# 4. Endothermic Reactions - Dissolution of Ammonium Nitrate in Water

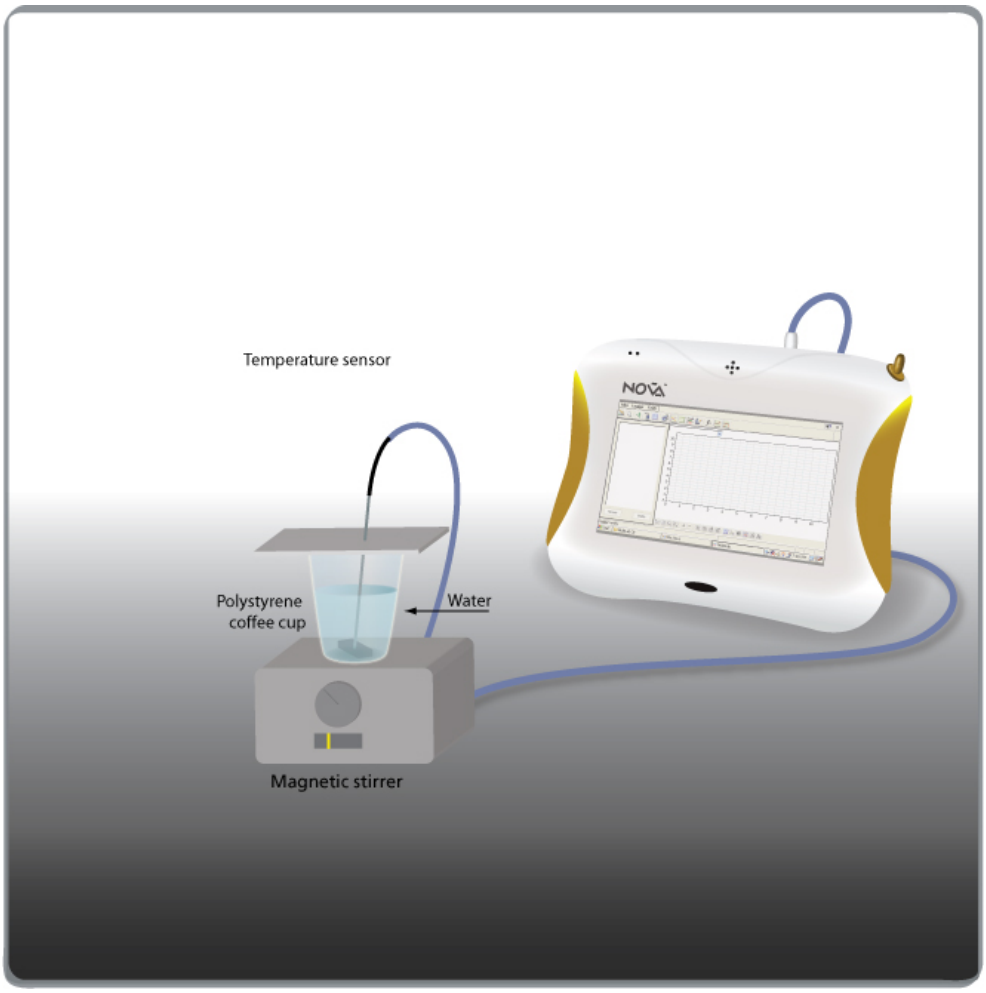


**Figure 1**

## Introduction

An endothermic process is a chemical reaction in which heat is absorbed. When we perform an endothermic reaction in a flask, it initially cools. Later, heat from the surroundings flows to the flask until the temperature balance is established.

In this experiment we follow temperature changes occurring during the dissolution of crystalline ammonium nitrate in water.

The heat of the reaction can be calculated from the following equation:

$$q = C\Delta t$$

Where $q$ = quantity of heat evolved/absorbed, $C$ = heat capacity, and $\Delta t$ = temperature change.

