Writing in Blood-Red Iron

Introduction

A seemingly plain piece of paper is sprayed with an aqueous iron (III) chloride solution and a blood-red message appears!

Concepts

- Complex ions
- Chemical reactions

Materials

Iron(III) chloride solution, $FeCl_3$, 0.1 M, 250 mL
Potassium thiocyanate solution, KSCN, 0.1 M, 25 mL
Blotting paper, 1 sheet*
Tape
Cotton swabs or brushes
Paper towels
Spray bottle

Safety Precautions

Potassium thiocyanate solution is slightly toxic by ingestion. The solution may generate toxic hydrogen cyanide gas if heated with concentrated acids. Do not heat and avoid contact with concentrated acids. Iron(III) chloride solution is irritating to the skin and eyes. Do not spray near anyone when developing the signs. Avoid contact of all chemicals with eyes and skin. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water after completing the demonstration. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

Dip cotton swabs or a fine brush into the potassium thiocyanate solution. Use the swabs to draw a message on blotting paper. Allow the sign to air dry. The writing should not be visible (the solution is colorless or pale yellow.)

Procedure

1. Tape the sign on the presentation board in the classroom or lab. Place paper towels underneath the sign.
2. Fill the spray bottle about one-third full with the iron(III) chloride solution just before beginning the demonstration.
3. Set the stage about the contents of the message. (see the *Tips* section).
4. Observe the color changes. *(The message will turn red.)*

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. Leftover potassium thiocyanate and iron(III) chloride solutions can be saved for future use (if less than six months) or disposed of by Flinn Suggested Disposal Method #26b. Do not store the iron(III) chloride solution in the spray bottle. Chloride ions will corrode the spray mechanism.

Tips

- For best results, use absorbent blotting or chromatography paper to draw the messages. Regular writing paper will cause the liquid to run off, making a mess.
- The message has more meaning in a story. Tell where and when the message was found and what it is supposed to reveal. For example, written on the wall in the book, *Harry Potter and the Chamber of Secrets*, were two different messages: “The chamber of secrets has been opened, enemies of the Heir beware!” or “Her skeleton will remain in

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the chamber forever." Have fun with the messages using references students may know or make up your own.

- The chemical reaction that is used to develop the message in this activity is likely to come up again several times over the course of the year in chemistry. The formation of iron(III)–thiocyanate complex ions is a classic reversible reaction that is usually studied in more detail in a unit on equilibrium.
- A video of this demonstration, *Opening Day Signs for Chemistry,* presented by Annis Hapkiewicz, is available for viewing as part of the Flinn Scientific "Teaching Chemistry" eLearning Video Series. Please visit the eLearning Web site at http://elearning.flinnsci.com for viewing information. The video is part of *The Exciting Nature of Chemistry* video package.

Discussion

A *chemical change* is defined as a change in the composition and properties of a substance. The transformation of old materials (reactants) into new substances (products) as a result of a chemical change is called a *chemical reaction*. Both in the natural world and in the laboratory we recognize that a chemical reaction has occurred by observing the appearance of products with physical and chemical properties different from the reactants from which they were made.

There are many types of observable changes that can be used to identify that a chemical reaction has occurred. Signs of chemical change include:

- formation of solid particles, called a ***precipitate***, upon mixing of two liquids
- release of ***gas*** bubbles that are not due to a physical change (such as boiling)
- a ***color change*** that does not result from dilution or color mixing
- a ***temperature change*** that is not caused by external heating or cooling.

These signs of change illustrate the dynamic nature of chemical reactions. What they do not show, however, is where the real action is taking place—at the level of atoms and molecules. Chemical reactions arise due to the rearrangement of atoms and molecules. Compounds are formed when atoms of different elements combine to form molecules. Molecules of one compound can exchange atoms or groups of atoms with other elements or compounds, generating new substances.

Thiocyanate ions, SCN^-, are added to the blotting paper in the preparation step. When an excess of hydrated iron(III) ions from the iron(III) chloride solution are mixed with a small amount of potassium thiocyanate, complex ions are formed (Equation 1).

$$[Fe(H_2O)_6]^{3+}(aq) + SCN^-(aq) \rightarrow [Fe(H_2O)_5SCN]^{2+}(aq) \qquad \textit{Equation 1}$$

(pale yellow) limited quantity (orange-red)
Yellow *Colorless* *Dark red*

Iron(III) ions react with thiocyanate ions to form dark-red complex ions having the general formula $Fe(SCN)_n^{3-n}$. (The product is often assumed to be just $FeSCN^{2+}$.) See Equation 2.

$$Fe^{3+}(aq) + SCN^-(aq) \rightarrow Fe(SCN)_n^{3-n}(aq) \qquad \textit{Equation 2}$$

Yellow *Colorless* *Dark red*

Connecting to the National Standards

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

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard F: Science in Personal and Social Perspectives; science and technology in society.

Content Standards: Grades 9–12

Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter
Content Standard F: Science in Personal and Social Perspectives; science and technology in local, national, and global challenges.

Materials for *Writing in Blood-Red Iron* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP7503	Chemical Wizardry—Multi-Demonstration Kit
F0045	Iron(III) Chloride Solution, 0.1 M
P0178	Potassium Thiocyanate Solution, 0.1 M
AP5338	Bottle, Spray Mist Dispenser, 16 oz
FB0678	Blotting Paper, 12" x 19", 10 sheets/pacakge

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