Answer all questions with ✱

New Odor is produced

Some chemical changes produce NEW smells. The chemical change that occurs when an egg is rotting produces the smell of sulfur. If you go outdoors after a thunderstorm, you may detect an unusual odor in the air. The odor is an indication that lightning has caused a chemical change in the air.

How Do You Identify a Chemical Reaction?

Look at the images in **Figure 4**. Even without reading the caption, you probably can tell that each image shows a chemical reaction. How can you tell when a chemical reaction occurs? **Chemical reactions involve changes in properties and changes in energy that you can often observe.**

Changes in Properties One way to detect chemical reactions is to observe changes in the physical properties of the materials. Changes in properties result when new substances form. For instance, formation of a precipitate, gas production, and a color change are all possible evidence that a chemical reaction has taken place. Many times, physical properties such as texture and hardness may also change in a chemical reaction.

Changes in physical properties can be easy to recognize in a chemical reaction, but what about the chemical properties? During a chemical reaction, reactants interact to form products with different chemical properties. For example, sodium (Na) and chlorine (Cl_2) react to form an ionic compound, sodium chloride (NaCl). Both reactants are very reactive elements. However, the product, sodium chloride, is a very stable compound.

Vocabulary Identify Multiple Meanings Precipitation can mean rain, snow, or hail. In chemistry, precipitation is the formation of a solid from

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Solid forms

Formation of a Precipitate

The mixing of two liquids may form a precipitate. A **precipitate** (pree SIP uh tayt) is a solid that forms from liquids during a chemical reaction. For example, the precipitate seen in this curdled milk has formed from the liquids milk and lemon juice.

FIGURE 4

Evidence of Chemical Reactions

Many kinds of change provide evidence that a chemical reaction has occurred.

Design Experiments Describe how you would test the best method for separating the precipitate from the liquid in curdled milk.

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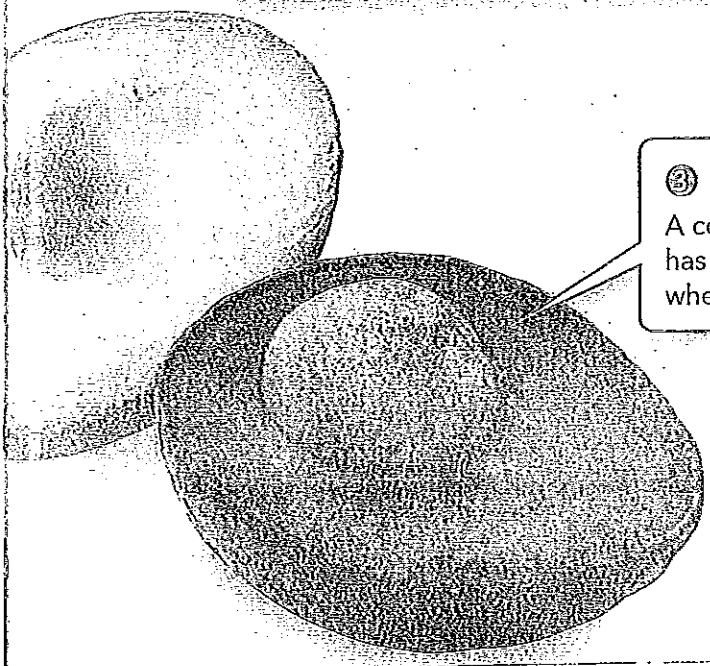
Although you may observe a change in matter, the change does not always indicate that a chemical reaction has taken place. Sometimes physical changes give similar results. For example, when water boils, the gas bubbles you see are made of molecules of water, just as the liquid was. Boiling is a physical change. The only sure evidence of a chemical reaction is that one or more new substances are produced.

Observe Bread dough rises from gas bubbles produced when yeast reacts with sugar. What evidence in a slice of bread shows the presence of gas?

② Gas Production

Another observable change is the formation of a gas from solid or liquid reactants. Often, the gas formed can be seen as bubbles.



