Introduction to Acids and Bases

EXPERIMENT 20A

By the 1500s chemists recognized that certain substances shared a common property—a sour taste. These substances possessed other characteristic properties as well. They were given the collective name of "acids" from the Latin word *acidus*, meaning "sour". Another group of substances, called alkalis (or bases), were prepared from the ashes of wood. Bases had a slippery feel and were discovered to be effective cleaners.

When defining acids or bases, it is important to realize that there are two types of definitions—*operational* (or *laboratory*) definitions and *conceptual* definitions. An operational definition is a description of expected test results from a laboratory situation. A conceptual definition attempts to explain the operational definition.

Tests for acidity and alkalinity are commonplace today in such fields as gardening and swimming pool maintenance. For example, specialized acid-base test kits are available to home gardeners who wish to monitor the acidity or alkalinity of their soil. One component of such kits is a chemical indicator solution which will show a characteristic color, depending on the conditions of acidity.

In Part I of this experiment you will first test several unknown solutions of acids and bases and note some of their properties. The similarities of properties should enable you to write some operational definitions. Next, the identities of the unknown solutions will be revealed, and you will attempt to write conceptual definitions of acids and bases.

In the past, several conceptual definitions of acids and bases were proposed by chemists. What is certainly the most fundamental definition was suggested by Svante Arrhenius in the late 1800s. Arrhenius, one of Sweden's most famous chemists, was awarded the Nobel prize in chemistry in 1903 for his work with ionic solutions. It is quite likely that your conceptual definitions of acids and bases in this experiment will be similar to those of Arrhenius.

Part II of this experiment involves acid-base tests of household products. From the results you obtain and the information provided, you will be asked to classify the household products according to your operational and conceptual definitions of acids and bases.

OBJECTIVES

1. to become familiar with a variety of typical laboratory tests for acids and bases
2. to develop operational definitions of acids and bases
3. to develop conceptual definitions of acids and bases
4. to test a variety of household products and classify them as acids or bases

MATERIALS

Apparatus

6 small test tubes (10 mm × 75 mm)
6 medicine droppers
glass square (10 cm × 10 cm) or Corning Cell Wells 6 × 4 or spot plate
test-tube rack
lab apron
safety goggles

Reagents

magnesium ribbon (6 cm)
phenolphthalein solution in a dropper bottle
methyl orange solution in a dropper bottle
blue litmus paper
red litmus paper
set of 6 unknown solutions
set of 6 household products (vinegar, Easy-Off® oven cleaner, household ammonia, lemon juice, 7-Up®, milk of magnesia)

PROCEDURE

Part I Tests of Unknown Solutions

CAUTION: Remember, A to F are unknowns; whether they are hazardous or not, it is always a good practice to minimize your contact with unknown chemicals. Some of these chemicals are corrosive to skin, eyes, or clothing. Wear safety goggles and gloves when handling them; wash away spills or splashes with plenty of water. Call your teacher.

1. Put on your lab apron and safety goggles.
2. Label your 6 test tubes A to F, then obtain corresponding samples of the 6 unknown solutions. The test tubes should be about one third full, so that you can reach each sample with a medicine dropper. Place the test tubes in a test-tube rack, and put a clean medicine dropper in each.
3. On a piece of paper the size of your glass square, construct a labelled grid similar to Table 1, with one exception: do not include the column for magnesium on the grid. Your grid will therefore have 6 rows and 4 columns. Instead of a glass square, you can use Corning Cell Wells #25820, which provide a 6 × 4 grid.
4. Place the glass square on top of the grid and place 1 or 2 drops of the phenolphthalein and methyl orange indicator solutions in the appropriate squares of the grid. Tear the red and blue litmus papers into small pieces and place these pieces in the appropriate squares.
5. Using the medicine dropper, add 1 or 2 drops of solution A to the phenolphthalein square of the grid. Record your observations in your copy of Table 1 in your notebook.
6. Add solution A to the methyl orange, blue litmus, and red litmus squares of the grid, and record the results.
7. Repeat Steps 5 and 6 for the other 5 unknown solutions.
8. Obtain a 3.0 cm length of magnesium ribbon and cut it into 6 pieces of approximately equal length. Place a piece of magnesium in each of the 6 test tubes and record your observations in your data table.
9. Clean up your apparatus according to the reagent disposal instructions.
10. Before you leave the laboratory, wash your hands thoroughly with soap and water; use a fingernail brush to clean under your fingernails.