

How to Get Hydrogen from Zinc

Student Worksheet

Name _____

Overview: Someday, hydrogen fuel cells using zinc will be all the rage. In today's experiment, you'll witness this cutting edge reaction.

What to Learn: You should understand that heating zinc in the presence of oxygen causes a single replacement reaction to occur, which forms hydrogen. This may become an important process for creating a hydrogen fuel cell in the future.

Materials

- Gloves
- Goggles
- Chemistry stand
- Zinc (Zn) powder ([MSDS](#))
- Measuring spoon
- 4 test tubes
- Test tube holder
- Alcohol burner
- Lighter
- One-hole rubber stopper
- Rubber tubing
- 90° bend glass tubing
- Water
- Measuring syringe
- Stirring rod
- Clear pan

Lab Time

1. Prepare your materials
 - a. Connect the test tube holder to the chemistry stand
 - b. Carefully place a 1-hole rubber stopper on the short end of a glass tube. Connect rubber tubing to the long end of the glass tube.
 - c. Prepare a water bath by filling a pan about 2/3 full with water.
2. In a clean, dry test tube, add 4-5 large spoonfuls of zinc powder. Cap your chemical and clean the spoon.
3. Using a measuring syringe, add water drop by drop until every bit of zinc powder has been absorbed. Use a stirring rod or measuring spoon to mix.
4. Turn the test tube horizontal and add dry zinc powder mid-way down the test tube. Do not allow the wet zinc to mix with the dry zinc.
5. Put the stopper connected to the 90° glass tubing on the test tube and place it into test tube holder. Put the end of the rubber tubing into the water bath.
6. Put a clean test tube into the water bath, making sure it completely fills with water.

7. Light the alcohol burner and gently heat the warm, dry zinc. Let the first few bubbles escape into the water bath (they are air bubbles), then insert the rubber tube up into the test tube in the water bath. Prop the end of the test tube on the edge of the water bath.
8. Continue to heat the dry zinc until the bubbles have replaced all of the water in the test tube.
9. When the test tube is full of hydrogen gas, lift it straight up and bring over the flame from the alcohol burner to hear a “pop.”
10. Collect a second sample of hydrogen gas, but this time only fill the test tube about 1/3 of the way full. Lift this sample straight up from the water bath and let the water run out. Then, turn it on its side as you bring it close to the flame. What was this explosion like?
11. Try filling your test tube with different amounts of hydrogen and see how it affects your explosion. Record your results in your data table.

Important! Dispose of the zinc (Zn) left in the test tube in the outside trash. Accidentally ingesting (and it should only be accidental) of zinc (Zn) or zinc chloride (ZnCl₂), will harm you or animals. It will not be one of your best days. Call 911 if this happens.

After you have finished your experiment, be careful of the hot test tube containing the zinc compound. The test tube is very hot, and there will be a difference in pressure between the water tank and the test tube. Because the test tube has been heated, the pressure is less than atmospheric pressure.

As it cools, the water in the tank, which is at atmospheric pressure (the pressure of the air in the room) is higher than in the test tube. The test tube’s low pressure is looking to suck something, anything, up the glass tube. The water, sitting there at normal air pressure, notices the need. Water climbs up the tube in response to the test tube’s request.

At the conclusion of the experiment, with the heat off, the test tube starts to cool and water then donates some stuff to equalize the pressure. If allowed to, that cool water hits that hot zinc, or hot test tube, and the test tube could explode and the zinc could quickly react, blowing out the stopper and spewing hot zinc all over you.

Cleanup: Clean everything thoroughly after you are finished with the lab. After cleaning with soap and water, rinse thoroughly. Chemists use the rule of “three” in cleaning glassware and tools. After washing, chemists rinse out all visible soap and then rinse three more times. Dry them before putting them away.

Storage: Place all chemicals, cleaned tools, and glassware in their respective storage places.

Disposal: Dispose of all solid waste in the outside garbage. Liquids can be washed down the drain with running water. Let the water run awhile to ensure that they have been diluted and sent downstream.

How to Get Hydrogen from Zinc Data Table

Amount of hydrogen gas in test tube (approximate values)	Observations of Explosion
Full	

1/3 full	

Exercises Answer the questions below:

1. What is the chemical equation that describes this reaction?
2. Today's reaction was an example of a single replacement reaction. What does this mean?
3. Why might the production of hydrogen be important in the years to come?
4. Explain why a tube filled partway with hydrogen and then turned on its side produces a bigger explosion. What are you letting in?

Exercises

1. What is the chemical equation that describes this reaction? ($\text{Zn} + \text{H}_2\text{O} \rightarrow \text{ZnO} + \text{H}_2$.)
2. Today's reaction was an example of a single replacement reaction. What does this mean? (In a single replacement reaction, a compound first breaks down into its elemental parts. Then, a new compound is created as the elements bond with new "partners." In this case, water broke down into hydrogen and oxygen, and the oxygen attached to the zinc, forming zinc oxide.)
3. Why might the production of hydrogen be important in the years to come? (Hydrogen is thought to be the "fuel of the future" for our cars and other vehicles.)
4. Explain why a tube filled partway with hydrogen and then turned on its side produces a bigger explosion. What are you letting in? (When you turn it on its side, it allows oxygen from the air to mix with the hydrogen, creating a bigger explosion.)

Closure: Before moving on, ask your students if they have any recommendations or unanswered questions that they can work out on their own. Brainstorming extension ideas is a great way to add more science studies to your class time.