Name_________________________ Date____________ Class____________

Simulating a Cold Pack

Lab 4
APPLICATION

Text reference: ***Chapter 2***

Introduction

Suppose you are on a hike and you sprain your ankle. The immediate application of a cold pack would be a wise first-aid practice. Injuries such as a sprained ankle are accompanied by an increase in blood flow to the affected area, which brings excess heat and contributes to swelling. A cold pack is much colder than your injured ankle, so it removes some of the heat, causes blood vessels to constrict, and reduces swelling, inflammation, and pain.

How exactly does a cold pack work? An instant cold pack, shown in Figure 4–1, usually consists of a tough plastic bag with two compounds inside: water and a salt such as ammonium nitrate (NH_4NO_3), a common lawn fertilizer. The water is sealed inside a fragile inner bag to keep it separated from the ammonium nitrate.

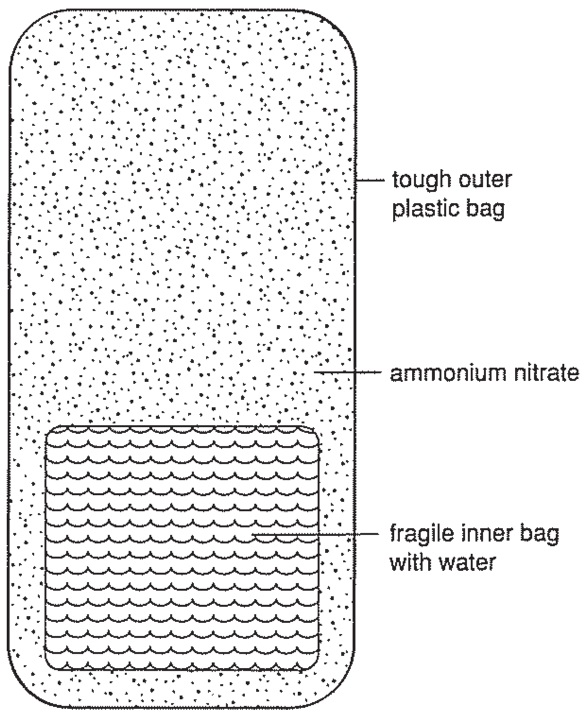

Figure 4–1

When the cold pack is needed, the ammonium nitrate is brought into contact with the water by squeezing the pack until the fragile inner container pops open. As the ammonium nitrate dissolves in the water, a subtle chemical change occurs. The water breaks the solid ammonium nitrate into positively and negatively charged particles (ions).

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Chemical changes always involve changes in energy. Often, heat is released, which may be detected as an increase in temperature. Other times, heat energy is absorbed, which results in a decrease in temperature.

In this investigation, you will experiment with the materials that make up an instant cold pack. You will combine water and ammonium nitrate in an insulated cup. The cup will prevent any heat exchange with the environment while the dissolving process removes heat from the water. In order to have a useful cold pack, there must be more than enough solid ammonium nitrate present to reduce the temperature of the liquid in the bag to near zero and keep it cold for an additional 10 to 15 minutes. You will determine the amount of ammonium nitrate solid necessary to lower the temperature to that of melting ice or below and to maintain that temperature for at least 10 minutes.

Pre-Lab Discussion

Read the entire laboratory investigation and the relevant pages of your textbook. Then answer the questions that follow.

1. Define *heat.* ______________________

2. Define *temperature.* ______________________

3. In your experience, in what direction does heat exchange occur? ______________________

4. Why are plastic foam cups used in this investigation? ______________________

5. Why should ammonium nitrate not be exposed to an open flame or to temperatures above 250°C? ______________________

6. Why should clothing splashed with ammonium nitrate solution be rinsed immediately with water? ______________________

Problem

How can an effective cold pack be made from ammonium nitrate and water?

