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40 ESTIMATION OF pH

Text Reference
Sections 19.2

PURPOSE

To estimate the pH of solutions by using acid–base indicators.

BACKGROUND

If you are interested in gardening, you may know that plants such as azaleas and rhododendrons prefer acidic soils. A part of soil testing consists of the measurement of the pH of the soil. pH is important for many other applications in the home and in industry. For example, maintenance of the proper pH of water is important in caring for swimming pools. There are several ways to test pH. One of the most important ways is by means of acid–base indicators such as phenolphthalein. In neutral and acidic solutions, phenolphthalein is colorless. In alkaline solutions, it is pink. By adding a few drops of a weak solution of the indicator to a solution to be tested, you can tell immediately whether the test solution is alkaline. Other acid–base indicators change colors at different pH values. By systematically testing a solution with a series of indicators, you can often arrive at a good estimate of the pH of a solution.

In this experiment, you will estimate the pH of several solutions by using acid–base indicators. You will then use the same indicators to test the pH of several common household chemicals.

MATERIALS (PER PAIR)

- safety goggles
- dropper pipet
- 5 small test tubes
- test-tube rack
- 10-mL graduated cylinder
- stirring rod
- plastic wash bottle
- pH meter (optional)
- 0.1*M* hydrochloric acid, HCl [I]
- 0.1*M* ethanoic acid, CH_3COOH
- household chemicals such as:
  - lemon juice
  - vinegar
  - bleach
  - baking soda
  - carbonated beverage
- 0.1*M* ammonia, NH_3 [T]
- 0.1*M* sodium hydroxide, NaOH [I]
- distilled water
- methyl red solution
- litmus solution (or litmus paper)
- bromthymol blue solution
- phenolphthalein solution
- shampoo
- cold tea
- aspirin
- milk
- liquid antacid

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SAFETY FIRST!

In this lab, observe all precautions, especially the ones listed below. If you see a safety icon beside a step in the Procedure, refer to the list below for its meaning.

Caution: Wear your safety goggles. (All steps.)

Caution: Hydrochloric acid and sodium hydroxide are irritants at the concentrations used in this experiment. (Step 1.)

Caution: Ammonia is an irritant. Do not inhale ammonia fumes. (Step 1.)

Caution: Return or dispose of all materials according to the instructions of your teacher. (Step 6.)

PROCEDURE

As you perform the experiment, record your observations in Data Tables 2 and 3.

1. Add 1–2 mL of the following to five separate, clean test tubes: 0.1*M* hydrochloric acid, 0.1*M* ethanoic acid, 0.1*M* ammonia, 0.1*M* sodium hydroxide, and distilled water.

2. Add 2 drops of methyl red indicator solution to each tube. Flick to mix the contents. Record the final color in Data Table 2 and estimate the pH of the solution by referring to Data Table 1.

3. Using fresh samples of the solutions, repeat the procedure for each of the other indicators named in Data Table 1. If you are using paper indicator strips, use a glass rod to transfer a drop of the solution to the indicator strip. Record the results of all the tests in Data Table 2.

4. Test the common household chemicals that are available to you. Test liquids directly. Solids should be dissolved or suspended in water before testing. Record your results in Data Table 3.

5. If a pH meter is available, use it to determine the pH of the household chemicals.

6. Follow your teacher's instructions for proper disposal of the materials.

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OBSERVATIONS

DATA TABLE 1: COMMON ACID–BASE INDICATORS

Indicator	Color in Acid (HIn form)	Color in Base (In^- form)	pH Range
litmus	red	blue	5.2–7.5
bromthymol blue	yellow	blue	6.0–7.6
phenolphthalein	colorless	pink	8.2–10.0

DATA TABLE 2: INDICATOR REACTIONS WITH STANDARD SOLUTIONS

Solution	Red Litmus Paper	Blue Litmus Paper	Bromthymol Blue	Phenolphthalein	Estimated pH
0.1*M* HCl					
0.1*M* ethanoic acid					
distilled water					
0.1*M* ammonia					
0.1*M* NaOH					

DATA TABLE 3: INDICATOR REACTIONS WITH HOUSEHOLD CHEMICALS

Substance	Methyl Red	Litmus	Bromthymol Blue	Phenolphthalein	Estimated pH	Measured pH

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ANALYSES AND CONCLUSIONS

1. Compare the pH of 0.1*M* ethanoic acid with that of 0.1*M* hydrochloric acid. Compare the pH of 0.1*M* ammonia with that of 0.1*M* sodium hydroxide. Explain any differences.

2. Which of the indicators used in this experiment could most accurately identify a neutral solution? Explain.

3. Are the household chemicals you tested acidic, basic, or neutral?

GOING FURTHER

Develop a Hypothesis

Based on the results of this lab, develop a hypothesis about how acid–base indicators change colors at different pH's.

Do Research

If resources are available, read articles or books to collect information about the chemical structures of acid–base indicators under different conditions of pH that may or may not support your hypothesis.