Name _____ Class _____ Date _____

Skills Practice Lab **MICROSCALE**

Generating and Collecting H_2

Hydrogen gas has the lowest density of all the substances found on Earth. Once, hydrogen was used in blimps and dirigibles. Today, however, such aircraft use only helium, even though helium is less buoyant and considerably more difficult to obtain. Why was helium substituted for hydrogen? What was wrong with using hydrogen? To answer these questions, you will generate and collect small quantities of hydrogen gas and test the samples to find out for yourself some of the properties of hydrogen.

OBJECTIVES

Observe the production of H_2.

Use the technique of water displacement to collect H_2 gas.

Formulate hypotheses for reactions of H_2 gas in different situations.

MATERIALS

- beaker, 100 mL or larger (2)
- Bunsen burner or candle
- $CuSO_4$, 0.2 M
- forceps or tongs (optional)
- gloves
- HCl, 1.0 M
- lab apron
- micro H_2 generator
- pegs, small, to fit holes in stoppers (5)
- Petri dish, half
- rubber stoppers, one-holed (5)
- safety goggles
- tap water
- test tubes, small (5)
- wooden splints

Always wear safety goggles, gloves, and a lab apron to protect your eyes and clothing. If you get a chemical in your eyes, immediately flush the chemical out at the eyewash station while calling to your teacher. Know the location of the emergency lab shower and eyewash station and the procedures for using them.

Do not touch any chemicals. If you get a chemical on your skin or clothing, wash the chemical off at the sink while calling to your teacher. Make sure you carefully read the labels and follow the precautions on all containers of chemicals that you use. If there are no precautions stated on the label, ask your teacher what precautions to follow. Do not taste any chemicals or items used in the laboratory. Never return leftovers to their original container; take only small amounts to avoid wasting supplies.

Call your teacher in the event of a spill. Spills should be cleaned up promptly, according to your teacher's directions.

Acids and bases are corrosive. If an acid or base spills onto your skin or clothing, wash the area immediately with running water. Call your teacher in the event of an acid spill. Acid or base spills should be cleaned up promptly.

Do not heat glassware that is broken, chipped, or cracked. Use tongs or a hot mitt to handle heated glassware and other equipment because hot glassware does not always look hot.

When using a Bunsen burner, confine long hair and loose clothing. If your clothing catches on fire, WALK to the emergency lab shower and use it to put out the fire. A beaker of water should be kept near at all times, in case you need to quickly extinguish a burning wood splint.

Procedure

1. Put on safety goggles, gloves, and a lab apron.
2. Label one beaker *water* and the other *spent solution.* Fill the appropriately labeled beaker with water. Be sure both beakers are nearby as you proceed.
3. Label the test tubes *1*, *2*, *3*, *4*, and *5*. Fill test tubes 1, 3, 4, and 5 completely full of water. Fill test tube 2 only half way. Insert the one-holed stoppers into all five test tubes. Avoid creating air bubbles in the test tubes.
4. The micro H_2 generator is a plastic vial containing several pieces of zinc metal capped with a lid that has a nozzle.

   Make sure your H_2 generator cap has a nozzle and that the nozzle is not plugged before continuing with the experiment.

   Remove the cap, and carefully add enough 1.0 M HCl to fill the vial to within 1 cm of the top. Replace the cap, and set the H_2 generator in the petri dish. Add a few drops of $CuSO_4$ solution as a catalyst. Observe the reaction, and record your observations.

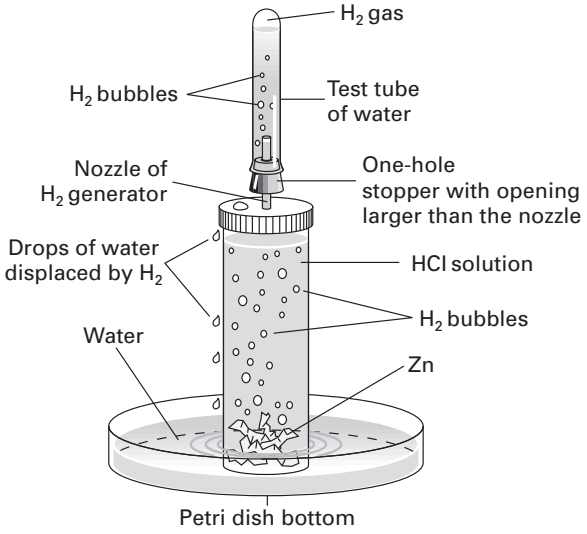

Figure 1

Observations:

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5. To collect the gas, place water-filled test tube 1 upside down over the nozzle of the generator, as shown in **Figure 1.** As soon as the test tube is completely filled with hydrogen, remove it from the nozzle and plug the stopper hole with a small peg to prevent the collected gas from escaping. Repeat this procedure using test tubes 2, 3, 4, and 5.
6. If the reaction slows down so that it takes more than 1 min to collect the tube of hydrogen gas, lift off the tube and uncap the vial. Decant the remaining liquid into the beaker labeled *spent solution* and replace it with fresh solution. Replace the cap and nozzle, and resume collecting gas.

