Mystery Fire Message

Introduction

A glowing splint touched to an apparently blank piece of paper starts a combustion reaction that mysteriously traces a message in the paper.

Concepts

- Combustible materials
- Decomposition reaction

Materials

Potassium nitrate solution, KNO_3, saturated, 10 mL
Manila paper or newsprint
Masking tape
Matches
Paintbrush, small tip
Wooden splints

Safety Precautions

This demonstration produces a significant amount of smoke from the smoldering paper and should be carried out in a well-ventilated area. Potassium nitrate is a strong oxidant and a fire and explosion risk when heated or in contact with organic material. It is also a skin irritant. Wear chemical-resistant gloves, a chemical-resistant apron, and chemical splash goggles. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

Prepare the saturated potassium nitrate solution by stirring 5 to 6 grams of the solid (KNO_3) in 10 mL of distilled or deionized water. All the KNO_3 solid may not dissolve.

Procedure

1. Take a small paintbrush, dip it into the saturated potassium nitrate solution, and paint a message on the paper. Make certain that all the letters are connected so the entire message will burn into the paper. *Note:* Watch out for letters with closed circles, because the center of the circle will fall out when the message burns.
2. If using manila paper, paint over the message a second time.
3. Tape the paper to the edge of a desk, lab bench, or chalk tray so that it hangs freely. Whatever is close to the paper when the message burns may also be charred.
4. Using a match, light a wooden splint and allow it to burn for 10–15 seconds.
5. Blow out the splint and touch the glowing end to the paper along the path of the message. The glowing splint may need to be blown on as it touches the paper to ignite the message.
6. Wait and watch as the message burns into the paper. This process can take up to ten minutes, so other demonstrations can be carried out while the message appears.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The excess potassium nitrate solution may be disposed of according to Flinn Suggested Disposal Method #26b.

Tips

- Letters with closed circles can be painted without completely closing the circle. Leaving about one inch open will permit reading the message while preventing the center from falling out.

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- Notebook paper or copy paper will not work for this demonstration. Packing paper from Flinn orders works very well.

Discussion

Potassium nitrate (nitre, saltpeter) is an odorless, white, crystalline solid and was one of the original components of gun powder. Today, it is used in fireworks and in the manufacture of glass, matches, gun powder, and blasting powders. It is also used in freezing mixtures, impregnating candle wicks, and tempering steel. Mixtures of potassium nitrate and combustible materials are readily ignited, as in this reaction. When the potassium nitrate is touched by the glowing splint, it decomposes to potassium nitrate, KNO_2, and oxygen, O_2 (Equation 1).

$$2KNO_3(s) = \text{heat} \rightarrow 2KNO_2(s) + O_2(g) \qquad \textit{Equation 1}$$

The released oxygen then reacts with the paper, producing a combustion reaction. The energy released from the combustion is sufficient to start the reaction cycle of decomposition and combustion for the adjacent saturated paper. The energy released is insufficient to ignite the paper not painted with the potassium nitrate solution. Mixtures with finely divided combustible materials, like carbon and sulfur in gun powder, can react explosively.

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, transfer of energy
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Acknowledgment

Special thanks to Kathleen Holley of Crowley High School in Crowley, Texas, for showing us, and providing the instructions for, this demonstration.

Reference

Bretherick, L. *Hazards in the Chemical Laboratory;* The Royal Society of Chemistry: London, 1986.

Lanners, E. *Secrets of 123 Classic Science Tricks and Experiments;* TAB: 1987.

Materials for *Mystery Fire Message* are available from Flinn Scientific, Inc.

Catalog No.	Description
P0070	Potassium nitrate, 100 g
AP4444	Wooden splints, pkg. 100

Consult the Flinn Scientific website for current prices.