

# Goldenrod Isn't Always!

Some brands of goldenrod paper contain the dye C.I. Direct Yellow 4. This dye is an acid-base indicator and, as such, is yellow in its acid form and red in its base form. Using this dye (or other similar indicators) to classify a solution as acidic, basic, or neutral involves testing the solution on both forms of the indicator. If the acid form color changes, the solution is basic; if the base form color changes, the solution is acidic; and if neither changes, the solution is neutral.

## Materials

- sheet of Springhill® goldenrod paper that contains C.I. Direct Yellow 4
- shallow pan
- toothpicks, cotton swabs, or small spoon
- several plastic cups or glasses
- teaspoon measure
- candle or paraffin
- 3 teaspoons baking soda
- spray bottle of ammonia-containing cleaner
- at least 1 of the following:
  - vinegar
  - citrus juice (orange, lemon, or grapefruit)
- at least 4 of the following aqueous test solutions
  - colorless soft drink
  - milk
  - milk of magnesia
  - approximately 1 teaspoon table salt in 1 cup water
  - approximately 1 teaspoon table sugar in 1 cup water
  - approximately 1 teaspoon baking powder in 1 cup water
  - approximately 1 teaspoon detergent in 1 cup water
  - approximately 1 teaspoon shampoo in 1 cup water
  - approximately 1 teaspoon crushed antacid tablet in 1 cup water
- goggles

## Safety

If any solutions other than those listed are tested, it is advisable to wear goggles, because some household products can be harmful. Due to their corrosive nature, do not test oven or toilet-bowl cleaners. Household ammonia or its vapors can damage the eyes—should contact with the eyes occur, rinse the affected area with water for 15 minutes and seek medical attention. Do not wear contact lenses when working with ammonia because its vapors may condense on the contact lenses and damage the eye.

## Exploration

- Step 1 Dissolve 3 teaspoons baking soda in a glass of water and pour into the shallow pan. Cut off a 1-inch x 3-inch strip of the goldenrod paper. Allow it to soak in the baking soda solution for at least 5 minutes, then remove it and record its color. Allow the paper to dry and record its color. Cut this treated paper (base form) and a similar-sized piece of untreated paper (acid form) into ten smaller pieces.

- Step 2 Using a toothpick, cotton swab, or spoon, spot either vinegar or citrus juice on both a piece of treated and untreated goldenrod paper and record each color. What is the color of the acid form and the base form of C.I. Direct Yellow 4?
- Step 3 As in Step 2, spot each of 4 test solutions on both a piece of treated and untreated goldenrod paper and record each color. Classify each solution as acidic, basic, or neutral.
- Step 4 Cut off another strip of goldenrod paper. Write your initials on it with a candle or a piece of paraffin. Spray the paper with an ammonia-containing cleaner. What do you observe? Explain.

### **Challenge**

When is the color of goldenrod paper not yellow and how can this paper be used to classify various household materials as acidic, basic, or neutral?

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## Concepts

acid, base, acid-base indicator

## Expected Student Responses to Exploration

Step 1 (a) The paper is a bright orange color when it is wet.

(b) The paper turns a deep red when dry.

Step 2 (a) solution      red paper      yellow paper      vinegar (or citrus)      yellow yellow

(b) The acid form of the dye is yellow and the base form of the dye is red.

Step 3 (a) solution      red paper      yellow paper      (b) acidity

soft drink              yellow              yellow              acidic

milk                      red                      yellow              neutral

milk magnesia          red                      red                      basic

table salt                red                      yellow              neutral

sugar                      red                      yellow              neutral

baking powder          red                      rose                      basic

detergent                red                      red                      basic

shampoo                 rose                      rose                      basic

antacid tablet          red                      rose                      basic

Step 4 (a) All the yellow paper turns to red, except for the student's initials.

(b) The ammonia must form a basic aqueous solution. The wax coats the paper, protecting the dye underneath from being changed.

## Expected Student Answer to Challenge

Goldenrod is not yellow when in contact with a base. The results of testing a household material on both red (base form) and yellow (acid form) goldenrod can be used to classify it as acidic if the red turns yellow, basic if the yellow turns red, and neutral if neither changes color.

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