   For **steps 7** through **11,** read the directions carefully and predict what might happen. Write your predictions in **Table 1.** Then follow the directions, and record your observations alongside your predictions in the data table.

   Because this investigation is carried out on a microscale level, the pop tests in steps 7 through 11, though potentially loud, are completely safe. The test tubes may be held with forceps or tongs or in your hand. Your teacher will tell you how you should hold the test tubes for the pop tests. Be sure to keep the gas-generating vial away from the flame and the wooden splint!

7. Flaming wooden splint and test tube 1 (hydrogen): Light the Bunsen burner or candle, and use it to light one end of a wood splint. Remove the stopper from test tube 1, and carefully insert the burning splint into the mouth of the test tube. Record your observations in **Table 1.**
8. Flaming wooden splint and test tube 2 (half hydrogen): Repeat the pop test described in **step 7** with test tube 2, which contains only half as much hydrogen as test tube 1 did. Record your observations in **Table 1.**
9. Glowing wooden splint and test tube 3 (hydrogen): Repeat the pop test with test tube 3, but this time blow out the flame, making sure a glowing ember persists on the tip of the wooden splint as you insert it into the test tube. Record your observations.
10. Unstopper test tube 4 and hold it mouth upward for 30 s; then try the pop test. Record your observations.
11. Unstopper test tube 5 and hold it mouth downward for 30 s; then try the pop test. Record your observations.
12. If your teacher approves, refill the test tubes first with water and then with hydrogen gas and recheck any of the observations you made. Record all observations.
13. Clean all apparatus and your lab station. Return equipment to its proper place. Dispose of chemicals and solutions in the containers designated by your teacher. Do not pour any chemicals down the drain or in the trash unless your teacher directs you to do so. Shut off the gas valve completely before leaving the laboratory. Wash your hands thoroughly before you leave the lab.

TABLE 1 EXPERIMENTAL OBSERVATIONS

Test-tube number	Predictions	Observations
1. Flame, pure H_2		
2. Flame, 50% H_2		
3. Ember, pure H_2		
4. Mouth up, flame		
5. Mouth down, flame		

Analysis

1. **Analyzing Information** What evidence was there that a reaction was occurring inside the generator?

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2. **Relating Ideas** Write a balanced chemical equation for the H_2 generator reaction.

3. **Relating Ideas** Write a balanced chemical equation for the reaction taking place during the pop test. (Hint: Water vapor is the product of the reaction.)

Conclusions

1. **Inferring Conclusions and Resolving Discrepancies** Compare your results for test tubes 1 and 2. Test tube 2 had only half as much hydrogen; was the pop test only half as loud? Explain your answer, referring to the balanced chemical equation for the pop test.

2. **Inferring Conclusions and Resolving Discrepancies** Consider your results for test tube 3. Did the hydrogen ignite? Can you explain why you observed what you did?

3. **Inferring Conclusions and Resolving Discrepancies** Is hydrogen gas more dense or less dense than air? (Hint: compare your results for test tubes 4 and 5. What was different about how they were treated, and how did this affect their pop test results?)

Generating and Collecting H_2 *continued*

4. **Organizing Conclusions** Using your observations of the hydrogen gas in each trial, the generation reaction, and the pop tests, list as many chemical properties of hydrogen as you can. Explain what evidence you have for each one. (At least four properties were observable in the experiment.)

5. **Organizing Conclusions** Using your observations from this experiment, list as many physical properties of hydrogen as your can. Explain what evidence you have for each one. (At least four properties were observable in this experiment.)

6. **Predicting Outcomes and Designing Experiments** Air is about 20% oxygen. Use this information to predict what ratio of air to hydrogen will provide the loudest pop test. Design an experiment that will test a range of proportions, including the one that you predicted would be the loudest. If your teacher approves your suggestions, test your predictions.