



# Make Your Own Hot and Cold Packs

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## Topic

Endothermic and exothermic reactions



## Time

1 hour



## Safety

**Please click on the safety icon to view the safety precautions. Do not eat any of the substances used in this experiment. Dispose of all liquids by flushing them down the toilet. Wash any utensils thoroughly.**

## Materials

calcium chloride (used to melt ice on driveways in winter)

sodium thiosulfate (used in photography). If unavailable, substitute alum (used as an astringent and in pickling).

potassium chloride (e.g., Morton Lite™, used as a substitute for table salt)

sodium bicarbonate (baking soda)

five sandwich-size zip-lock bags

juice glass or 100-mL beaker

measuring spoons

measuring cup

glass stirring rod or spoon

hot glove

saucepan

heat source (hot plate or stove)

## Procedure

### PART A

1. Put 1 tbs calcium chloride into a plastic bag. Add 65 mL water and shake the bag. Observe what happens. How does it feel? Enter your observations of the reaction in the appropriate column on the data table.
2. Put 1 tbs of sodium bicarbonate (baking soda) into another bag. Add 65 mL water and shake the bag. Observe what happens. Enter your observations in the appropriate column on the data table.
3. Put 1 tbs calcium chloride and 1 tbs sodium bicarbonate into a third bag, and add 125 mL ( $\frac{1}{2}$  cup) water to the bag. *Do not close the bag.* Shake the contents. Observe what happens. Enter this reaction in the appropriate column on the data table.

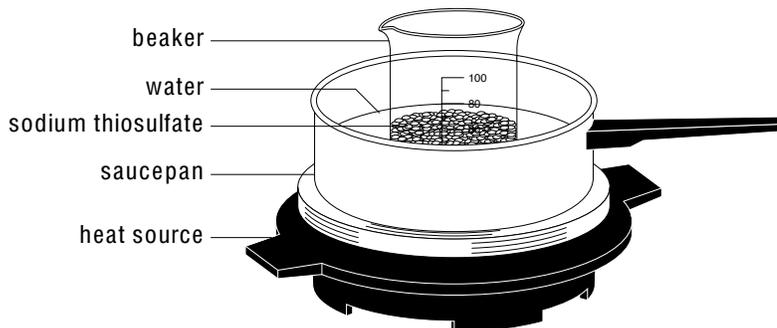
DATA TABLE		
Procedure (substances)	Observations	Reaction: endothermic or exothermic
A-1. Calcium chloride and water		
A-2. Sodium bicarbonate and water		
A-3. Calcium chloride sodium bicarbonate and water		
B-3. Potassium chloride and water		
C-7. Sodium thiosulfate added to solution		

**PART B**

- Put 1 tbs potassium chloride (salt substitute) into a different bag.
- Pour 65 mL ( $\frac{1}{4}$  cup water) into the bag.
- Close the bag and shake it. Observe what happens. Enter your findings on the data table.

**PART C**

- Fill the beaker or juice glass half full of sodium thiosulfate (or alum).
- Add  $\frac{1}{4}$  tsp water to the sodium thiosulfate or 3 tbs water to the alum.
- Fill the saucepan  $\frac{1}{4}$  to  $\frac{1}{2}$  full of water, and place it on your heat source. Place the beaker or glass in the saucepan, as shown in the figure, and heat the pan until the water inside begins to boil. Wearing the hot glove and using the stirring rod or spoon, stir the sodium thiosulfate or alum until it all dissolves.



- When the sodium thiosulfate (or alum) has dissolved, turn off the heat and allow the beaker to remain in the water until it reaches room temperature.
- When it is cool, carefully remove the beaker from the water. Be sure not to shake the beaker or jar the contents in any way.

- Carefully pour the contents of the beaker into a bag. Watch for crystals forming. If there are crystals forming, you must work quickly.
- Add a small amount (approximately  $\frac{1}{8}$  tsp) sodium thiosulfate (or alum) to the bag. Close the bag and shake it. Observe what happens. Enter your findings on the data table.
- Which reactions were endothermic?
- Which reactions were exothermic?
- What do you think happened in Part A? Explain.
- What happened in Part B? Explain.
- What happened in Part C? Explain.

### What's Going On

The steps involving the following substances resulted in endothermic reactions:

A-2, sodium bicarbonate and water

A-3, calcium chloride + sodium bicarbonate and water

B-3, potassium chloride and water

The steps involving the following substances resulted in exothermic reactions:

A-1, calcium chloride and water

C-7, recrystallization of sodium thiosulfate (or alum)

In Part A you added the water to the calcium chloride, and it dissolved in the water. Because it took less energy to break the bonds that held the calcium chloride together as a solid than was given off when it dissolved, it was an exothermic reaction. Adding water to the sodium bicarbonate also dissolved it, but it felt cold because it took a lot of energy to break the bonds of the sodium bicarbonate before it could dissolve. When both substances were added to the water, they reacted with each other, giving off the carbon dioxide gas that you observed. This was a chemical reaction. To react with each other, the substances first had to dissolve in the water and then form new bonds with each other. This chemical reaction required more energy than was given off when the new substances, such as the carbon dioxide, were formed, so it felt cold to the touch.

In Part B you again observed an endothermic reaction when the salt substitute dissolved. When the salt substitute was added to water, energy was needed to break the bonds holding the solid together before it could dissolve in the water. Shaking the bag helped provide some energy. The heat from the room and your hands also helped provide the energy needed to break apart the potassium chloride bonds.

In Part C you observed both an endothermic and then an exothermic reaction. You started by heating the sodium thiosulfate to break it apart (melt it). This was an endothermic process. You then let the sodium thiosulfate cool. If you were very careful not to jar the mixture as it cooled, it was able to release much of the energy required for it to melt. Instead of rebonding, it remained in a state called *supersaturation*. Just picking it up might have caused it to rebond, but if you were lucky, you were able to get it into the bag. By adding a little bit of the solid, you initiated the bonding process and could feel the great amount of heat released as the crystal bonds formed. It released as much heat as you originally gave it to get it to melt. This exothermic reaction is used in heat packs that hunters and skiers use to keep their hands and feet warm.

### Connections

Every reaction requires some energy to get started and gives off some energy as the products are formed. Often this energy takes the form of heat. If more energy is given off when the products are formed than was required to start the reaction, the reaction feels hot to the touch. We call this an *exothermic reaction*. Burning a piece of paper is an example of an exothermic reaction. You must provide some initial energy (in the form of a match) to get the reaction going, but in the end more energy is given off than it took to start the reaction. If more energy is required to get the reaction going than is given off when the products are formed, the reaction will feel cold to the touch. This is an *endothermic reaction*. The reason that it feels cold is that the reaction is taking energy from the environment around it.

In this experiment, you made hot and cold packs like those used in the school athletic department to treat injuries. Hot and cold packs are practical applications of exothermic and endothermic reactions.

# Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say “be careful with hot liquids” or “don’t cut yourself with the knife” does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

## PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

## PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

## USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don’t use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

**USING CHEMICALS**

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

**HEATING INSTRUCTIONS**

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

**WORKING WITH MICROORGANISMS**

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

**GOING ON FIELD TRIPS**

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

**FINISHING UP**

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES