Production of Hydrogen

The procedure will allow the student to generate hydrogen gas and examine some of its properties.

Materials
- Mossy zinc
- 3 M hydrochloric acid
- 125 mL Erlenmeyer flask and stopper
- Stopper
- Wood splint
- Beral pipettes
- Candle and matches

Substitutions
- Galvanized nail
- Muriatic acid
- Small jar
- Lid
- Toothpick
- Droppers

Procedure
1. Place a small amount of mossy zinc or a galvanized nail in the flask.

2. Add one dropper full of HCl (aq) to the zinc. Gas bubbles will be produced. Stopper the flask loosely.

3. After 20 seconds, light the wood splint from the candle, and prepare to test for the gas.

4. Carefully place the burning splint at the mouth of the flask. Be prepared for the reaction! Replace the lid a wait for more gas to collect.

5. Re-light a splint and test the gas again.

Questions
1. Write the equation for the production of the gas in the above experiment.
2. Describe the reaction between the gas and the burning splint.
3. Why must the container be stoppered in order for the gas to be collected?
4. What property of hydrogen made it less desirable as the fill gas for the large dirigibles of the 1920’s and 1930’s?
Teacher's Notes
During the sixteenth century a Swiss-German physician named Paracelsus noted that a flammable gas was formed when iron reacted with sulfuric acid. He did not realize that the gas was a pure substance. In 1766, Cavendish determined that the flammable material was a distinct substance when he was able to produce the gas by reacting a variety of acids with several metals. However, it was Lavoisier who named the gas hydrogen, which means, "water producer".

Hydrogen is produced when an active metal replaces this element in hydrochloric acid. This reaction is called a single replacement reaction:
\[ \text{Zn (s) + 2HCl (aq) } \rightarrow \text{ ZnCl}_2 (aq) + \text{H}_2 (g) \]
Hydrogen has a density less than air, so we must use a stopper or lid to keep it from escaping. For large commercial ventures hydrogen is generally produced by the electrolysis of water. Hydrogen is liberated at the cathode when a direct current is passed through water containing a small amount of an electrolyte.

Solution Preparation
Commercial muriatic acid is a strong acid and therefore must be used with care! Gloves may be worn when working with this chemical. To prepare a 3M solution: slowly add 100 mL of concentrated muriatic acid to 300 mL of (distilled) water. This mixture will get HOT.

Safety Precautions
1. Proper eye protection should be used at all times.
2. Hydrochloric acid is corrosive. Proper care should be used to protect skin and clothing.
3. If you are using glass bottles or jars, the containers should be wrapped with tape to avoid glass fragments if the container is broken or explodes.
4. Hydrogen gas is very reactive! Do not have open flames or sparks near gas production or storage area. Pressure will build up quickly inside the flask or jar, so the container should never be tightly sealed.

Disposal
All solids may be placed in the trash can. Acid solutions should be poured down the sink followed by water to clear the plumbing.