

Colorful Indicators

Purpose

To demonstrate several reactions with carbon dioxide and indicators that result in a variety of color changes.

Materials

| | |
|----------------------------|----------------------------|
| 12 demo glasses | phenol red indicator |
| phenolphthalein indicator | methyl red indicator |
| bromothymol blue indicator | universal indicator |
| sodium hydroxide | dry ice (CO ₂) |
| hydrochloric acid | insulated gloves |
| thymolphthalein indicator | |

Procedure

1. Fill each of 12 demo glasses as follows:
 - 1st pair: add 1 mL of thymolphthalein indicator solution.
 - 2nd pair: add 1 mL of phenolphthalein indicator solution.
 - 3rd pair: add 1 mL of phenol red indicator solution.
 - 4th pair: add 1 mL of bromothymol blue indicator solution.
 - 5th pair: add 1 mL of methyl red indicator solution.
 - 6th pair: add 1 mL of universal indicator solution.
8. Add 1 mL of 0.1 *M* NaOH solution to each demo glass. Then dilute each with 100 mL of DI H₂O.
9. Wearing gloves, drop a chunk of solid carbon dioxide into one demo glass of each pair and note the color changes.

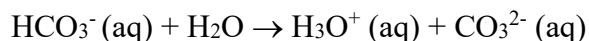
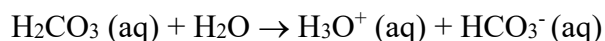
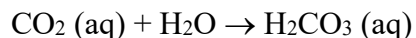
Additional Information

1. 5.0 *M* aqueous ammonia may substitute for sodium hydroxide. The pH will not fall low enough to change the color of methyl red.

2. Indicator color changes:

| <u>Test Tube Pair Number</u> | <u>Indicator</u> | <u>Color Change</u> Original → NaOH → CO ₂ | <u>pH Range</u> |
|--------------------------------------|---------------------|--|-----------------|
| 1 | thymolphthalein | colorless → blue → colorless | 10.6 - 9.4 |
| 2 | phenolphthalein | colorless → pink → colorless | 10.0 - 8.2 |
| 3 | phenol red | red → red → yellow | 8.0 - 6.6 |
| 4 | bromothymol blue | blue → blue → yellow | 7.6 - 6.0 |
| 5 | methyl red | orange → yellow → red | 6.0 - 4.8 |
| 6 | Universal indicator | green → purple → orange | |

3. Initial pH in all the test tubes is about 11.
 4. Dissolved CO₂ reacts with water in the following manner:



PREPARATION OF THE INDICATOR SOLUTION:

1. Dissolve 0.04 gram of thymolphthalein in 50 mL of ethanol and dilute the resulting solution to 100 mL with distilled water.
2. Dissolve 0.05 gram of phenolphthalein in 50 mL of ethanol and dilute the resulting solution to 100 mL with distilled water.
3. Dissolve 0.04 gram of phenol red in 11 mL of 0.1 M NaOH and dilute the resulting solution to 100 mL with distilled water.
4. Dissolve 0.04 gram of bromothymol blue in 6.4 mL of 0.01 M NaOH and dilute the resulting solution to 100 mL with distilled water. Dissolve 0.02 gram of methyl red in 60 mL of ethanol and dilute the resulting solution to 100 mL with distilled water.
5. To prepare Yamada's universal indicator dissolve 0.005 gram thymol blue, 0.012 gram methyl red, 0.06 gram bromothymol blue, and 0.10 gram phenolphthalein in 100 mL of

ethanol. Add enough 0.01 M sodium hydroxide until the solution is green and dilute the resulting solution to 200 mL with distilled water.

7. To prepare 0.1 M sodium hydroxide dissolve 4.0 grams of NaOH in 500 mL distilled water and dilute the resulting solution to 1.0 liter with distilled water.

Reference

Shakharshiri, Bassam; Chemical Demonstrations, Volume II, 1985.