Hydrogen Bubbles

Introduction

Make and ignite hydrogen-filled soap bubbles! It's a very visual, fun, inexpensive and easy demonstration that is sure to excite your students.

Concepts

- Density of gases
- Combustion
- Water displacement

Materials

Joy® or Dawn® dishwashing liquid, 40 mL
Glycerin, 6 mL
Hydrochloric acid, HCl, 3 M, 75 mL
Zinc, mossy, Zn, 20 g
Water, 400 mL
Graduated cylinder
Matches
Igniting stick (see *Preparation*)
  Candle
  Meter stick
  Tape or rubber bands, 2
Gas generator bottle (see *Preparation*)
Gas generator bottle or flask
Two-holed stopper
Thistle tube or long-stem funnel
Bent glass tubing
Latex or plastic tubing, 1 m
Funnel, small

Safety Precautions

Hydrochloric acid is toxic by ingestion or inhalation and severely corrosive to skin and eyes. Hydrogen gas is very flammable and yields explosive mixtures with air. Perform this demonstration outdoors or in a room with high ceilings. The hydrogen bubbles rise rapidly and produce a sizable flame when ignited. Perform away from all flammable materials and ignite the bubbles away from the gas generator, yourself, and the audience. Tie back long hair. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Students and other spectators should also wear chemical splash goggles during this demonstration. Please review current Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. Prepare a soap bubble solution by mixing 40 mL of Joy® or Dawn® dishwashing liquid, 400 mL of water (distilled or deionized water works better than tap water), and 6 mL of glycerin.
2. Set up the gas generator as shown in Figure 1. Carefully insert one end of the bent glass tubing through a two-holed rubber stopper. Attach latex or plastic tubing to the free end of the glass bend. Insert a small funnel into the other end of the latex or plastic tubing. Insert the stem of a thistle tube or long stem funnel through the other hole in the stopper. Make sure the stem will be close to the bottom of the flask when the stopper is inserted into the neck of the flask. Place 20 grams of mossy zinc in the bottom of the flask. Stopper the flask. A gas generating bottle is available from Flinn Scientific, Catalog No. AP1558.
3. Prepare an igniting stick as shown in Figure 2. Attach a candle to the end of a long stick such as a meter stick, wood pointer, or dowel rod. Attach the candle to the stick using tape or rubber bands.

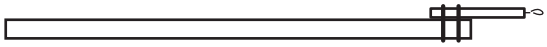

Figure 2. Igniting stick

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Publication No. 10070
061616

Procedure

1. Pour 75 mL of 3 M hydrochloric acid through the thistle tube into the gas generating flask. The stem of the thistle tube should be submerged into the acid solution to prevent loss of hydrogen gas.
2. The mixture will begin to fizz as the hydrogen gas is produced. Allow the hydrogen gas to flow through the tubing for about 3 minutes to flush all the air out of the system.
3. While the hydrogen gas is being produced at a generous and consistent rate, dip the small funnel into the soap bubble solution and then raise it slightly above the solution. As a hydrogen-filled bubble begins to form, lift the funnel up and give the funnel a little shake to release the bubble. When released, the bubble will rise quickly.
4. Ignite the hydrogen bubble using the igniting stick. *Caution:* Keep the igniting stick away from the gas generator and ignite the bubbles in an area away from any flammable materials. Do not ignite the hydrogen-filled bubbles near a smoke detector or heat sensor.
5. Repeat steps 3 and 4 to collect more hydrogen bubbles. Add more acid to the gas generator as needed to keep a constant flow of hydrogen gas.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The soap solution may be disposed of according to Flinn Suggested Disposal Method #26b. The acid solution may be neutralized using Flinn Suggested Disposal Method #24b. The zinc can be rinsed with water and saved for reuse.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
- MS-PS1 Matter and Its Interactions
  - PS1.A: Structure and Properties of Matter
  - PS1.B: Chemical Reactions
- MS-PS3 Energy
  - PS3.A: Definitions of Energy
  - PS3.B: Conservation of Energy and Energy Transfer

Disciplinary Core Ideas: High School
- HS-PS1 Matter and Its Interactions
  - PS1.B: Chemical Reactions
- HS-PS3 Energy
  - PS3.A: Definitions of Energy
  - PS3.B: Conservation of Energy and Energy Transfer
  - PS3.D: Energy in Chemical Processes

Science and Engineering Practices
- Asking questions and defining problems
- Constructing explanations and designing solutions

Crosscutting Concepts
- Cause and effect
- Energy and matter
- Stability and change

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Tips

- The hydrogen bubbles will rise very quickly—it is difficult for one person to generate the bubbles and also ignite them. This demonstration works best with two demonstrators, one generating the bubbles and the other igniting them. Practice this demonstration before performing it in front of students.
- If there are difficulties forming bubbles, then the hydrogen gas production may be too fast or slow. To slow down the gas production, either wait a few minutes or dilute the acid with water. To increase the rate, add more acid.
- The characteristics of this soap solution seem to improve upon aging. If possible, make the solution a few days in advance.

Discussion

Zinc reacts with hydrochloric acid to produce hydrogen gas according to Equation 1.

$$Zn(s) + 2HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq) \qquad \textit{Equation 1}$$

Hydrogen gas is less dense than air and the hydrogen bubbles will rise quite rapidly once released. When the hydrogen bubbles are ignited, the hydrogen reacts with oxygen in the air to produce water according to Equation 2.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l) \qquad \textit{Equation 2}$$

Acknowledgment

Many science teachers perform this demonstration but we give special thanks to Penney Sconzo, The Westminster Schools, Atlanta, GA for providing us with these instructions.

Materials for *Hydrogen Bubbles* are available from Flinn Scientific, Inc.

Catalog No.	Description
H0034	Hydrochloric Acid Solution, 3 M, 500 mL
Z0003	Zinc, Mossy, 500 g
G0007	Glycerin, 500 mL
C0192	Candles, 5″ × 1¼″, pkg./4
AP1558	Gas Generating Bottle
GP8004	Thistle Tube, Glass
AP8160	Thistle Tube, Polyethylene
GP5040	Funnel, Short-stem, Fluted

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

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