Experiment 7: ATMOSPHERIC GASES

One of the driving forces for double-displacement reactions is formation of a gas as a product. In this experiment, you will study double-displacement reactions involving a bicarbonate, a sulfite, and a nitrite and a strong acid as a means of forming CO_2, SO_2, and NO_2. Oxygen gas will be generated by the decomposition of hydrogen peroxide (H_2O_2), which is catalyzed by iron (III) chloride. The chemical properties of oxygen, CO_2, SO_2, and NO_2 will then be studied.

1. Oxygen

The purpose of this part of the experiment is to demonstrate some of the chemical reactions by which oxygen can be produced, and to examine some of its chemical properties. You should keep in mind most reagents releasing oxygen are powerful oxidizing agents, which react violently with oxidizable materials. Hot potassium chlorate, for example, can react explosively with charcoal, a wood splint, with scraps of paper, or similar combustible materials.

A. Preparation of Oxygen

1. Fit a 125 mL Erlenmeyer flask with a one-hole rubber stopper and gas delivery tube. The delivery tube should be arranged so that the oxygen gas produced will displace water from wide mouth bottles. Your instructor will show you how to assemble the apparatus.

2. Add 75-80 mL of 3% hydrogen peroxide to the flask. Then add two heaping spatulas of solid iron (III) chloride. Swirl the reaction mixture gently, and collect the oxygen gas produced. Have several (4 or 5) bottles ready, so that you can change bottles quickly without losing oxygen. Cover each bottle immediately after it is filled.

3. When you are finished, put the spent, but very acidic, solution in the bucket labeled "Waste iron (III) chloride and peroxide".

B. Reactions with Oxygen

Oxygen readily combines with other elements. Some of the common reactions are demonstrated in the experiments below.

1. Carbon: Using a deflagrating spoon, lower glowing charcoal into a bottle of oxygen. Then set a wood splint afire, and blow it out. While the splint is still aglow, lower it into a bottle of oxygen. The product formed is carbon dioxide.

2. Sulfur: Do this experiment in the hood. Using a deflagrating spoon, lower burning sulfur into a bottle of oxygen. Very carefully smell the gases emitted from this reaction. Sulfur dioxide and sulfur trioxide are the most likely products.

3. Iron: Using forceps, heat some steel wool until it is red hot, and then lower it into a container of oxygen. record your observations. To deduce the formula of the product, you should note that iron can be oxidized to either Fe^{2+} or Fe^{3+}. The latter is more likely.

4. Magnesium: Using forceps set a piece of magnesium ribbon afire, and then lower it into a container of oxygen. Pay particular attention to the rate of this reaction, and carefully examine the nature of the product by moistening the white residue and testing the pH with a small piece of indicator paper.