Chapter Resources

Chemical Reactions

Includes:

Reproducible Student Pages

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☑ Chapter Tests
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☑ Laboratory Activities
☑ Foldables—Reading and Study Skills activity sheet

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**Additional Assessment Resources available with Glencoe Science:**

- ExamView® Pro TestMaker
- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker at [gpscience.com](http://gpscience.com)
- Interactive Chalkboard
- The Glencoe Science Web site at: [gpscience.com](http://gpscience.com)
- An interactive version of this textbook along with assessment resources are available online at: [mhn.com](http://mhn.com)
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Hands-On Activities
Mini LAB

Designing a Team Equation

Procedure
1. Obtain **15 index cards** and mark each as follows: five with Guard, five with Forward, and five with Center.
2. Group the cards to form as many complete basketball teams as possible. Each team needs two guards, two forwards, and one center.

Analysis
1. Write the formula for a team. Write the formation of a team as an equation. Use coefficients in front of each type of player needed for a team.

   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________

2. How is this equation like a chemical equation? Why can’t you use the remaining cards?

   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________

3. How do the remaining cards illustrate the law of conservation of matter in this example?

   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
Creating a Colorful Chemical Reaction

Procedure
1. Pour 5 mL of water into a test tube.
2. Sprinkle a few crystals of copper(II) bromide into the test tube and observe the color change of the crystals.
3. Slowly add more water and observe what happens.

Analysis
1. What color were the copper(II) bromide crystals after you added them to the test tube of water?

2. What color were they when you added more water?

3. What caused this color change?
Catalyzed Reaction

Lab Preview

Directions: Answer these questions before you begin the Lab.

1. What is the potential harmful effect of hydrogen peroxide, H₂O₂, if handled improperly?

2. Why do you think it is significant that a catalyst is unchanged by the chemical reaction of which it is a part?

A balanced chemical equation tells nothing about the rate of a reaction. One way to affect the rate is to use a catalyst.

Real-World Question

How does the presence of a catalyst affect the rate of a chemical reaction?

Materials

test tubes (3) sand (1/4 teaspoon)
test-tube stand hot plate
3% hydrogen peroxide, H₂O₂ (15mL) wooden splint
10-mL graduated cylinder beaker of hot water
small plastic teaspoon manganese dioxide, MnO₂ (1/4 teaspoon)

Goals

- Observe the effect of a catalyst on the rate of reaction.
- Conclude based on your observations whether the catalyst remained unchanged.

Safety Precautions

WARNING: Hydrogen peroxide can irritate skin and eyes. Wipe up spills promptly. Point test tubes away from other students.
**Hands-On Activities**

**Communicating Your Data**

Compare your results with those of your classmates and discuss any differences observed. **For more help refer to the Science Skill Handbook.**

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**Conclude and Apply**

1. **Observe** the changes that happened when the solids were added to the tubes.

2. **Infer** which substance, sand or MnO₂, was the catalyst.

3. **Identify** what remained in each tube after the H₂O₂ was driven away.

---

**Procedure**

1. Label three test tubes and set them in a test-tube stand. Pour 5 mL of hydrogen peroxide into each tube.
2. Place about ¼ teaspoon of sand in tube 2 and the same amount of MnO₂ in tube 3.
3. In the presence of a catalyst, H₂O₂ decomposes rapidly producing oxygen gas, O₂. Test each tube by: lighting a wooden splint, blowing out the flame, and inserting the glowing splint into the tube. The splint will relight if oxygen is present.
4. Place all three tubes in a beaker of hot water. Heat on a hot plate until all of the remaining H₂O₂ is driven away and no liquid remains.

(continued)
Chemical Reactions

Use the Internet

Fossil Fuels and Greenhouse Gases

You’ve probably heard a lot about global warming and the greenhouse effect. According to one theory, certain gases in the atmosphere might be causing Earth’s average global temperature to rise. The gases carbon dioxide, nitrous oxide, and methane, known as greenhouse gases, result from chemical reactions with oxygen when fossil fuels, such as coal, oil, and gas, are burned. What are some everyday activities that you do that might involve energy from fossil fuels? Form a hypothesis about how certain activities add greenhouse gases to our atmosphere.

Real-World Question
What do you do to produce greenhouse gases?

Goals
- **Observe** how you use fossil fuels in your daily life.
- **Gather data** on the process of burning fossil fuels and how greenhouse gases are released.
- **Research** the chemical reactions that produce greenhouse gases.
- **Identify** the importance of fossil fuels and their effect on the environment.
- **Communicate** your findings to other students.

