Hydrogen and Oxygen
Generating, Collecting, and Testing

Introduction: Hydrogen is a clear, colorless gas which is said to be "combustible" -- meaning that it can burn readily. Oxygen, also a clear, colorless gas, is said to "support combustion" - meaning that it must be present for combustible materials to burn. In this lab you will be generating, collecting and testing both hydrogen and oxygen gas. Hydrochloric acid will be reacted with zinc to produce hydrogen. (In general, any strong acid and almost any metal will react to produce hydrogen). Hydrogen peroxide in the presence of manganese dioxide catalyst will quickly decompose into oxygen and water. By collecting and igniting some different hydrogen:oxygen mixtures, you will compare the loudness of the pops to determine the most reactive (loudest) mixture.

Equipment Required

- 1 - 125 ml beaker - waste beaker for used HCl and H_2O_2
- 1 - 250 ml beaker - filled 3/4 full with water
- 1 - 400 ml beaker - filled 3/4 full with water
- 1 - hydrogen generator: a small test tube 2/3 filled with zinc, equipped with a stopper and nozzle
- 1 - oxygen generator: a small test tube 1/3 filled with manganese, equipped with a stopper and nozzle
- 1 - short stem Beral pipette: your gas container (a small plastic bulb)
- 1 - Bunsen burner
- 1 - stock bottle of 1 M hydrochloric acid HCl
- 1 - stock bottle of 5% hydrogen peroxide H_2O_2

Procedure: (Record all observations)

1. **Water Supply**: Use the 250 ml beaker as a test tube holder, and the 400 ml beaker to fill the plastic bulb with water.
2. **Gas collecting bulb**: Check to see if your collection bulb has been marked off into six equal parts. If not, come to the front lab bench and use the stencil and marker to make these divisions.
3. **Heat source**: Light your Bunsen burner and adjust it so that you have a medium flame (the solid blue one).
4. **Generating the Hydrogen**: The test tube labeled "hydrogen generator" contains pieces of zinc metal and is topped with a stopper and nozzle. Remove the stopper and add enough 1M HCl to fill the test tube within 2 cm. of the top. Replace the stopper and stand the generator in the 250 ml. beaker of water. Wait 10 seconds before using.
5. **Collecting the Hydrogen**: To avoid mixing any air with our hydrogen, we will use a technique called water displacement. Fill the bulb with water by submerging the bulb in the 400 ml beaker with the opening pointed upwards. Squeeze the bulb several time until there is no more air inside. Now invert the bulb and carefully insert the end of the generator nozzle into the bulb. As the bubbles rise, water will be forced out. Let it drip into your beaker.
6. **Pop-Test**: Hold your filled collection bulb horizontally with the mouth about 1 cm. from the flame. Gently squeeze a small portion of the contents of the bulb into the flame and

observe. Squeeze again and again and again. If you don't get a sharp "pop" on the third or fourth squeeze, refill the bulb and try again.

7. **Generating the oxygen**: The test tube labeled "oxygen generator" contains pieces of manganese dioxide and is topped with a stopper and nozzle. Remove the stopper and add enough 5% hydrogen peroxide (H_2O_2) to fill the test tube to within 2 cm. of the top. Replace the stopper and stand the generator in the beaker of water. Wait 10 seconds before using.
8. **Collecting the oxygen**: Fill the bulb with pure oxygen by the water displacement technique. Ignite a tooth pick, blow it out, and see if you can get the glowing ember to reignite by squeezing oxygen from the bulb at the glowing portion of the pick. Fill the bulb with oxygen again and try a pop test.
9. **Testing different mixtures**:
    - Now we will be testing different mixtures of hydrogen and oxygen.
    - Using the marks on the side of your bulbs, collect varying quantities of hydrogen and oxygen.
    - Start by collecting 1 part hydrogen and 5 parts oxygen. This is referred to as a 1:5 ratio of hydrogen to oxygen.
    - Then ignite the mixture with the Bunsen burner by performing a pop-test.
    - Repeat the above with varying ratios of hydrogen to oxygen: 2:4, 3:3, 4:2, and 5:1. Perform a pop test each time giving it some kind of rating so that you can compare the loudness of the different mixtures.

    Note: If either gas generator slows down too much, carefully pour out the liquid into the 125 ml waste beaker, making sure not to lose any of the metal into the beaker. Then, replace the liquid with the correct kind for that tube. See 4 and 7 for details about the correct liquid.
10. **Confirming the Loudest Pop:** Now try your two loudest mixtures a couple of times to determine which one is actually the loudest.
11. **Clean up Procedure**: Carefully pour out each liquid into the waste beaker, making sure not to lose any of the metal. Rinse the metal with water twice by pouring in some water and dumping it out, **making sure not to lose any of the metal** each time. Try covering most of the test tube opening with the stopper when rinsing and dumping water, so that you can avoid loosing the metal down the drain. Return equipment to the front of the room.

Hydrogen and Oxygen Lab Questions

On a separate sheet of paper:

1) Re-read the introduction to this lab, paying attention to the terms "combustible" and "supports combustion". Hydrogen is said to be "combustible" and oxygen "supports combustion". What are the differences between these two terms? What observations did you make to that agree with the definitions for hydrogen being "combustible" and oxygen "supporting combustion".

2) After adding 1M HCl to the hydrogen generator and after adding 5% H_2O_2 to the oxygen generator, the procedure instructed you to wait 10 seconds before collecting gas. Explain why this step is necessary if we want to collect pure hydrogen and pure oxygen.

3) Create a bar graph to compare the loudness of your different mixtures of gas. Label each bar with the ratio of hydrogen to oxygen, and include the pop-tests for a bulb filled with all hydrogen and all oxygen. Don't forget to include all the necessary parts of a good graph.

4) Compare your data with the class data for the most reactive mixture. What were the similarities?

5) What is the Law of Constant Composition?

6) The loudness of the pop-test is related to the completeness of reaction between hydrogen and oxygen. In our experiment the loudest pop should have indicated a complete reaction with no hydrogen or oxygen left over. According to the class data, which ratio of hydrogen : oxygen showed the most complete reaction?

7) Does the class data support a constant composition for the compound water? Why or why not?

8) If the class data did not verify the Law of Constant Composition, what might be some reasons why people found different ratios of hydrogen : oxygen for the loudest pop?