Activity #5

INVISIBLE INK

KEY CONCEPT

Some acid-base indicators are colorless under some conditions.

SKILLS	observing, investigating
TIME	5 minutes for the demonstration,15 minutes for the activity
AUDIENCE	middle school students

OBJECTIVE

To demonstrate that what appears to be magic may really be science.

SAFETY

Wear chemical splash goggles when doing this activity. Aqueous ammonia is one of several solutions that may be used in this activity. Do not use aqueous ammonia unless safety precautions are followed. Aqueous ammonia or its vapors can damage the eyes. Use aqueous ammonia only in a well-ventilated area. Should contact with eyes occur, rinse the affected area with water for 15 minutes. Medical attention should be sought while rinsing. Contact lenses should not be worn when working with ammonia.

Isopropyl alcohol (rubbing alcohol) is poisonous if taken internally and is flammable. Do not let participants ingest or use near flames. If contact with eyes occurs, rinse eyes with water for 15 minutes and get medical attention.

CONTENT FOCUS

A phenolphthalein solution makes a good “invisible” ink. It will dry colorless. Rewetting with any moderately basic solution will turn it red, bringing out the message. If the base used is aqueous ammonia (or window cleaner with ammonia), the ammonia will evaporate as the message dries:

$$NH_{3(aq)} \longrightarrow NH_{3g}$$

The pink color will disappear as the ammonia leaves the solution because the solution will no longer be basic.

Other basic solutions, such as baking soda in water, will produce a “permanent” message when sprayed on the phenolphthalein. To erase such a message, it must be resprayed with an acid such as vinegar, which will neutralize the base.

ADVANCE PREPARATION

Phenolphthalein Indicator Solution: Phenolphthalein solution can be purchased from chemical and school supply companies.

Prepare a sign for the demonstration. (e.g., “Chemistry Is Colorful!”)

Purchase or prepare the basic solutions. For the demonstration, use a window cleaner with ammonia (e.g., Windex® with Ammonia D) or household ammonia. The household ammonia may be diluted; however, the more dilute, the faster the message will disappear. A solution of 1 Tablespoon (15 ml) of household ammonia in 1-cup (240 ml) water will turn the sign pink and evaporate back to colorless in a few seconds. Spraying with ammonia **must** be done **outside** or in a **very well ventilated** area. Ammonia fumes are very pungent.
If you use this activity with students, do not use ammonia unless the students can go outside to spray their messages. A baking soda solution works very well to “develop” the message and can be painted on. Vinegar can be used to make the ink “disappear.” To prepare the baking soda solution, use 1 tablespoon (15 ml) of baking soda for each 1 cup (240 ml) of water. Stir or shake well to dissolve as much as possible. Bottle the baking soda solution and vinegar in small containers such as baby food jars for convenience.

TIPS

- Signs sprayed with aqueous ammonia or ammonia-containing products may be reused.

- It may help to mark the top of the right side of the paper lightly with pencil so the sign is right side up when sprayed.

MATERIALS

DEMONSTRATION

- “invisible” sign
- aqueous ammonia or other basic solution in spray bottle

ACTIVITY

- paper
- cotton swabs
- phenolphthalein solution
- baking soda solution
- vinegar

PROCEDURE

DEMONSTRATION

1. Move the group outside or to a very well ventilated area.
2. Show the participants the sheet of paper with the “invisible” sign.
3. Tell the group that the sprayer contains a solution, which is basic. (If the solution is ammonia, warn them that it may have a very pungent smell.)
4. Spray the sign and observe.
5. Discuss what has occurred.

ACTIVITY

1. Use the cotton swabs to write a message or draw a picture with the phenolphthalein solution. Allow it to dry.
2. Use the other end of the cotton swab to paint over the paper with the baking soda solution.
3. Observe any changes. Allow the paper to dry.
4. Use a fresh cotton swab to paint over the message or picture with vinegar.
5. Observe any changes. Allow the paper to dry.

EXTENSIONS

“Invisible” signs can also be made using red cabbage indicator. See Activity 7 - Red Cabbage Indicator for instructions on preparing the indicator. The message is first written with a solution made using an acid or base and allowed to dry. Vinegar or boric acid, baking soda or washing soda dissolved in water will work. The message is then “developed” by spraying with red cabbage indicator solution. If acidic and basic solutions are used to write different parts of the message, these different parts will show up as different colors.

A wide variety of other acid-base indicators can similarly be used to make “color-change” signs.

SUGGESTED QUESTIONS

1. What color is phenolphthalein in acidic solution? What color is phenolphthalein in basic solution?
   Phenolphthalein is colorless in acidic solution and pink in basic solution.

2. If a solution containing the base ammonia was used in the demonstration, could you smell the ammonia?
   Participants should have been able to smell the ammonia.
   What happened to the message as the paper dried?
   The message disappears as the paper dries.
   What happened to the ammonia as the paper dried?
   The ammonia evaporates (leaves the solution as a gas) as the paper dries. We know the ammonia evaporated because we could smell it in

the air. Because the ammonia left the paper, the phenolphthalein is no longer in a basic environment and returns to its colorless form.

3. If a solution containing the base baking soda was used in the activity, could you smell the baking soda? What happened to the message as the paper dried? What happened to the baking soda as the paper dried?
   Students should not be able to smell the baking soda. The message remains as the paper dries. The baking soda does not evaporate so the phenolphthalein remains in a basic environment and stays pink.

4. Describe what happened to the message or picture when you painted vinegar onto your paper. Is vinegar a **basic** solution or is it an **acidic** solution?
   The message slowly disappears as the vinegar neutralizes the baking soda. Phenolphthalein is colorless in acidic solutions so vinegar must be acidic.