Materials

chemical splash goggles
laboratory apron
graduated cylinder, 100-mL
tap water
plastic foam cup
4 large pieces weighing paper
laboratory balance
spatula
ammonium nitrate (NH_4NO_3)
thermometer
stirring rod
clock

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Safety

Wear your goggles and lab apron at all times during the investigation. Ammonium nitrate is poisonous and can burn or explode when dry or if it is exposed to temperatures above 250°C. Do not expose ammonium nitrate to fire or store in a hot environment. Clothing splashed with ammonium nitrate solution becomes flammable when dried. If ammonium nitrate accidentally comes in contact with your skin or clothing, rinse it off with large quantities of water and inform your teacher immediately. Dispose of the ammonium nitrate solution as instructed by your teacher.

Note the caution alert symbols here and with certain steps of the Procedure. Refer to page *xi* for the specific precautions associated with each symbol.

Procedure

1. Put on your goggles and lab apron. Fill the graduated cylinder with 50 mL of tap water that is at room temperature, and pour the water into the plastic foam cup.
2. Place a weighing paper on the laboratory balance and determine the mass of the paper. Then use a spatula to measure out a mass of 15.0 g of ammonium nitrate, allowing for the mass of the paper. Repeat this step three more times, so that you have four 15.0-g portions of ammonium nitrate. **CAUTION:** *Ammonium nitrate is poisonous and may explode or burn when dry. Avoid contact with skin and clothing. If contact occurs, rinse with large quantities of water.*
3. Using the thermometer, measure the temperature of the water and record this value in the data table.
4. Add one of the 15.0-g portions of ammonium nitrate to the cup and stir it slowly with the stirring rod until it is dissolved. Measure and record the temperature of the water. Also record your observations, such as how much time it takes for the ammonium nitrate to dissolve and how quickly the temperature of the solution changes.
5. Repeat Step 4 with each of the remaining 15.0-g portions of ammonium nitrate until enough of the compound is present to maintain the temperature of the water at 0°C or below for at least 10 minutes.
6. Dispose of the ammonium nitrate solution according to your teacher's instructions. Clean up your work area and wash your hands before leaving the laboratory.

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Observations

Data Table

Mass of NH_4NO_3 in Solution (g)	Temp. (°C)	Change in Temp. (°C)	Observations
0.0			
15.0			
30.0			
45.0			
60.0			

Calculations

1. Calculate the change in temperature that occurs after each 15.0-g portion of ammonium nitrate is added to the water, and write these values in the Data Table.

Critical Thinking: Analysis and Conclusions

1. At what point did the largest change in temperature occur? How can this observation be explained? *(Interpreting data)* ______________________________

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2. Identify any patterns that you observed as the portions of ammonium nitrate were added to the water. *(Making comparisons)* ______________________________

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3. What do you think would happen if you tried to dissolve another 15.0 g of ammonium nitrate in the water? Explain your reasoning. *(Drawing conclusions)* ______________________________

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Critical Thinking: Applications

1. In this investigation, the insulated cup prevents the cold solution from being warmed by the outside environment. Would you expect a commercial cold pack to remain as cold for the same length of time if it was applied to an injured ankle? Explain. *(Applying concepts)*

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2. Predict what happens to any undissolved ammonium nitrate in the cold pack as heat is absorbed. *(Making predictions)* ____________________

3. One of the dangers of using a cold pack made of ice—especially one taken from a freezer—is frostbite. In light of the temperatures reached by the addition of the final portions of ammonium nitrate, would you expect the danger of frostbite to exist with a cold pack made from ammonium nitrate? Explain. *(Making judgments)* ____________________

Going Further

1. Describe how you would design an instant cold pack from common household items, ammonium nitrate, and water. Include a list of the materials needed, directions for using the cold pack, and the appropriate safety warnings. Make a sketch of your design. (Note: You can calculate the ratio of the mass of ammonium nitrate per gram of water used in the investigation, and use the ratio to specify the amount of each compound needed in your design.)
2. Ammonium nitrate is commonly used as a fertilizer. You might think that it could be disposed of simply by adding it to soil or water. Consult an environmentalist or do library research to determine what problems might be created by dumping large amounts of ammonium nitrate into the environment.