(g) + \text{heat} + \text{light}$$

A larger scale demonstration of the dehydration of sucrose by sulfuric acid is called the "Carbon Souffle" and is available from Flinn Scientific as a free ChemFax.

Connecting to the National Standards

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

Unifying concepts and processes: Grades K–12
Consistancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy
Content Standards: Grades 9–12
Content Standard B: Physical Science, chemical reactions, interactions of energy and matter

Materials for *Self-Igniting Candle* are available from Flinn Scientific, Inc.

Catalog No.	Description
P0040	Potassium Chlorate, Laboratory Grade, 500 g
S0135	Sucrose, Laboratory Grade, 1 kg
S0228	Sulfuric Acid, 18 M, 100 mL
C0192	Candles, White, 50 × 1¼0, pkg. 4
AP1323	Spatula, Micro, pkg. 8

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