③ Color Change

A color change can signal that a new substance has formed. For example, avocados turn brown when they react with oxygen in the air.

Relate Evidence and Explanation Adding food coloring to water causes a color change. Is this evidence of a chemical reaction? Explain.

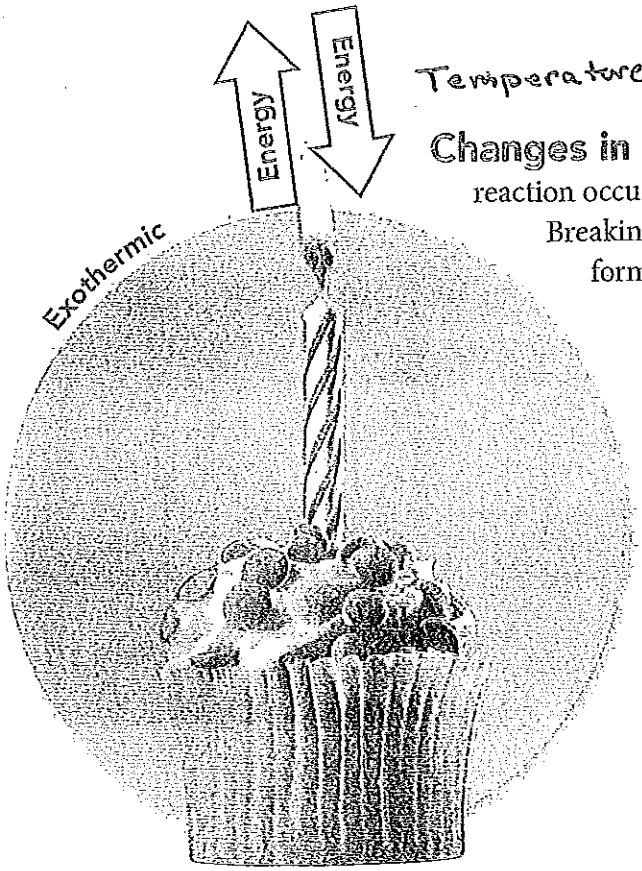
Apply Concepts Draw or describe evidence of a chemical reaction you have observed in food or in other types of matter. Label the evidence as a color change, formation of a precipitate, or gas production.

Temperature Change

Changes in Energy

Recall that a chemical reaction occurs when bonds break and new bonds form. Breaking bonds between atoms or ions requires energy, while forming bonds releases energy.

In an **exothermic reaction** (ek soh THUR mik), the energy released as the products form is greater than the energy required to break the bonds of the reactants. The energy is usually released as heat. For example, some stoves use natural gas. When natural gas burns, it releases heat. This heat is used to cook your food. Similarly, the reaction between oxygen and other fuels that produce fire, such as wood, coal, oil, or the wax of the candle shown in **Figure 5,** release energy in the form of light and heat.



In an **endothermic reaction** (en doh THUR mik), more energy is required to break the bonds of the reactants than is released by the formation of the products. The energy can be absorbed from nearby matter. When energy is absorbed, it causes the surroundings to become cooler. In **Figure 5,** baking soda undergoes an endothermic reaction when it is mixed with vinegar. The reaction absorbs heat from its surroundings, so the reaction feels cold. Not all endothermic reactions result in a temperature decrease. Many endothermic reactions occur only when heat is constantly added, as when you fry an egg. Heat must be applied throughout the entire process in order for the reactions that cook the egg to continue.

