Iron in Dollar Bills

Separation of Mixtures

Introduction

If asked to choose which would be most attracted by a magnet: a penny, a dime or a dollar bill, most students would probably choose the penny or the dime, but they would be wrong! That's because there is more iron in a dollar bill than there is in either the penny or the dime! What is it doing in there and is it possible to extract it?

Concepts

- Separation of mixtures
- Heterogeneous mixtures

Materials

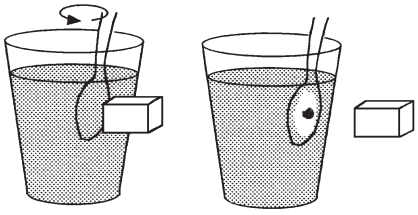
Hydrochloric acid, HCl, 3 M, 20 mL
Potassium thiocyanate solution, KSCN, 1 M, a few drops
Beaker, 100-mL
Blender
Cup, clear plastic
Dollar bill
Mega-magnet
Plastic spoon, white

Safety Precautions

Hydrochloric acid solution is severely corrosive to eyes, skin and other tissue. Potassium thiocyanate solution is moderately toxic by ingestion; emits toxic fumes of cyanide if strongly heated or in contact with concentrated acids. 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.

Procedure

1. First show there is an attraction between a magnet and the dark ink of a dollar bill by dangling the bill loosely by the edge in one hand and approaching a bottom corner from the side with one pole of the magnet. You should see a definite deflection of the bill toward the magnet (see Figure 1).
2. Pose the question: "Can the magnetic ink used in paper currency be separated and analyzed?" Then place the dollar bill in the blender along with 1 cup of water. Blend the bill for two to three minutes, until all large pieces have been thoroughly chopped up.
3. Pour the liquid (a 1 dolar solution!?) into a clear plastic cup.
4. Hold one pole of the magnet against the outside of the cup about midway up, and use the plastic spoon to gently stir the liquid for a minute or so (see Figure 2).



5. Lift the magnet aside and observe. On the inside surface of the cup, just behind where the magnet was positioned, you should be able to observe a dark, concentrated spot of black ink (see Figure 3).
6. Scoop out the black spot with the plastic spoon and place the iron particles in a 100-mL beaker..
7. Add 20 mL of 3 M HCl to the beaker and swirl to dissolve the iron.
8. Add a few drops of 1 M potassium thiocyanate. The dark red color produced is the $FeSCN^{2+}$ complex ion, confirming that the ink was indeed iron-based.

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Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste The resulting solution may be neutralized and disposed of down the drain with excess water according to Flinn Suggested Disposal Method #24b.

Tips

• Never use your own dollar. Before they know what you're going to do, ask to borrow one from the class—this makes the demonstration even more fun. When the student who volunteered the dollar sees it go into the blender, his or her jaw usually hits the floor. You can be reassuring and say that you're just trying to increase his "liquid assets" or that you heard she had a "cash flow" problem. When the demonstration is over, hand the cup of blended money back to its owner saying "and you were afraid you wouldn't get your dollar back," or "Here's your change." You may want to give him or her one of yours at the end of the class.

• New dollar bills work best. If the bill is faded, you may find very little iron in it.

• To keep the iron spot from falling and to increase the visibility of the spot, hold the back of the plastic spoon against the back side of the spot and then lift the magnet away, as shown in Figure 3.

• You may have heard that defacing currency is a federal offense. It is only illegal if done for fraudulent purposes.

Discussion

The deflecting of the dollar bill with the magnet is a demonstration that has been around for years. Why does the government use iron in its paper currency ink? Two reasonable explanations have been proposed. First, the iron is just one of many anti-counterfeiting measures—supposedly it is rather difficult to get the iron suspended in the ink. Second, the iron pattern enables vending machines to magnetically "read" the currency and to distinguish between a $1-bill, a $5-bill, or just a blank piece of paper! Whether it is one of these two reasons or whether it turns out the best ink to use just happens to contain elemental iron dust, the demonstration still serves as a good thought provoker!

Below are the reactions involved when adding the HCl and KSCN solutions to the iron.

Dissolving Reaction $2Fe(s) + 6H^+(aq) \rightarrow 3H_2(g) + 2Fe^{3+}(aq)$

Testing Reaction $Fe^{3+}(aq) + SCN^-(aq) \rightarrow FeSCN^{2+}(aq)$

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
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 and properties of matter, chemical reactions

Acknowledgments

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Reference

ChemCom, Heikkinen, H., Ed.; American Chemical Society, Kendall/Hunt: Dubuque, Iowa, 1988, p 31.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Iron in Dollar Bills* activity, presented by Bob Becker, is available in *Separation of Mixtures*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Iron in Dollar Bills* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP1738	Mega-Magnet
AP1369	Blender, Single-Speed
H0034	Hydrochloric Acid Solution, 3 M, 500 mL
P0226	Potassium Thiocyanate Solution, 1 M, 500 mL

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