

Phenolphthalein Is Pink in Base

Acid–Base Indicators

Introduction

Phenolphthalein is a large organic molecule used as an acid–base indicator. Phenolphthalein turns a bright red color as its solution becomes basic. In a strongly basic solution, this red color fades to colorless.

Concepts

- Acid–base indicators
- Chemical equilibrium

Background

Phenolphthalein has the colorless structure shown in Figure 1 when the solution pH < 8. As the solution becomes basic and the pH increases (pH 8–10), the phenolphthalein molecule (abbreviated H₂P) loses two hydrogen ions to form the red-violet dianion (abbreviated P²⁻) shown in Figure 2. At a high pH, the P²⁻ ions reacts with hydroxide ions to form the colorless POH³⁻ ion.

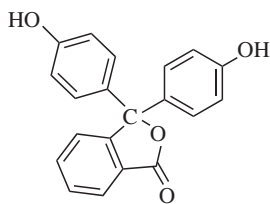


Figure 1. H₂P is colorless.

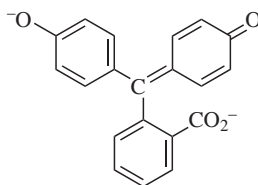


Figure 2. P²⁻ is red.

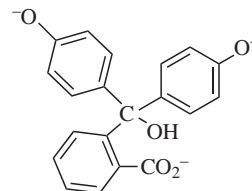
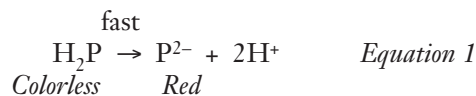


Figure 3. POH³⁻ is colorless.

The colorless-to-red transition of H₂P to P²⁻ (Equation 1) is very rapid and the red color develops instantly when the pH reaches its transition range (pH 8–10). If the concentration of hydroxide ions remains high, the red P²⁻ dianion will slowly combine with hydroxide ions to form a third species, POH³⁻ (Equation 2), which is again colorless. The rate of this second reaction is much slower than the first and depends on the concentration of phenolphthalein and hydroxide ions. Thus, the color of the red P²⁻ species will gradually fade in a basic solution.



Materials (for each demonstration)

Hydrochloric acid solution, HCl, 3 M, 10 mL
Phenolphthalein solution, 0.5%, 3mL
Sodium hydroxide pellets, NaOH, 2
Sodium hydroxide solution, NaOH, 3 M, 5 mL

Beral-type pipet, disposable
Test tubes, borosilicate, 16 × 100mm, 3
Test tube rack
Wash bottle

Safety Precautions

Hydrochloric acid solution is toxic and corrosive to eyes and skin tissue. Sodium hydroxide is a corrosive solid; skin burns are possible. Considerable heat is evolved when sodium hydroxide pellets are added to water. It is very dangerous to eyes; wear face and eye protection plus gloves when handling and using sodium hydroxide. The sodium hydroxide solution is severely corrosive to skin and eyes. The phenolphthalein solution is a flammable liquid, a fire risk, and is moderately toxic. Wear chemical splash goggles, chemical-resistant

Phenolphthalein Is Pink in Base *continued*

gloves, and a chemical-resistant apron. Please consult current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Place the three test tubes in the test tube rack. Add approximately 5 mL of water from the wash bottle to test tube 1, 5 mL of 3 M sodium hydroxide solution, NaOH, to test tube 2, and 5 mL of 3 M hydrochloric acid solution, HCl, to the 3rd test tube.
2. Add several drops of phenolphthalein solution to each test tube. Swirl each test tube. The tubes containing water and acid will remain colorless; the tube with sodium hydroxide solution will turn dark pink or red.
3. Add 2 sodium hydroxide pellets to test tube 2. Swirl to dissolve the pellets. Continue swirling until the red color fades to colorless.
4. Now add approximately 5 mL of the hydrochloric acid to test tube 2. The color of the solution is now pink!

Disposal

The basic solution in test tube 2 may be disposed of by dilution with water, neutralization, and then by flushing it down the drain according to Flinn Suggested Disposal Method #10. The acidic solution in test tube 3 may be disposed of by dilution with water, neutralization, and then by flushing it down the drain according to Flinn Suggested Disposal Method #24b. Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes.

Tips

This procedure will also work with the acid–base indicators crystal violet and bromphenol blue. Crystal violet will change from violet to colorless and the bromphenol blue from blue to colorless.

Connecting to the National Standards

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

Unifying Concepts and Processes: Grades K–12

Systems, order, and organization
Evidence, models, and explanation

Content Standards: Grades 5–8

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

Content Standards: Grades 9–12

Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Phenolphthalein Is Pink in Base* activity, presented by Bob Lewis, is available in *Acid–Base Indicators*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Phenolphthalein Is Pink in Base* are available from Flinn Scientific, Inc.

| Catalog No. | Description |
|-------------|--|
| S0074 | Sodium Hydroxide, Pellets |
| S0447 | Sodium Hydroxide Solution, 3 M |
| H0013 | Hydrochloric Acid Solution, 3 M |
| P0115 | Phenolphthalein Indicator Solution, 0.5% |

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.