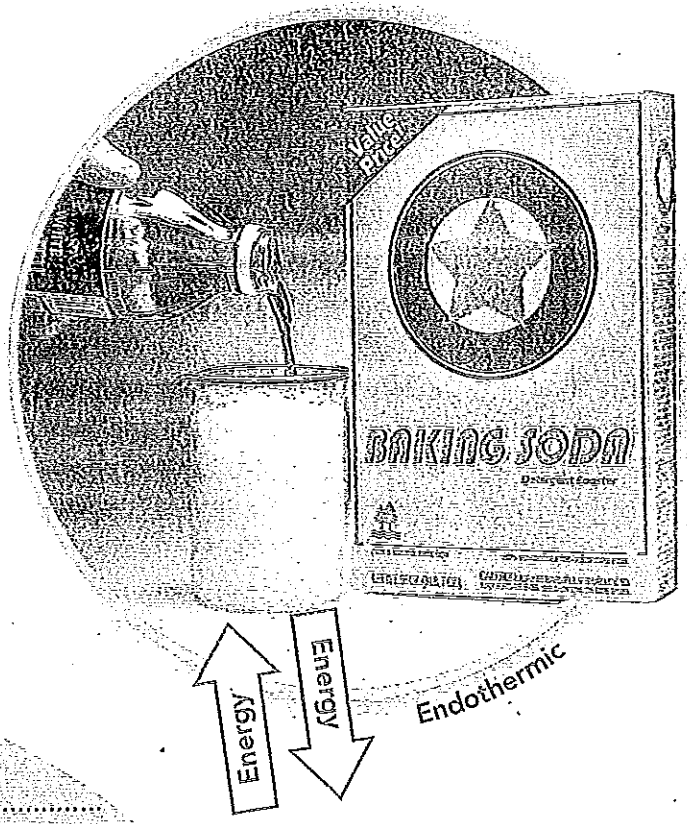


FIGURE 5

VIRTUAL LAB **Exothermic and Endothermic Reactions**

Chemical reactions either absorb energy or release energy.

Complete the following tasks.

1. **Interpret Photos** Shade in the arrow that indicates the direction the net energy is moving for each reaction.
2. **Infer** How might each reaction feel if you were to put your hands near it?

do the math! Analyzing Data

A student adds magnesium oxide to hydrochloric acid. She measures the temperature of the reaction every minute. Her data are recorded in the table.

Time (min)	Temperature (°C)
0	20
1	24
2	27
3	29
4	29

① **Graph** Plot the data from the table onto the graph. Then name the graph.

② **Interpret Data** Is the reaction endothermic or exothermic? Explain.

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③ **Read Graphs** In which time interval did the temperature increase the most?

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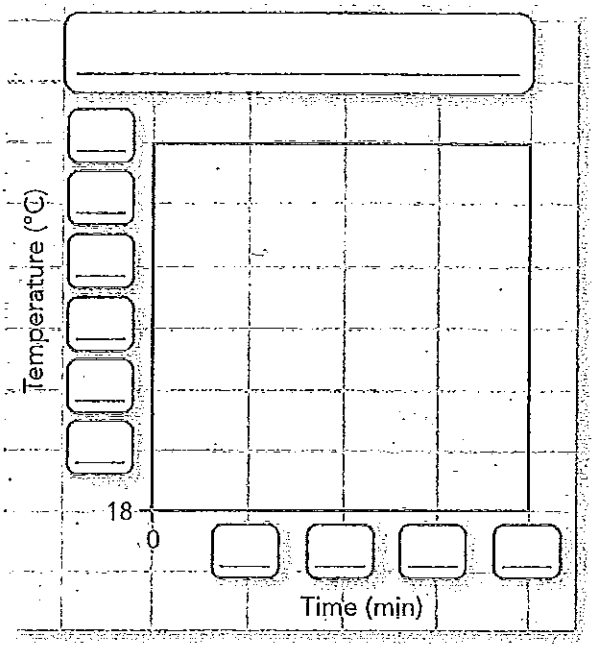

Lab zone Do the Lab Investigation *Where's the Evidence?*

Assess Your Understanding

2a. List What changes in physical properties can be used as evidence that a chemical reaction has occurred?

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b. Apply Concepts What evidence of a chemical change is observed when rust forms on iron?

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c. Compare and Contrast How are endothermic and exothermic reactions the same? How are they different?

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got it?

O I get it! Now I know that two kinds of changes you can observe when chemical reactions occur are _____

O I need extra help with _____

Go to MY SCIENCE COACH *online for help with this subject.*