# Boiling Cold

## Evaporation and Boiling

## Introduction

The cooling effect of evaporation is nature's way of cooling our bodies as well as the Earth. Liquid butane in a plastic bag provides a good example of this phase change!

## Concepts

- Solids and liquids
- Pressure
- Phase change

## Materials

Butane, spray can, refill container

Bag, plastic, zipper-lock, large

## *Safety Precautions*

*Follow directions on spray can. Directing the spray at skin may cause frostbite. Product is flammable; keep contents away from an open flame and electrical equipment. Wear chemical splash goggles, a chemical-resistant apron, and chemical-resistant gloves. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.*

## Procedure

1. Place the nozzle of the spray can inside an opened zipper-lock bag and close the bag around the nozzle.
2. Compress the nozzle for 3–5 seconds, spraying the butane into the bag. Seal the bag. There should be several mL of a very cold liquid in the bag.
3. Allow the liquid in the bag to flow from one corner of the bag to the other. Water vapor from the air will condense on the outside of the bag.
4. Hold the corner of the bag that contains the liquid and note how the liquid boils vigorously and the volume of the bag is increasing.

## Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Follow directions on spray can. The bag may be opened and the gas allowed to escape into the room.

## Tips

- Several bags may be prepared and passed around the room.
- If a large quantity of spray is used, the bag will fill up with gas and the liquid will not boil as readily.

## Discussion

Butane boils at 0.5 °C. At room pressure, it is a gas. It can be liquefied at room temperature by increasing the pressure. Once butane is liquefied it will remain a liquid until the pressure is lowered, in this demo, by pressing the nozzle and allowing some gas to escape.

$$\text{Butane(l)} + \text{energy} \rightarrow \text{Butane(g)}$$

The evaporation process is endothermic, and the container and the sprayed object get very cold. When sprayed into the bag, the temperature drops to approximately –5 °C and the butane liquefies at room pressure. Water vapor from the air condenses on the outside of the bag due to the temperature of the liquid inside. Discuss what is going on with your



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students. Many students have no idea where this water comes from. This can be related to why an ice cold drink or a toilet sweats during the summer. The bag and the liquid can show qualitatively the effect of pressure on boiling point. This can be done more effectively in a large syringe. Collect some of the cold liquid into a syringe, plug the tip, and pull back on the handle to reduce pressure.

## 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 B: Physical Science, structure and properties of matter, interactions of energy and matter

## Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Boiling Cold* activity, presented by Jesse Bernstein, is available in *Evaporation and Boiling*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

# Phase Diagram