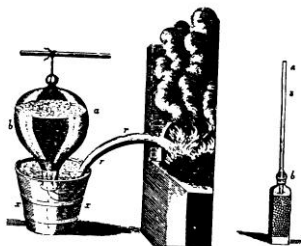


## Hydrogen Gas: Production, Collection, and Flammability by William C. Deese

**Description:** Bottles of hydrogen gas are collected by the displacement of water in a pneumatic trough. The flammability of hydrogen is demonstrated by the ignition of sample with burning splints.

### Steven Hales' First Pneumatic Trough

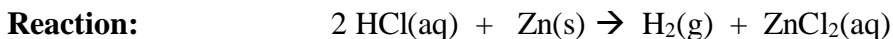


**Materials:** 4 gas collection bottles, 3 2-inch glass plates, 1 long stem funnel, 1 two hole stopper for bottle, glass tubing, pneumatic trough or similar container, ring stand, clamp, about 3 feet of flexible tubing, 6M HCl, mossy zinc, matches, wood splints.

**Procedure:**

- 1) Clamp one bottle to the ring stand for stability.
- 2) Place about 5 grams of mossy zinc in the bottle.
- 3) **Very carefully** insert a three-inch length of glass tubing through the smaller hole in the stopper. Use lubricant.
- 4) **Very carefully** insert the long stem funnel through the larger hole in the stopper so it will reach almost to the bottom of the bottle.
- 5) Attach the flexible tubing to the short glass tube.
- 6) Fill the pneumatic trough about 3/4 full of water.
- 7) Fill the 3 remaining bottles with water and stand them upside down in the trough.
- 8) Slowly pour about 100 ml of 6M HCl through the funnel.
- 9) Place the end of the flexible tubing under the water in the trough.
- 10) Allow bubbles to escape for about 15 seconds.
- 11) Collect three bottles of gas by the displacement of water. (When each bottle is full, slide a glass plate over the mouth and place it on the bench.)
- 12) Quench the reaction by diluting the reaction mixture with water.
- 13) Light a wood splint. Test one of the gas samples for flammability with a burning splint by holding a bottle upside down and approaching the mouth with the flame.
- 14) With a second bottle of hydrogen, insert a glowing splint and make observations. (Hold the bottle inverted at all times.)
- 15) Finally, with the third bottle of pure hydrogen, thrust a burning splint well into the inverted bottle. Make observations.

**Clean Up:** Disassemble the apparatus. Pour the reaction mixture into the waste container provided. This waste should be neutralized with dilute base. The liquid portion can be poured down the sink. The solids should be collected and stored in a suitable container.



**Discussion:** This activity is designed to give experience in the generation of hydrogen gas and the use of a pneumatic trough. Step 13 shows the combustion of hydrogen gas. The burning is slow and occurs at the mouth of the bottle because no oxygen is available inside the container. Air gradually mixes with the burning hydrogen at the opening of the bottle. The only product of the reaction is water vapor. Some of this water vapor condenses on the inside of the bottle and may be visible. (This is obvious if the combustion is performed in a dry bottle.) The glowing splint is extinguished when thrust into pure hydrogen because of the lack of oxygen. When a burning splint is thrust inside the pure hydrogen sample, the flame ignites the hydrogen at the mouth - air interface but doesn't burn inside the bottle. This event is usually made obvious by the ignition of the splint in the middle at the mouth of the bottle where a flammable mixture of oxygen and hydrogen is burning.

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