

# Disappearing Ink

## Introduction

Is it magic? Is it a mystery? No—it is just science. Students write secret messages using disappearing ink and then use chemistry to develop and transmit the messages.

## Concepts

- Acids and bases
- pH
- Acid–base indicators

## Materials

- Disappearing ink, 50 mL
- Sodium hydroxide solution, NaOH, 0.01 M, 75 mL
- Beaker(s), 50- or 100-mL
- Cotton-tipped applicators (e.g., Q-tips®)
- Filter paper or chromatography paper
- Glass or plastic demonstration tray
- Spray bottle(s)



## Safety Precautions

*Thymolphthalein solution contains ethyl alcohol and is an alkaline solution; moderately toxic by ingestion. Sodium hydroxide solution is a body tissue irritant. Wear chemical splash goggles and chemical-resistant gloves. Avoid exposure of all chemicals to eyes and skin. Do not allow students to place disappearing ink on their own clothing or on the clothing of others. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.*

## Preparation

Prepare disappearing ink by purchasing 0.04% thymolphthalein solution and adding dilute sodium hydroxide dropwise until it is blue. Disappearing ink is also made by dissolving 0.1 g of thymolphthalein powder in 50 mL of 95% ethyl alcohol then adding 200 mL of deionized water. Add 1 M sodium hydroxide solution dropwise until the solution is blue (about 1 mL).

## Procedure

1. Use a cotton-tipped applicator to write a message with thymolphthalein “disappearing ink” solution on a large piece of chromatography or filter paper. The color will fade from blue to colorless almost immediately.
2. Allow the secret message to dry and disappear completely. If necessary, blow on the secret message to make the ink dry and disappear faster.
3. Once the ink has disappeared it can be “developed” (made to reappear) by spraying the message with a mist of 0.01 M NaOH solution from a spray bottle. The blue color will reappear almost instantly and will usually last 3–5 minutes before it fades again.
4. Have students experiment with different solutions to determine the conditions which make the ink color reappear. Some solutions to try include washing soda (sodium carbonate) solution and household (sudsy) ammonia solution. Windex™ or other glass cleaning solutions do not work. Ask the students to estimate the pH range at which the indicator transition takes place.

## 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. The disappearing ink and any remaining solutions may be stored for future use or neutralized according to Flinn Suggested Disposal Method #10.

## Tips

- Writing and developing disappearing ink messages works best on filter paper or chromatography paper. Some lower-grade filter papers tend to absorb the ink or developing solutions too fast and the resulting message may look more

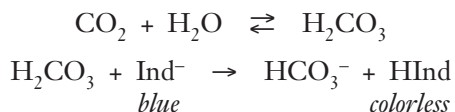
like an

ink-blot test rather than a written message. Index cards or plain paper, on the other hand, do not absorb the solutions as well and the solutions tend to simply “run off.”

- Set up a special developing area for spraying the sodium hydroxide solution. This can be done over a glass tray or a plastic demonstration-style tray to contain the sprayed mist. Always spray in a direction away from others in the lab. Good housekeeping is important—clean up any residual basic solution from the work area after the demonstration is over.
- If, after repeated use and exposure to air over time, the original disappearing ink solution loses its deep blue color, the color can be restored by the addition of a few drops of the 0.1 M sodium hydroxide solution. Do not add too much or it may take too long to “disappear.”
- This is an ideal activity for open-house days in the chemistry lab. Have students prepare filter paper “cards” to hand out to parents and other visitors as they enter the classroom. The visitors can be directed to a special area where volunteers can develop their secret messages—Welcome, Chemistry is pHun, Chemists Love Solutions, ChemMystery, etc. (Volunteers should wear goggles and gloves and should spray in a direction away from all visitors—the hood is a perfect place to set up developing trays.)

## Discussion

Disappearing ink is a mixture of thymolphthalein indicator, ethyl alcohol, sodium hydroxide solution, and water at pH 11. When the ink is applied to paper, the blue color quickly vanishes. The disappearance of the blue color in air is due to the effect of  $\text{CO}_2$ , which reacts with moisture in the air and on the paper to form carbonic acid ( $\text{H}_2\text{CO}_3$ )—the pH change is enough to push the basic form of the indicator ( $\text{Ind}^-$ ) back to its colorless acidic form ( $\text{HInd}$ ).



Thymolphthalein is a weak organic acid that behaves as an acid–base indicator in the pH range 9.3 (colorless) to 10.5 (blue). It exists in two different forms—an acid form  $\text{HInd}$ , which is colorless, and a corresponding conjugate base form  $\text{Ind}^-$ , which is blue. The color transition range for an acid–base indicator depends on the strength of the weak acid  $\text{HInd}$ . The color change is due to the changing proportion of the indicator molecules in the acid or base form.

## Connecting to the National Standards

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

**Unifying Concepts and Process: Grades K–12**

Evidence, models, and exploration

**Content Standards: Grades 5–8**

Content Standard A: Science as Inquiry

Content Standard B: Physical Science, properties and changes of properties in matter

**Content Standards: Grades 9–12**

Content Standard A: Science as Inquiry

Content Standard B: Physical Science, chemical reactions

**Materials for *Disappearing Ink* are available from Flinn Scientific, Inc.**

A demonstration kit with enough materials for several classes of students to perform this demonstration is also available.

Catalog No.	Description
T0072	Thymolphthalein, 1 g
T0079	Thymolphthalein Indicator Solution, 0.04%, 100 mL
S0149	Sodium Hydroxide Solution, 0.1 M, 500 mL
E0009	Ethyl Alcohol, 95%, 500 mL
AP5429	Large Demonstration Tray
AP5338	Spray Mist Dispenser Bottle
AP8894	Disappearing Ink—Chemical Demonstration Kit

Consult the [Flinn Scientific website](#) for current prices.