The Hungry Dragon

Combustion Reactions

Introduction

Coloured flames and smoke shoot out of a large test tube when wooden splints or pieces of candy are tossed down its throat!

Concepts

- Combustion reactions
- Exothermic reactions
- Oxidation and oxidizing agents
- Organic chemistry

Materials

Large Pyrex® test tubes, 25 × 200 mm (heavy-walled ignition tubes), 2
Potassium chlorate, $KClO_3$, 5 g
Sodium chlorate, $NaClO_3$, 5 g
Ring stands, 2
Utility clamps, *without rubber sleeves*, 2
Meker or Bunsen burners, 2
Wooden splints
Candies, small (M&Ms®, Gummy Bears®, etc.)
Safety shield
Tongs or forceps, 2
Table top protection (see *Safety Precautions*)

Safety Precautions

This is a teacher demonstration only. Never scale this demonstration up. Perform this demonstration using a safety shield. Use only heavy-walled Pyrex® test tubes and always inspect the test tube for cracks or chips before use. Make sure the potassium chlorate is uncontaminated—contaminated potassium chlorate can flame or explode unexpectedly when heated or moderately shocked. Potassium chlorate and sodium chlorate are strong oxidizers and dangerous fire risks. Contact of potassium or sodium chlorate with metal powders, nonmetals such as sulfur, and combustible organic powders may cause fires or explosions. Keep away from contact with organic materials, including rubber stoppers, rubber tubing, etc. Avoid contact with eyes and skin. Do NOT dispose of excess sodium or potassium chlorate in the trash.

Do this activity in an operating fume hood. Cover benchtop with non-flammable covering such as sheet metal or fiberglass sheeting (Sheetrock™ or wallboard also works well). Insert flammables with tongs or forceps. Keep hands back! Never stand in front of the apparatus or aim it at anyone. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. All observers must also wear chemical splash goggles. Please review current Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

Set up the apparatus as shown in the diagram. Be certain that the test tube is clamped securely to the stand. Adjust the burner so the tip of the flame will just touch the bottom of the test tube. *Never stand in front of the apparatus or aim it at anyone. Read all safety precautions and use a safety shield.*

Procedure

1. Place 5 g of pure potassium chlorate into the test tube. Place 5 g of sodium chlorate into a second test tube. Be certain each test tube is well clamped to the stands. Slant tubes as indicated in Figure 1 on the next page.
2. Light the burners and carefully heat the potassium chlorate until it has melted.
3. Using tongs or forceps, carefully thrust a wooden splint into the mouth of each test tube. Step back as flames and smoke are given off! The lavender or purple glow is due to potassium, the yellow-orange glow is from the sodium.
4. Add additional splints, one at a time until oxygen gas production is exhausted. *Note:* Candies may be substituted in place of the splints if desired. The “Dragon” eats the candy, expelling smoke and flames.

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Disposal

It is recommended that you consult your local school board and/or municipal regulations for proper disposal methods that may apply before proceeding.

Tips

- This demonstration is dangerous if not performed properly. Carefully read and follow all safety precautions before carrying out the reaction. Practice the demonstration before doing it in front of the class.
- Please do not do this demonstration if you do not have the necessary equipment or experience to perform it safely.

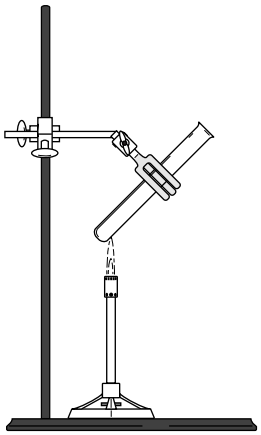

Figure 1.

Discussion

When solid potassium chlorate and sodium chlorate are heated, they undergo decomposition reactions producing solid potassium and sodium chloride, respectively, and oxygen gas (Equations 1 and 2). When an organic substance, such as a wooden splint or piece of candy, is added to the molten potassium or sodium chlorate, a combustion reaction occurs between the organic substance and the oxygen produced in the decomposition reaction. Equation 3 is the balanced chemical equation for the combustion of sucrose. The combustion reaction is highly exothermic, producing intense light, heat, and large amounts of combustion products. The colour of the flame corresponds to the characteristic flame test–emission colour of the alkali metal. The reaction with potassium chlorate produces an intense lavender or purple flame, while the reaction with sodium chlorate burns with a bright yellow-orange flame.

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g) \qquad \textit{Equation 1}$$

$$2NaClO_3(s) \rightarrow 2NaCl(s) + 3O_2(g) \qquad \textit{Equation 2}$$

$$C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(g) + \text{Energy} \qquad \textit{Equation 3}$$

Acknowledgments

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Flinn Video Series

A video of the *The Hungry Dragon* activity, presented by Jamie Benigna, is available at flinnsci.ca.

Materials for *The Hungry Dragon* are available from Flinn Scientific Canada Inc.

Catalogue No.	Description
PJ0040	Potassium Chlorate, 500 g
GP6077	Pyrex® Test Tube, Heavy-walled, 25 × 200 mm
AP4444	Splints, Wood, Pkg/100

Consult www.flinnsci.ca or your *Flinn Scientific Canada Catalogue/Reference Manual* for current prices.