

DISAPPEARING INK

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Introduction

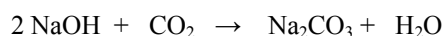
Disappearing ink is a dark blue water-based solution which, when squirted on clothing, table cloths, or other materials, will disappear within minutes leaving only a colorless wet spot that will evaporate slowly. When dry, there may be a small amount of white residue that remains visible on dark clothing.

The pH of the commercial disappearing ink solution is about 10-11 (moderate to strong base). Addition of acid, such as hydrochloric acid, HCl, causes the solution to turn colorless forming a white precipitate. Addition of base, such as sodium hydroxide, NaOH, dissolves the precipitate and restores the blue color. If the "ink" is squirted on cloth, the colorless wet spot that remains after the color fades is slightly acidic with a pH of about 5-6. Addition of base to the wet spot causes the blue color to return. The blue color will also return if base is placed on the dried "ink" spot.

Due to its color change with pH, the material used to make the disappearing ink was identified as an acid-base indicator called thymolphthalein, $C_{28}H_{30}O_4$ (colorless to blue at pH 9.3-10.5). (See Figure 1)

The disappearing ink is made by dissolving a small amount of thymolphthalein in ethyl alcohol followed by dilution with water. The blue color is obtained by the addition of a sodium hydroxide solution.

The pH change which causes the color to fade is a result of the reaction of the sodium hydroxide, NaOH, with carbon dioxide, CO_2 , in the air, to form sodium carbonate, Na_2CO_3 , according to the following reaction:



Once the sodium hydroxide is neutralized, the acidity of the alcohol changes the "ink" to colorless.

One of the most interesting applications of disappearing ink was Hollywood Hair[®] Barbie[®], a Barbie doll that came with a small bottle of Magic Hair Mist. When the Magic Hair Mist was sprayed onto the Barbie's hair, her hair would turn pink and then slowly fade back to its original blonde color. This was a disappearing ink reaction.

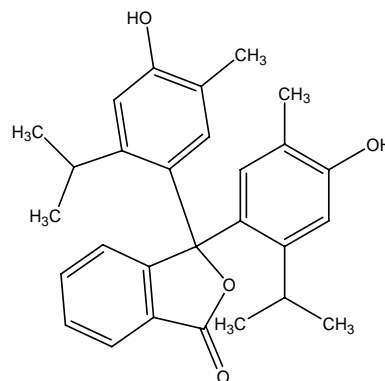


Figure 1. The structure of thymolphthalein.

MAKING DISAPPEARING INK

Materials needed:

thymolphthalein

ethyl alcohol (ethyl rubbing alcohol, a 70% solution of ethyl alcohol, is available at drug stores or use denatured alcohol available in hardware and paint stores.)

sodium hydroxide solution, NaOH, 3 M (A 3 M NaOH solution can be prepared by mixing 12 g of NaOH with 100 mL water. CAUTION: Use a heat proof container, such as a Pyrex flask or beaker, the solution will get hot.)

(NOTE: With young children, a 0.1 M solution of sodium hydroxide can be substituted for safety reasons. To prepare a 0.1 M solution, mix 0.4 g of NaOH with 100 mL of water.)

water

5 oz plastic cup or 150-mL beaker for mixing the "ink"

4 oz bottle for storing the "ink"

cloth to test the "ink"

2 droppers

Safety Precautions

Sodium hydroxide is caustic. If any gets on the skin, wash thoroughly with water. If any gets in the eyes, flush well with water and get medical assistance immediately.

Disappearing ink is a very dilute alkaline solution. Although it is not harmful in small quantities, it should be rinsed from the skin with water in the event of contact. Take care to avoid squirting it in anyone's face or eyes.

Procedure

Measure out a 0.10 gram of thymolphthalein into a 150-mL beaker or 5 oz plastic cup. Add 10 mL of ethyl alcohol (or about 14 mL of ethyl rubbing alcohol) and stir to dissolve the solid. Add 90 mL water and stir. The solution will be milky white.

Add 20 drops (1 mL) of 3 M sodium hydroxide solution. The solution will turn blue.

Use a dropper to put a few drops of the disappearing ink onto a piece of cloth. The color should fade from blue to colorless in about 3 minutes. If the color fades too quickly, add an additional 5 drops of sodium hydroxide and test again. (NOTE: After a few days, the disappearing ink may fade to colorless quickly. Addition of a few drops of sodium hydroxide will restore the solution to a 3 minute fading time.)

To demonstrate the reaction of carbon dioxide with sodium hydroxide, moisten an area of the cloth with the disappearing ink (do not soak it), hold up the cloth, stretching it between your hands, and blow through it. The carbon dioxide in your breath will cause the disappearing ink to change from blue to colorless.

Store the disappearing ink in an air-tight bottle.

Alternative Procedure for use with young children

Measure out a 0.10 gram (a "pinch") of thymolphthalein into a 150-mL beaker or 5 oz plastic cup. Add 10 mL of ethyl alcohol (or about 14 mL of ethyl rubbing alcohol) and stir to dissolve the solid. Add 60 mL water and stir. The solution will be milky white.

Add 30 mL of 0.1 M sodium hydroxide solution. The solution will turn blue.

Store the disappearing ink in an air-tight bottle.

MAKING RED DISAPPEARING INK

Substitute phenolphthalein, $C_{20}H_{16}O_4$, for thymolphthalein in the procedure above. Phenolphthalein is pink at pH 8.2-9.8. (See Figure 2)

MAKING TWO COLOR DISAPPEARING INK

Use both phenolphthalein and thymolphthalein in the procedure above. The original color will be purple which fades to pink and then to colorless.

To make a Hollywood Hair[®] Barbie[®] and Hollywood Hair[®] Barbie[®] Magic Hair Mist:

Hollywood Hair[®] Barbie[®]:

For **pink** hair: Prepare a 1% solution of phenolphthalein in denatured alcohol.

For **blue** hair: Prepare a 1% solution of thymolphthalein in denatured alcohol.

For **purple** hair: Prepare a 1% solution of phenolphthalein and thymolphthalein in denatured alcohol, or mix equal amounts of individual 1% solutions prepared above.

Hollywood Hair[®] Barbie[®] Magic Hair Mist:

Place 10 mL (2 teaspoons) of ethyl alcohol (or about 14 mL [3 teaspoons] of ethyl rubbing alcohol) into a 5 oz cup.

Add 90 mL water.

Add 10 drops of 3 M sodium hydroxide solution (recipe above).

Store the Magic Hair Mist in an air-tight bottle.

If Hollywood Hair[®] Barbie's[®] hair no longer turns pink, or you don't have a Hollywood Hair[®] Barbie[®], you can restore the hair, or treat the hair of any Barbie or other doll with light colored, waterproof hair, by lightly spraying, or brushing some phenolphthalein solution, or thymolphthalein solution, or a mixture of the two, as prepared above, onto Barbie's[®] hair. Allow the hair to dry before use.

To turn the hair colors, spray lightly with the Hollywood Hair[®] Barbie[®] Magic Hair Mist. CAUTION: Use this material on the hair of a doll only! Do not use this on human hair!

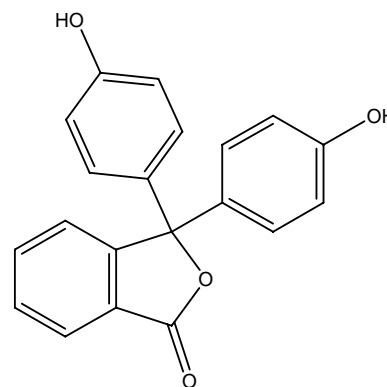


Figure 2. The structure of phenolphthalein