

Wax Vapor Combustion in a Test Tube

Introduction to Reaction Rates

Introduction

A typical candle is made up of wax and a wick. As the wick burns, the heat melts the wax, and the liquid is “wicked up” where the heat of the flame vaporizes it. The wax vapor reacts with oxygen in the air, and this reaction gives off heat and light. The cycle continues as more wax is melted from the heat of the combustion reaction, wicked up, and vaporized. Is it possible to burn a candle without a wick?

Concepts

- Combustion
- Kinetics
- Chemical reactions

Materials

Candle	Pipet, Beral-type, large bulb
Hydrogen peroxide, H_2O_2 , 3%	Rubber stopper, 1-hole
Yeast, active dry	Scissors
Bag, resealable, quart-size	Scoop
Bunsen burner	Tape, electrical
Butane safety lighter	Test tube, 12 × 75 mm
Nail	Test tube clamp

Safety Precautions

While a 3% solution of hydrogen peroxide is very weak, it is still an oxidizer and a skin and eye irritant. Remove all combustible materials from the demonstration area. The reaction may produce a loud pop. Wear hearing protection, chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. 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. Cut one corner off the bottom of the resealable plastic bag, just large enough to insert the rubber stopper in half-way.
2. Insert the rubber stopper into the corner opening from the inside. The rubber stopper should fit snugly.
3. Use electrical tape to completely seal the hole in the bag around the rubber stopper.
4. Insert a nail in the hole in the stopper from the outside (see Figure 1).
5. Taper the stem of the jumbo pipet a bit by wrapping the open end of the stem around your index finger and pulling while holding the end firmly between the index finger and thumb. Do not pull too hard. Once the stem has been slightly stretched, cut the thicker end off (see Figure 2).

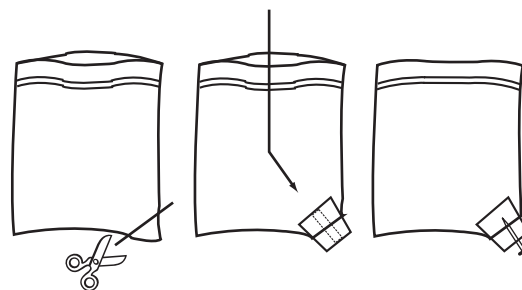


Figure 1.



Figure 2.

Procedure

1. Pour approximately 30 mL of 3% hydrogen peroxide into the plastic bag.
2. Add 2 generous scoops of yeast to the bag.
3. Press out most of the air from the bag and seal it.
4. Shake the bag to mix the contents. Set the bag aside.
5. Break off a small piece of candle wax with your thumbnail or with the end of a metal scoop.
6. Place the piece of candle wax in a small borosilicate glass test tube. Set the test tube aside.
7. Remove the nail from the rubber stopper.
8. Squeeze as much air as possible from the pipet bulb and insert the tip of the pipet into the hole in the rubber stopper, as far as it will go.
9. Release the pipet bulb to draw up oxygen from the bag. *Note:* The gas drawn into the bulb is not pure O₂, but a mix of O₂, air, and water vapor. The important factor is the gas in the bulb has a much higher concentration of O₂ than air.
10. Remove the pipet from the stopper and reinsert the nail.
11. Light the Bunsen burner.
12. At this point, put on a hearing protector.
13. Using a test tube clamp, hold the test tube at a slant over the burner flame until the wax melts and then boils.
14. Remove the test tube from the flame. Warn students to cover their ears.
15. Insert the stem of the pipet into the test tube about halfway and bend the stem so the bulb is below the mouth of the test tube (see Figure 3). *Caution:* Keep the hand holding the pipet bulb away from the mouth of the test tube.
16. Give the pipet bulb a quick squeeze. The wax vapor should react with the oxygen with a loud pop and a flame.
17. Repeat steps 7–16 as desired.

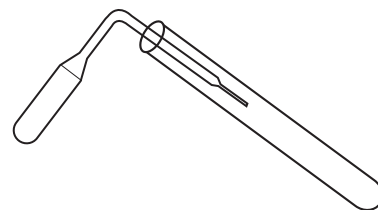


Figure 3.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Paraffin wax and the sealed plastic bag may be disposed of according to Flinn Suggested Disposal Method #26a.

Tips

- Students may think that forcing the gas from the bulb has an effect on the reaction. Show students that the concentration of oxygen in the air is not enough to cause the wax vapor to react by squeezing a bulb full of air into the test tube.
- The hotter the wax vapor the better. Make sure the wax is completely melted and boiling before introducing the oxygen.

Discussion

Candles are made of paraffin wax, a long-chain hydrocarbon. Paraffin does not burn well in the solid or liquid state, so candles are designed to melt and then evaporate the wax. As the combustion reaction occurs, the heat released continues to melt and evaporate more wax, and the candle continues to burn. In Equation 1 below, the “CH” represents the paraffin wax hydrocarbon.



Equation 1

Wax Vapor Combustion in a Test Tube *continued*

The concentration of oxygen in air is about 21%. A greater concentration is needed for the combustion reaction above to take place when a wick is not present to bring the liquid wax to the flame. This higher concentration of oxygen is easily produced by the decomposition of hydrogen peroxide, using yeast as a catalyst (See Equation 2).



Connecting to the National Standards

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

Unifying Concepts and Processes: Grades K–12

Systems, order, and organization
Evidence, models, and explanation
Constancy, change, and measurement

Content Standards: Grades 5–8

Content Standard A: Science as Inquiry
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, chemical reactions, interactions of energy and matter

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Wax Vapor Combustion in a Test Tube* activity, presented by Bob Becker, is available in *Introduction to Reaction Rates* and in *Bob Becker's Favorite Combustion Reactions*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Wax Vapor Combustion in a Test Tube* are available from Flinn Scientific, Inc.

Catalog No.	Description
H0009	Hydrogen Peroxide, 3 %, 473 mL
C0192	Candles, White, Pkg/4
Y0008	Yeast, Baker's
AP8850	Pipet, Super-Jumbo, Pkg/20
GP6005	Test Tube, Borosilicate Glass, 12 75 mm
AP6521	Test Tube Clamp, Wood
AP8779	Hearing Protector

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