

Carbon Dioxide Fire Extinguisher

Properties of Carbon Dioxide



Introduction

Three candles of varying heights—which candle will go out first when a jar is inverted over them?

Concepts

- Gas properties
- Density
- Temperature effects
- Combustion
- Sublimation

Materials

Bell jar or large beaker (2-L)

Candles, 3

Materials for Optional Procedure

Dry Ice, $\text{CO}_2(\text{s})$

Beaker or jar, large

Bucket

Butane safety lighter

Gloves

Safety Precautions

Keep flammables away from the open flame. Handle dry ice with gloves. Never place dry ice in a sealed container! Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

Place candles so they are at three different heights. This can be done by using different sized candles and candleholders or by placing the candles on three different height beakers or other support.

Optional:

Fill a bucket half way with dry ice and allow it to sit undisturbed for about 10 minutes in order to have it fill up with $\text{CO}_2(\text{g})$.

Procedure

1. Place the bell jar or large beaker beside the unlighted candles.
2. Ask the students to predict in writing which candle will go out first and to explain why their prediction will occur.
3. Light the candles and invert the bell jar or large beaker over the candles. Candles will extinguish from top to bottom.

Optional

1. Place the candles at three different heights in a large jar or beaker.
2. Light the candles.
3. Slowly pour the carbon dioxide gas down the side into the jar or beaker. The candles will extinguish one-by-one from the bottom to the top.

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 materials may be saved for future demonstrations. The excess dry ice may sublime under a fume hood.

Tips

- Pre-burn the candles before the demonstration. They will light and burn easier this way.
- A larger jar will provide more time for all of the candles to extinguish.

Discussion

Candle wax (paraffin wax) combines with oxygen to form carbon dioxide and water. The reactant oxygen is at room temperature. The product carbon dioxide is at a temperature of approximately 275 °C. The density of the oxygen at 25 °C is 1.31 g/L and the density of the carbon dioxide at 275 °C is 0.978 g/L. Therefore, after burning begins, the oxygen will be located at the bottom of the container because it is denser than the warmer carbon dioxide.

Optional

Carbon dioxide (dry ice) sublimates at a temperature of –79 °C. At this temperature, it has a density of 1.56 g/L. The density of oxygen at 25 °C is 1.31 g/L. As the denser gaseous carbon dioxide is poured into a vessel containing a number of lit candles, the candles are extinguished one at a time from the bottom up.

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 9–12

- Content Standard A: Science as Inquiry
- Content Standard B: Physical Science, structure and properties of matter, interactions of energy and matter

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Carbon Dioxide Fire Extinguisher* activity, presented by George Gross, is available in *Properties of Carbon Dioxide*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Carbon Dioxide Fire Extinguisher* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP4835	Paraffin Candles, Pkg/10
GP1045	Beaker, 2000-mL
AP6655	Bell Jar, 3.5-L

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