Data Source
**SCIENCEOnline** Visit gpscience.com/internet_lab for more information about fossil fuels, the chemical reactions that produce greenhouse gases, uses of fossil fuels, their effects on the environment, and data from other students.

Make a Plan
1. **Observe** the activities of your daily life. How are fossil fuels used each day?
2. **Develop** a way to categorize the different chemical reactions and the greenhouse gases they produce.
3. **Search** reference sources to learn what chemical reactions produce greenhouse gases.
4. **Identify** some activities and functions that do not use fossil fuels.
5. **Infer** if it is possible to never use fossil fuels.
Follow Your Plan
1. Make sure your teacher approves your plan before you start.
2. Research the chemical reactions that are commonly understood to produce greenhouse gases.
3. Compare the different reactions and their products.
4. Record your data on a separate sheet of paper.

Analyze Your Data
1. Record in your Science Journal the activities that scientists believe contribute to the greatest amount of greenhouse gases to our atmosphere.
2. Analyze the types of chemical reactions that produce greenhouse gases. What types of reactions are they?
3. Compare your results with other students. Do your results agree with those of environmental scientists? Why might you have identified different contributors to the greenhouse effect?

4. Make a table of your data on a separate sheet of paper.

Conclude and Apply
1. Predict How do you think your data would be affected if you had performed this experiment 100 years ago?

2. Infer What processes in nature might also contribute to the release of greenhouse gases? Compare their impact to that made by fossil fuels.

Communicating Your Data
SCIENCEOnline Find this lab at the link below. Post your data in the table provided. Compare your data to that of other students. Combine your data with that of other students and write an entry in your Science Journal that explains how the production of greenhouse gases could be reduced. gpscience.com/internet_lab
Conservation of Mass

In a chemical reaction, the total mass of the substances formed by the reaction is equal to the total mass of the substances that reacted. This principle is called the law of conservation of mass, which states that matter is not created or destroyed during a chemical reaction.

In this experiment, sodium hydrogen carbonate, NaHCO₃ (baking soda), will react with hydrochloric acid, HCl. The substances formed by this reaction are sodium chloride, NaCl; water, H₂O; and carbon dioxide gas, CO₂.

**Strategy**
You will show that new substances are formed in a chemical reaction.
You will show the conservation of mass during a chemical reaction.

**Materials**
- sealable plastic sandwich bag containing sodium hydrogen carbonate, NaHCO₃
- hydrochloric acid, HCl
- plastic pipette
- paper towel
- metric balance

**Procedure**
1. Obtain the plastic sandwich bag containing a small amount of sodium hydrogen carbonate.
2. Fill the pipette with the hydrochloric acid solution. Use a paper towel to wipe away any acid that might be on the outside of the pipette. Discard the paper towel.
   **WARNING:** Hydrochloric acid is corrosive. Handle with care.
3. Carefully place the pipette in the bag. Press the bag gently to eliminate as much air as possible. Be careful not to press the bulb of the pipette. Seal the bag. See Figure 1.
4. Measure the mass of the sealed plastic bag using the metric balance. Record this value in the Data and Observations section.
5. Remove the plastic bag from the balance. Without opening the bag, direct the stem of the pipette into the sodium hydrogen carbonate. Press the bulb of the pipette and allow the hydrochloric acid to react with the sodium hydrogen carbonate. Make sure that all the acid mixes with the sodium hydrogen carbonate.
6. Observe the contents of the bag for several minutes. Record your observations in the Data and Observations section.
7. After several minutes, measure the mass of the sealed plastic bag and its contents. Record this value in the Data and Observations section.
Laboratory Activity 1 (continued)

Data and Observations

Table 1

<table>
<thead>
<tr>
<th>Mass of plastic bag before reaction (in grams)</th>
<th>Observations from Step 6</th>
<th>Mass of plastic bag after reaction (in grams)</th>
</tr>
</thead>
</table>

Questions and Conclusions

1. Why was it important for the plastic bag to be sealed?

2. What did you observe that indicated that a chemical reaction took place?

3. Compare the mass of the plastic bag and its contents before and after the chemical reaction.
4. Does your comparison in Question 3 confirm the conservation of mass during this chemical reaction? Explain.

