

Frozen Beaker: Endothermic Reactions *Preparer's Version*

Introduction

Endothermic reactions are chemical reactions that absorb heat energy from their surroundings, resulting in a decrease in temperature. In the context of the reaction between barium hydroxide and ammonium chloride, this process exemplifies an endothermic reaction. When solid barium hydroxide and solid ammonium chloride are mixed together, they undergo a reaction that consumes heat energy from the surroundings to break bonds and form new compounds. Specifically, in this reaction, barium hydroxide reacts with ammonium chloride to produce solid barium chloride, water, and ammonia gas:



Safety Hazards

- Personal Protective Equipment
 - Safety glasses/goggles
 - Nitrile gloves
 - Chemical & flame retardant lab coat
- Physical Hazards
 - Ammonia is flammable and may form combustible dust mixtures in air.
- Chemical Hazards
 - Barium hydroxide may cause severe skin and eye damage.
 - Ammonium chloride is toxic if ingested; may cause serious eye irritation.
 - Ammonia causes severe skin and eye burns; may cause severe respiratory irritation.
 - Barium chloride is toxic if ingested; may cause eye, skin, and gastrointestinal irritation.

Materials

- Low-density wood (such as balsa wood)
- Deionized water squirt bottle
- 32 g barium hydroxide, octahydrate
- 16 g ammonium chloride
- Glass stir rod
- 400 mL beaker

Safety Data Sheet(s)

- [Barium hydroxide](#)
- [Ammonium chloride](#)
- [Ammonia](#)
- [Barium chloride](#)

Procedure

Note: This reaction generates ammonia gas. Only conduct this reaction in a well-ventilated area.

1. Measure 32 g of solid barium hydroxide, octahydrate.
2. Measure 16 g of solid ammonium chloride.
3. Fill a small to medium squirt bottle with deionized water.
4. Provide a glass stir rod and either paper towels or a way to clean off the stir rod before packing it back up after the reaction.
5. Provide a small piece (approximately 8" x 3") and a 400 mL glass beaker.

Tips & Tricks

- Make sure there is enough water on the piece of balsa wood to completely cover the bottom surface of the beaker.
- If balsa wood is not available, make sure the alternative is also a low-density wood.
- Make sure to warn the performer that this reaction will generate ammonia gas, and for them to keep their face away from the space immediately above the beaker. This demonstration should only be performed in a large or outdoor space, in a well-ventilated area.

Clean-Up Procedures

1. Use deionized water to dilute the slurry of barium chloride in the beaker and pour it into a waste bottle. This may take several rounds, as the slurry can easily get stuck to the beaker.
2. Be mindful of the ammonia gas. It is best to clean the beaker inside of the fume hood.
3. Rinse all bottles, beakers, and labware thoroughly with deionized water at least three times and pour the runoff into the waste bottle.
4. Clean thoroughly with laboratory soap.