**Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

35 pts

Micro Mole Rockets

Hydrogen and Oxygen Mol Ratio

**Introduction**

The combustion reaction of hydrogen and oxygen is used to produce the explosive energy needed to power a space shuttle. The reaction is also being engineered to serve as a source of continuous energy for fuel cells in electric vehicles. What factors determine the explosiveness of the reaction of hydrogen with oxygen?

In this lab, we will generate microscale quantities of hydrogen and oxygen and test their explosive nature, first separately then in mixtures of various proportions. Our goal is to find the most “powerful” gas mixture and use it to launch a pipet rocket across the room.

**Background**

Hydrogen, the most abundant element in the universe, is a colorless, odorless gas. It is combustible, which means that it burns quite readily. Hydrogen gas is conveniently generated in the lab by the reaction of zinc metal with hydrochloric acid.

Oxygen, the most abundant element on Earth, is also a colorless, odorless gas. Oxygen gas supports combustion, that is, it must be present for combustible materials to burn. Small scale quantities of oxygen gas are conveniently generated in the lab by the decomposition of hydrogen peroxide. The decomposition reaction of hydrogen peroxide requires a catalyst (something that speeds up a reaction) to begin the reaction. A variety of different catalysts, including manganese, manganese dioxide, potassium iodide, and even yeast have been used in this reaction. In this lab, we will use manganese dioxide as our catalyst to speed up the decomposition of hydrogen peroxide and generate oxygen gas.

*Experiment Overview*

The purpose of this experiment is to generate hydrogen and oxygen and determine the optimum ratio for their combustion reaction to give water. Your job is to determine the proportions or mol ratio of hydrogen and oxygen that will produce the most powerful rocket.

**Pre-Lab Questions**

1. (2 pts)Write the balanced chemical equation for the single-replacement reaction of zinc and hydrochloric acid to generate hydrogen gas.
2. (2 pts)Write the balanced chemical equation for the manganese dioxide (MnO2) – catalyzed decomposition of hydrogen peroxide to generate oxygen gas and water. (Since a catalyst is not really a reactant or product, it is usually written over the yield arrow)

**Materials**

Hydrochloric Acid, Hydrogen Peroxide, Manganese Dioxide, Zinc, Pipets, Test Tubes, Clay, Telsa Coil, Rubber Stoppers

**Safety Precautions**

Hydrochloric acid is toxic by ingestion and inhalation and is corrosive to skin and eyes. Hydrogen peroxide is a skin and eye irritant. Avoid contact of all chemicals with skin and eyes and notify your teacher immediately in case of a spill**. Wear Goggles.** Wash your hands before leaving your lab station.

**Construction of the Rockets**

1. Microscale gas generators consist of a small test tube, a rubber stopper a gas delivery tube, and a gas collection bulb.
2. (1 pt) Cut a couple pipets shown in Figure 1b. This will make the gas collecting bulbs and the four gas-delivery tubes. Discard the middle part of the pipet stem. It is important that the bulbs have similar lengths. Trim the lengths so they are equal.
3. Place the gas deliver tube ends into the tops of rubber stoppers as shown in figure 1a.

FIGURE 1

1. Prepare two hydrogen gas generators by placing about four pieces of mossy zinc into the bottom of a test tube. These are to be shared with your table.
2. Prepare two oxygen gas generators by placing about a pea size amount of manganese dioxide into the bottom of the remaining test tube. These are to be shared with your table.

Calibrating Gas Collection Bulbs

1. Fill a 250-mL beaker about half full with tap water.
2. Fill the bulb completely with water and remove it from the beaker.
3. Squeeze the water out of the pipet bulb into an empty graduated cylinder to measure the total volume (V) of water in the bulb. Record the total volume.
4. (2 pts)Refill the pipet bulb, and then squeeze out one- sixth of the total volume (V/6) into an empty graduated cylinder. Release the squeeze and use a permanent pen to mark the water-level on the side of the bulb or gently scratch a line with a paper clip.
5. Squeeze the second V/6 volume, mark the level again.
6. Repeat for the remainder of the water until your bulb is divided into 6 equal volume increments.
7. Once the first pipet bulb is calibrated, the rest can be copied to save time. Place a small piece of paper (around the same length of the pipet bulb) next to the bulb, with the top of the paper lined up with the top of the bulb. Mark the paper where the marks are made on the paper. Use this as a template to mark the rest of the bulbs.

Collect and test Hydrogen and Oxygen Gasses

1. Add 3 M hydrochloric acid to the mossy zinc in one of the hydrogen gas generators until the liquid level is about two fingers high from the bottom of the tube. Cap the tube with the gas delivery stopper (size 3). Let sit for a minute before collecting gas. This should only be done when you are ready to collect hydrogen gas in your rocket.
2. Add 3% hydrogen peroxide to the manganese dioxide in one of the oxygen gas generators until the liquid level is about 1cm below the mouth of the test tube. Cap the tube with the gas deliver stopper. Let sit for a minute before collecting gas. This should only be done when you are ready to collect oxygen gas.

Launch the Rockets!

1. Before you launch your rockets.

* What is the chemical reaction that is taking place in your rocket?
* What is the fuel for your rocket?
* Record the amount oxygen, hydrogen, and water in your rocket.

1. (10 pts)Try with different O2 : H2 : H2O ratios. Think before launching each time.
2. (2 pts)Think of other design factors that might make a rocket travel farther. Then try them.

Data Tables

Rocket Properties of O2: H2 Gas Mixtures

|  |  |
| --- | --- |
| **Oxygen: Hydrogen: H20 Mole Ratio** | **Distance/ Location launched** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Post Lab Questions

1. (4 pts) Draw a bar graph to illustrate the distance traveled from launching various oxygen: hydrogen: water gas mixtures.
2. (1 pt)What is the fuel in the mole rockets?
3. (2 pts)Write a balanced chemical equation for the combustion reaction of hydrogen and oxygen to give water.
4. (3 pts)Complete the following sentence to describe the number of moles of each reactant involved in the combustion of hydrogen: \_\_\_\_\_\_\_\_\_\_\_ mole(s) of hydrogen react with \_\_\_\_\_\_\_\_\_\_\_ mole(s) of oxygen to give \_\_\_\_\_\_\_\_\_\_\_\_moles of water.
5. (1-3 pts)Which oxygen/ hydrogen gas mixture produced the most explosive rocket? Explain why this mixture was most explosive.
6. (2 pts)Why do the hydrogen and oxygen gas mixtures in the collection bulb not react as soon as they are collected? (Consider the role of the match and the properties of gas molecules at room temperature)