# Colorful Indicators

## Purpose

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

## Materials

- 12 demo glasses
- phenolphthalein indicator
- bromothymol blue indicator
- sodium hydroxide
- hydrochloric acid
- thymolphthalein indicator
- phenol red indicator
- methyl red indicator
- universal indicator
- dry ice ($CO_2$)
- insulated gloves

## 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 phenophthalein 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:

| Test Tube Pair Number | Indicator | Color Change<br>Original → NaOH → $CO_2$ | pH Range |
|---|---|---|---|
| 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 $CO_2$ reacts with water in the following manner:

$CO_2\ (aq) + H_2O \rightarrow H_2CO_3\ (aq)$

$H_2CO_3\ (aq) + H_2O \rightarrow H_3O^+\ (aq) + HCO_3^-\ (aq)$

$HCO_3^-\ (aq) + H_2O \rightarrow H_3O^+\ (aq) + CO_3^{2-}\ (aq)$

**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.