An Egg-splosive Demonstration

Bob Becker's Favorite Combustion Reaction Demonstrations

Introduction

A blown egg is charged with hydrogen gas and then lit at the top. A small "pop" is immediately heard, then 10–15 seconds later—without warning—a crisp, loud report and the entire egg is gone!

Concepts

- Activation energy
- Combustion
- Properties of hydrogen

Materials

Chicken egg, any size
Hydrogen gas source*
Beaker or bowl
Butane safety lighter
Electrical tape or putty
Nail or triangular file
Plastic tube, thin (OD < 3 mm)
Safety shield
Soda bottle, 2-L plastic

**See* Tips *section for possible sources.*

Safety Precautions

Hydrogen is a flammable gas and a severe fire hazard. Hydrochloric acid solution used to generate hydrogen gas (2–3 M) is toxic by ingestion and inhalation and corrosive to skin, eyes and other tissues. Exercise extreme caution when lighting the gas and keep the gas generator or lecture bottle away from flames. Use a safety shield. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. All students or other observers should wear safety glasses. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. To blow the egg, first wash it thoroughly—there's no telling where it may have been!
2. Using a nail or a triangular file, gently tap a small hole (2–3 mm diameter) in the top (narrow end) of the egg and a slightly larger hole (3–4 mm diameter) in the bottom. *Note:* See the *Tips* section for an alternative method.
3. Insert the nail or a wire and stir up the yolk, being careful not to increase the size of the hole.
4. Holding the egg over a beaker or bowl, blow into the small hole to force the egg's contents out through the larger hole.
5. Rinse out the inside several times with water, and allow the egg to dry overnight at room temperature or for 30–40 minutes in a warm (100 °C) oven.
6. Cut off the top portion of a 2-L plastic soda bottle. If desired, save the bottom portion for a "mini safety shield" (see the *Tips* section).

Publication No. 91627
061616

Procedure

1. Cover the top hole of the egg with a piece of tape or putty.
2. Introduce hydrogen gas slowly through the bottom hole using a thin delivery tube that extends upward to the top of the egg (see Figure 1).
3. Charge the egg for 30–40 seconds to flush out the air.
4. Using the top portion of the soda bottle as a support, stand the egg in an upright position with the taped hole on top behind a safety shield (see Figure 2).

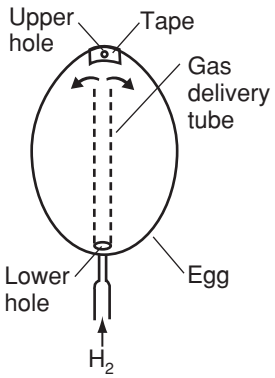

Figure 1.

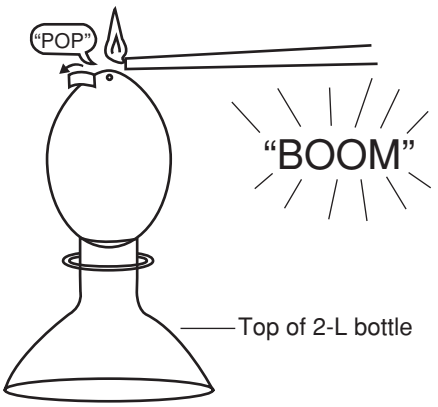

Figure 2.

5. To initiate the combustion reaction, simply remove the tape and hold a lit butane safety lighter briefly to the top hole.
6. Tell the students to cup their ears. Then . . . stand back! After a small initial "pop" sound, nothing appears to happen. A few seconds later—"BOOM!"—and the egg is gone.

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. Hydrochloric acid solution should be diluted by pouring it into a large beaker of water and then neutralized according to Flinn Suggested Disposal Method #24b. Leftover zinc may be rinsed with water and saved for reuse, or thrown away according to Flinn Suggested Disposal Method #26a.

Tips

- The source of hydrogen may be a lecture bottle or a gas generator bottle and the reaction of 2–3 M HCl with mossy zinc.
- A delivery tube extending directly into the egg is needed. A plastic juice box straw or the stem of a thin-stem pipet can serve as an adequate delivery tube for the hydrogen. Wrap electrical tape around one end to connect snugly into the tubing from the gas source.
- To avoid blowing into the egg, make the large hole in the bottom of the egg. Insert a thin-stem pipet into the egg to break up the yoke. Then force air into the egg by squeezing the pipet bulb and the contents will drip out. Repeat the last step until the egg is empty. Then make the smaller hole at the top of the egg, rinse and allow to dry.
- A cut-away 2-L bottle will suffice in place of the safety shield. Cut out one side of the bottle, leaving the bottom 2–3 inches intact as a reservoir to place the egg stand (the top of the 2-L bottle). The audience should wear safety glasses.
- Colleagues in the "Weird Science" team have repeated this demonstration using an ostrich egg! If this is attempted, be warned—the explosion is considerably more substantial, a regulation safety shield must be used, and the audience should be cautioned to cover their ears.
- The time-delay between the initial lighting of the egg and the subsequent explosion can vary quite significantly, lasting anywhere from a fraction of a second up to 30 or 40 seconds, depending on the size of the egg, the size of the two holes, and the extent to which the air inside the egg was effectively flushed out by the hydrogen.

Discussion

The initial pop is caused by a small portion of the hydrogen leaking out and mixing with the air immediately above the hole to form a small combustible mixture. Then, as more hydrogen gas slowly escapes through the top hole, it continues to react with the oxygen in the air and burns with an essentially invisible and silent flame. At the same time, oxygen-containing air is being drawn up into the egg through the bottom hole and mixing with the remaining hydrogen.

When enough air has entered the egg to form a combustible mixture with the hydrogen, the flame backfires down through the hole and ignites the mixture. Since the reaction is exothermic and the holes in the egg are not large enough to accommodate the rapid expansion of the gases, the pressure inside the egg increases rapidly and the egg explodes into several small pieces. The reaction is represented by Equation 1 below.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g) + \text{heat} \qquad \textit{Equation 1}$$

The most common problem teachers experience with this demonstration is that the egg detonates immediately upon lighting. Not only is this unnerving, it is also misleading—students might be left with the impression that pure hydrogen is reactive by itself. Premature detonation invariably occurs because there is residual air mixed in with the hydrogen. Keep three things in mind to avoid this problem. First, the gas delivery tube needs to extend all the way to the top of the egg. If the hydrogen is introduced into the middle, it results in more mixing than it does downward displacement of the air. Second, the hydrogen-producing reaction might be proceeding too slowly. Remember the egg shell is permeable (that's how developing chicks breathe!), and if the hydrogen is leaking out as fast as it is being put in, there is little chance of it flushing out all of the air. Finally, once the egg is removed from the hydrogen source, it must be uncovered and lit promptly. If this takes more than 10–15 seconds, enough hydrogen can leak out and air leak in to constitute a combustible mixture. Practice is essential.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, chemical reactions, interactions of energy and matter

References

Shakhashiri, B. Z. *Chemical Demonstrations;* University of Wisconsin: Madison, WI, 1985; Vol. 2, pp 131–136.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *An Egg-splosive Demonstration* activity, presented by Bob Becker, is available in *Bob Becker's Favorite Combustion Reaction Demonstrations*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *An Egg-splosive Demonstration* are available from Flinn Scientific, Inc.

Catalog No.	Description
Z0003	Zinc, Mossy, 500 g
H0034	Hydrochloric Acid Solution, 3 M, 500 mL
LB1015	Lecture Bottle, Hydrogen
LB1070	Hydrogen, Refillable Cylinder

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