Lesson 4
Temperature change

Name: ___________________________

S T U D E N T   A C T I V I T Y   S H E E T

Meet the scientist

Continent: Antarctica
Scientist: Jason Williams

My name is Jason Williams, and I am a chemist from the United States. I am here in Antarctica with a set of solar panels that I helped develop. As a chemist, my team and I built each *solar cell,* starting with tiny molecules. Solar cells convert the sun's energy into electricity. Our challenge was to make solar cell material better so that it converts the sun's energy into electricity more efficiently than before. We are also working on a way to make solar cells without using, or being left with, substances that are harmful to the environment.

There is no better place on Earth for solar energy than Antarctica! At least that's true in the summertime! From about October to March, which is summer down here, "days" are very long. In fact, during the month of December at the location where my panels will be installed, the sun stays up 24 hours per day for more than two weeks!

Antarctica's research stations become bustling communities during the summer. About 5,000 scientists live and work here at that time of year. They study climate change, animals, glaciers, and more. Researchers need electricity for their computers and other equipment. Long periods of sunlight and a high demand for electricity make Antarctica an ideal place to use solar energy.

The trick to making solar cells work is to find a good way to convert one kind of energy to another. Lots of important devices do something similar. A light bulb converts electrical energy into light energy. A battery converts chemical energy into electrical energy, which can be converted into sound energy by a radio or iPod. Solar cells turn the sun's energy into electricity.

In your final activity, you will convert energy between chemical and thermal energy using chemical reactions that change temperature!

Activity

Temperature changes are a clue that a chemical reaction is occurring.

- If the temperature increases during the chemical reaction, it is called an *exothermic* reaction.
- If the temperature decreases during a chemical reaction, it is called an *endothermic* reaction.

Use a thermometer while you conduct the following chemical reactions to find out which one is exothermic and which one is endothermic.

You will need

- Goggles
- Citric acid
- Sodium bicarbonate
- Calcium chloride
- Water
- Thermometer
- Small metric measuring cup
- Small scoop
- 2 small spoons
- 2 small clear plastic cups

Scoop

Spoon

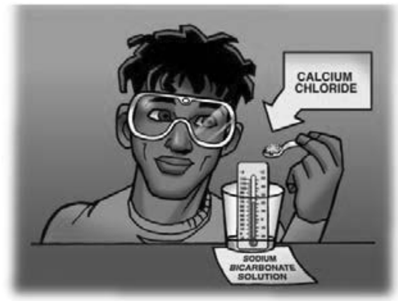
Procedure

Citric acid solution and sodium bicarbonate

1. Place 10 mL of water in a clear plastic cup.
2. Add 2 small scoops of citric acid and swirl until the citric acid dissolves.
3. Place a thermometer in the citric acid solution. Record this starting temperature in the chart on the next page.
4. With the thermometer still in the solution, add 1 spoon of sodium bicarbonate and swirl. Record the most extreme temperature reached.

Sodium bicarbonate solution and calcium chloride

5. Place 10 mL of water in a clear plastic cup.
6. Add 2 small scoops of sodium bicarbonate and swirl until the sodium bicarbonate dissolves.
7. Place a thermometer in the sodium bicarbonate solution. Record this starting temperature in the chart.
8. With the thermometer still in the solution, add 1 spoon of calcium chloride and swirl. Record the most extreme temperature reached.



How much does the temperature change in each chemical reaction?

Chemical reaction	Citric acid solution and sodium bicarbonate	Sodium bicarbonate solution and calcium chloride
Starting temperature		
Final temperature		
Difference in temperature		
Did the temperature go up or down?		
Is this reaction endothermic or exothermic?		

Your chemistry challenge

Conduct a chemical reaction so that the highest temperature reached is between 40° and 50° C. You will only adjust the amount of one reactant—calcium chloride. GOOD LUCK!

The rules

Start with a sodium bicarbonate solution made by dissolving 2 scoops sodium bicarbonate in 10 mL water, then add the amount of calcium chloride you and your group agree on.

How much calcium chloride does it take to make the temperature increase to between 40° and 50°C?

Amount of calcium chloride		
Starting temperature		
Final temperature		

The big chemistry idea

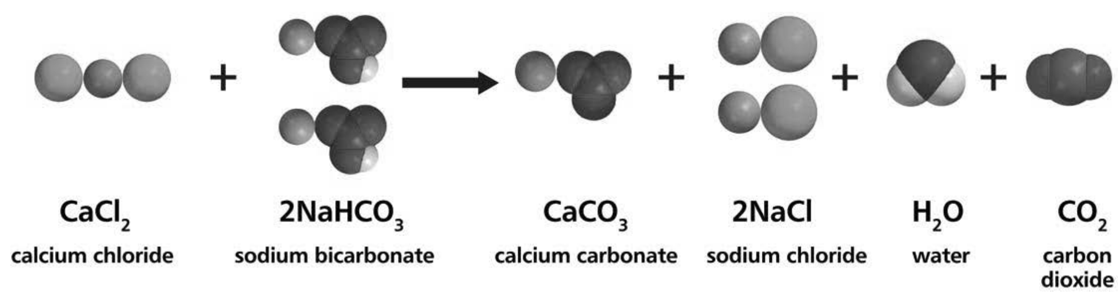
Remember that, during a chemical reaction, certain atoms or groups of atoms break their bonds, rearrange, and then form new bonds to make the products. As you can imagine, it takes energy to break bonds. When the chemical bonds in the products form, energy is released.

The amount of energy needed to break bonds compared to the amount of energy released when bonds are formed is usually different.

If it takes more energy to break the bonds in the reactants than is released when bonds form in the products, then the temperature goes down. This is called an *endothermic* reaction.

If more energy is released when bonds form in the products than was used to break the bonds of the reactants, then the temperature goes up. This is called an *exothermic* reaction.

Look at this chemical equation for the reaction you conducted to answer the question below.



Is more energy released when the products are formed than is used to break the bonds in the reactants?

Real-world application

When Jason and other scientists in Antarctica are far from a research station, they use a chemical reaction to warm their portable meals. The same concept also helps soldiers in the armed forces get a hot meal while serving on the front lines.

Soldiers need hot food, which gives them energy and lifts their spirits. But they are often far away from the nearest kitchen, and they can't carry bulky cooking equipment. Fortunately, soldiers carry with them an important weapon to meet this daunting challenge: chemistry.

Special packaged meals called MREs (Meals Ready to Eat) were first introduced in the 1970s. Today, they are still distributed to U.S. service members so that they can have hot meals, even when they are in remote locations.

MREs work by using a chemical reaction that quickly produces heat when activated. Every MRE includes a small pouch that contains the metal magnesium, ground up into very small pieces. Usually some iron filings are mixed with the magnesium. Adding water to the pouch causes the magnesium filings to quickly oxidize, or rust. This process generates enough heat to allow soldiers to heat prepared food rations.