

# EXPERIMENT: EXOTHERMIC AND ENDOTHERMIC REACTIONS

Syllabus reference 8.5.4

## INTRODUCTION

All chemical changes are accompanied by energy changes. Energy is absorbed or released when chemical bonds are broken and reformed. The most common form of this energy is heat.

As heat is absorbed or released during a reaction, the surroundings will correspondingly get colder or hotter. A measure of the heat energy exchanged between a reaction and its surroundings is the enthalpy change ( $\Delta H$ ) for the reaction.

Reactions which **absorb** heat energy are **endothermic** while reactions which **release** heat energy are **exothermic**.

### AIM

To observe the energy changes in different chemical reactions.



**SAFETY: Safety glasses must be worn. Sodium hydroxide (NaOH) is corrosive and barium hydroxide (Ba(OH)<sub>2</sub>) is toxic and corrosive. Do not allow contact with skin or eyes. Wash with water for 10–15 minutes if contact occurs.**

### EQUIPMENT

- 2 test tubes
- 1 polystyrene cup
- 50 mL measuring cylinder
- 1 plastic teaspoon or spatula
- steel wool
- distilled water
- test tube stoppers
- 25 mL saturated copper sulfate solution (CuSO<sub>4</sub>)
- approximately 1 teaspoon of each solid:
  - sodium hydroxide (NaOH)
  - ammonium chloride (NH<sub>4</sub>Cl)
  - hydrated barium hydroxide (Ba(OH)<sub>2</sub>·8H<sub>2</sub>O)
  - sodium chloride (NaCl)
  - ammonium thiocyanate (NH<sub>4</sub>SCN)
  - sodium ethanoate (NaCH<sub>3</sub>COO)

## PROCEDURE

### Part A: Displacement reaction

- 1 One-third fill a test tube with the saturated copper sulfate ( $\text{CuSO}_4$ ) solution. Record the temperature.
- 2 Roll enough steel wool into a tight ball to fit in the test tube. Hold it under the  $\text{CuSO}_4$  solution with the thermometer. Record the final temperature. Record any observations.

### Part B: Dissolving solids

- 1 Measure 25 mL of distilled water into the polystyrene cup and measure the initial temperature of the water.
- 2 Add one teaspoon of sodium hydroxide ( $\text{NaOH}$ ), stir to dissolve and record the final temperature. Wash out the cup.
- 3 Repeat the procedure with sodium chloride ( $\text{NaCl}$ ), ammonium chloride ( $\text{NH}_4\text{Cl}$ ) and sodium ethanoate ( $\text{NaCH}_3\text{COO}$ ).
- 4 Tabulate your results in the data table. Record any observations.

### Part C: Reaction between ammonium thiocyanate ( $\text{NH}_4\text{SCN}$ ) and barium hydroxide ( $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ )

- 1 Place about one teaspoon of  $\text{NH}_4\text{SCN}$  and one teaspoon of  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  in a test tube. Record the temperature.
- 2 Stopper the test tube and shake gently until a solution is formed.
- 3 Remove the stopper and smell cautiously.
- 4 Record the final temperature and any observations.

## RESULTS

SUBSTANCE/S	INITIAL TEMPERATURE	FINAL TEMPERATURE	TEMPERATURE CHANGE	EXOTHERMIC OR ENDOTHERMIC?

## OBSERVATIONS

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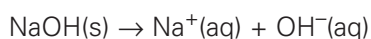
## QUESTIONS

- 1 Classify each of the reactions as exothermic or endothermic.
- 2 Write a balanced equation for the reaction in Part A.

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- 3 For the dissolution of sodium hydroxide the equation is generally written:



Write similar equations for the dissociation of NaCl, NH<sub>4</sub>Cl and NaCH<sub>3</sub>COO.

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- 4 Ammonium thiocyanate consists of the ions NH<sub>4</sub><sup>+</sup> and SCN<sup>-</sup>. What substance did you detect in Part C, step 3? Write a balanced equation for the reaction that occurred. Note that the reactants were present as solids and that the final reaction mixture was a clear solution.

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