

**A demonstration from the 2010 presentation of
*Once Upon a Christmas Cheery in the Lab of Shakhashiri***

WHERE'S THE BLUE?

A colorless solution turns blue after a 9-volt battery is dropped into it. The blue solution turns colorless when it is poured into a second beaker. A red cloth turns blue when it is dipped into the colorless solution. The blue cloth returns to red when it is immersed in a second colorless solution. A third colorless solution turns blue when liquid from the red cloth is wrung into it.



MATERIALS

- 0.5 g Congo red dye, $C_{32}H_{22}N_6Na_2O_6S_2$
- 1.85 L distilled water
- 2 g potassium iodide, KI
- 10 mL 3 M sulfuric acid, H_2SO_4 (To prepare 100 mL of stock solution, slowly pour 17 mL of concentrated (18 M) H_2SO_4 into 80 mL of distilled water, and after the mixture has cooled, dilute it to a volume of 100 mL with distilled water.)
- 5 g sodium hydroxide, NaOH
- 5 mL thymolphthalein indicator solution (To prepare 100 mL of stock solution, dissolve 0.04 g thymolphthalein in 50 mL of ethanol and add 50 mL of distilled water.)
- 10 mL 1% starch solution (To prepare 100 mL of stock solution, heat 100 mL water to boiling in a 250-mL beaker, make a slurry of 1 g of soluble (potato) starch in 5 mL of water, while stirring pour the slurry into the boiling water, and continue to stir and boil the mixture until the starch has dissolved.)
- 2 g ascorbic acid, $C_6H_8O_6$
- plastic or rubber gloves
- 600-mL beaker
- hot plate
- stirring rod
- thermometer
- 20- x 20-cm piece of white cotton cloth
- four 1-liter beakers
- marking pen
- 9-volt battery

PROCEDURE

Preparation

First, prepare the red cloth. Wearing gloves to avoid staining the skin, put 0.5 g of Congo red dye into a 600-mL beaker and add 250 mL of distilled water. Stir the mixture until the dye has dissolved. On a

hot plate, heat the solution to 60°C. Completely immerse the 20-cm x 20-cm piece of white cotton cloth in the warm dye solution. Keep the cloth in the warm solution for about 15 minutes, stirring the mixture occasionally to assure uniform dyeing of the cloth. Remove the cloth from the solution, wring out as much solution as possible, and then rinse the cloth several times in fresh water. Hang the cloth and allow it to dry.

Number four 1-liter beakers from 1 to 4.

Put 600 mL of distilled water into beaker 1. Add 2 g of KI to the beaker and stir the mixture until all of the solid has dissolved. Add 10 mL of 3 M sulfuric acid and stir the mixture.

Put 2 g of solid ascorbic acid into beaker 2.

Put 500 mL of distilled water into beaker 3. Add 5 g of solid NaOH and stir the mixture until the solid dissolves.

Put 500 mL of distilled water into beaker 4. Add 5 mL of thymolphthalein indicator solution to the water and stir the mixture.

Presentation

Explain that you are trying to obtain a blue color. Pour 10 mL of starch solution into beaker 1. The mixture remains colorless. Drop a 9-volt battery into the solution. Blue color will appear near the terminals of the battery. Stir to distribute the blue color.

After the solution has turned deep blue (in about 1 minute), explain that you want to retrieve the battery. Decant the blue solution from beaker 1 into beaker 2, allowing you to pick the battery from beaker 1. The blue solution turns colorless in beaker 2.

Explain that the blue is still in the solution and that it can be absorbed into the red cloth. Immerse the red dyed cloth into the solution in beaker 2. The cloth turns blue.

Explain that you prefer the cloth when it is red. Remove the cloth from beaker 2, and immerse the cloth in the solution in beaker 3. The cloth turns red again.

Explain that blue is still in the cloth. Remove the cloth from beaker 3 without wringing it. Hold the wet cloth over beaker 4 and wring it out. The liquid squeezed out of the cloth will cause the liquid in beaker 4 to turn blue.

HAZARDS

Solid sodium hydroxide can cause severe burns to the eyes, skin, and mucous membranes. Dust from the solid is very irritating to the eyes and respiratory system.

Because concentrated sulfuric acid is both a strong acid and a powerful oxidizing agent, it must be handled with great care. The dilution of concentrated sulfuric acid is highly exothermic and releases enough energy to cause burns. Therefore, when preparing dilute solutions of sulfuric acid, always add the acid to water, slowly and with stirring.

DISPOSAL

The waste solutions should be flushed down the drain with water.

The red cloth may be reused. It should be rinsed in fresh water and allowed to dry before storing.

The battery may be used several times. It should be rinsed and dried soon after use to prolong its usefulness. When exhausted, it should be discarded at a recycling site.