## Equipment

- Nova5000
- Temperature sensor (-25 °C to 110 °C)
- 5 g $NH_4NO_3$
- Polystyrene coffee cup
- Magnetic stirrer

## Equipment Setup Procedure

1. Launch MultiLab.
2. Connect the Temperature sensor to Input 1 (I/O-1) of the Nova5000.
3. Assemble the equipment as illustrated in Figure 1.
4. Click **Setup**  on the main toolbar and program the data logger according to the setup specified below.

## Data Logger Setup

**Sensors:**

Input 1: Temperature (-25 °C to 110 °C)

**Rate:**

Every second

**Samples:**

500 samples

## Experimental Procedure

1. Prepare a polystyrene cover to the polystyrene coffee cup. The cover should be flat and larger than the circumference of the coffee cup. Pierce a hole in the cover, and insert the Temperature sensor.
2. Pour 50 ml of tap water into the coffee cup.
3. Place the coffee cup on a magnetic stirrer.
4. Place the cover on the cup but leave a narrow opening so that $NH_4NO_3$ can be added.
5. Click **Run**  on the upper toolbar to begin recording data.
6. Wait until readings from the sensors are stable.
7. Start stirring the water in the coffee cup.
8. Add 5 g crystalline $NH_4NO_3$ to the cup and immediately replace the cover to ensure that the cup is well covered.
9. Follow changes in temperature registered on the monitor until no further changes in temperature are observed.
10. Click **Stop**  on the upper toolbar to stop collecting data.
11. Save your data by clicking **Save**  on the upper toolbar.

## Data Analysis

1. Use the First cursor  and the Second cursor  to display the change in the obtained temperature in the process and the time needed to reach the final temperature value.
2. Calculate the heat of the reaction.

***Note:*** *Water specific heat capacity at 25 °C is 4.18 (J/g* °C).*

An example of the graph Temperature vs. Time obtained in this experiment is shown below:

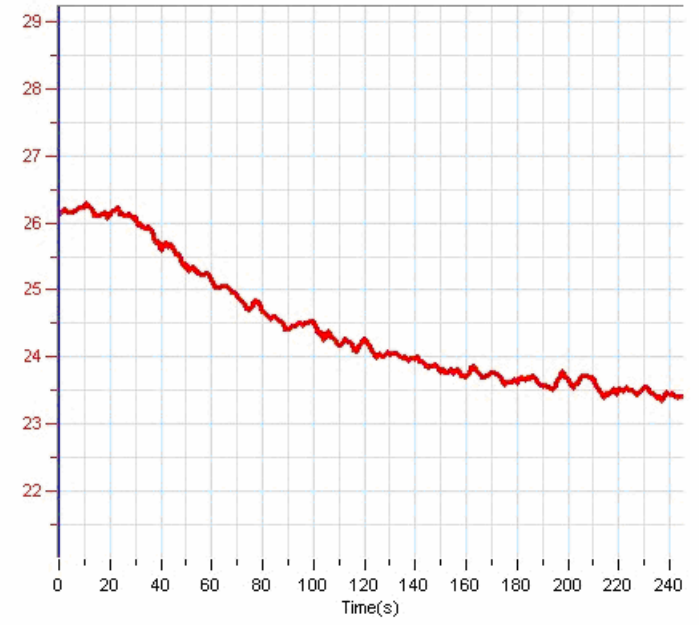


**Figure 2**

## Questions

1. What kind of chemical reaction is the dissolution of ammonium nitrate in water? Base your conclusions on the experiment you performed.
2. Try to assume the results of the dissolution of different amounts of $NH_4NO_3$ in water. What will be the extent of change in the temperature?
3. What will be the effect of warming the water prior to the dissolution of $NH_4NO_3$ in it? What will be the effect of cooling the water?

## Further Suggestions

1. Dissolve different amounts of $NH_4NO_3$ in water. Follow changes in temperature in each case. Calculate heat of the reaction in each case.
2. Examine the effect of increasing the water and/or the surrounding temperature, on the dissolution of $NH_4NO_3$.