Strategy Check

____ Can you demonstrate that new substances are formed in a chemical reaction?

____ Can you show the conservation of mass during a chemical reaction?
Chemical Reactions

The changes that occur during a chemical reaction are represented by a chemical equation. In an equation, chemical symbols represent the substances involved. The reactants are the substances that react. The products are the substances formed from the reaction. For example, reaction of the elements sodium and chlorine to produce sodium chloride is shown by the following chemical equation.

$$2\text{Na(s)} + \text{Cl}_2(g) \rightarrow 2\text{NaCl(s)}$$

Reactants Product

In a synthesis reaction, two or more substances react to form a new substance. You may think of a synthesis reaction as putting substances together to produce a new substance. The synthesis reaction that produces hydrogen peroxide is given by the equation below.

$$2\text{H}_2\text{O(l)} + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}_2(l) \quad \text{Synthesis reaction}$$

A decomposition reaction produces several products from the breakdown of a single compound. This process is similar to breaking a single compound into several simpler compounds and/or elements.

$$2\text{H}_2\text{O(l)} \rightarrow 2\text{H}_2(g) + \text{O}_2(g) \quad \text{Decomposition reaction}$$

In a single-displacement reaction, one element replaces another element in a compound. In the following reaction carbon displaces the hydrogen in water, forming gaseous carbon monoxide, and hydrogen is released as hydrogen gas.

$$\text{H}_2\text{O(l)} + \text{C(s)} \rightarrow \text{H}_2(g) + \text{CO(g)} \quad \text{Single-displacement reaction}$$

Strategy

You will recognize the reactants and products of a chemical reaction.
You will identify the type of chemical reaction you observe.
You will write a word equation for a chemical reaction.
You will write a balanced chemical equation using chemical symbols.

Materials

<table>
<thead>
<tr>
<th>Part A</th>
<th>Part B</th>
<th>Part C</th>
</tr>
</thead>
<tbody>
<tr>
<td>aluminum foil</td>
<td>aluminum foil</td>
<td>string</td>
</tr>
<tr>
<td>burner</td>
<td>burner</td>
<td>iron nail, Fe</td>
</tr>
<tr>
<td>matches</td>
<td>matches</td>
<td>beaker</td>
</tr>
<tr>
<td>steel wool, Fe</td>
<td>test tube</td>
<td>copper (II), sulfate solution, CuSO₄</td>
</tr>
<tr>
<td>tongs</td>
<td>spoon</td>
<td>watch or clock</td>
</tr>
<tr>
<td></td>
<td>baking soda, NaHCO₃</td>
<td>paper towel</td>
</tr>
<tr>
<td></td>
<td>test tube holder</td>
<td></td>
</tr>
</tbody>
</table>

WARNING: Copper(II) sulfate solution is poisonous. Handle with care. Wear goggles and apron.
Laboratory Activity 2 (continued)

Procedure

Part A—Synthesis Reaction
1. Protect the table with a sheet of aluminum foil. Place the burner in the center of the foil. Light the burner. **WARNING:** Stay clear of the flame.
2. Observe the color of the steel wool. Record your observations in the Data and Observations section.
3. Predict if there will be any changes in the steel wool if it is heated in the flame. Write your prediction in the Data and Observations section.
4. Hold the steel wool (containing iron, Fe) with the tongs over the flame as shown in Figure 1. As the steel wool burns, record any changes you observe.
5. Take the steel wool out of the flame and let it cool. Record your observations.

Part B—Decomposition Reaction
1. Set up a burner as in step 1 of Part A.
2. Place a spoonful of baking soda, NaHCO₃, in a test tube. In the Data and Observations section, write your prediction of what will happen as the baking soda is heated. Use the test-tube holder to heat the test tube in the flame, as shown in Figure 2. Do not point the mouth of the test tube at anyone.
3. Record the description and colors of the products formed inside the tube.
4. Test for the presence of CO₂. Light a wooden splint. Hold the flaming splint in the mouth of the test tube. If the flame of the splint goes out, CO₂ is present. Record your observations of the products of this reaction.

Figure 1

![Steel wool](image1.png)

Figure 2

![Baking soda](image2.png)
Part C—Single Displacement Reaction

1. Tie a string around the nail. Fill a beaker about half full with the CuSO₄ solution. Record the colors of the nail and the CuSO₄ solution in Table 1. WARNING: The CuSO₄ solution is toxic. Handle with care.

2. Predict what changes will happen to the appearance of the nail and the solution when mixed. Record your prediction in the Data and Observations section. Dip the nail in the CuSO₄ as shown in Figure 3. After 5 minutes, pull the nail from the solution and place it on a paper towel. Record the colors of the nail and the solution in Table 1.

3. Put the nail back into the solution and observe further color changes.

Data and Observations

Part A—Synthesis Reaction

1. Prediction of changes in heated steel wool:

2. Color of steel wool before burning:

3. Color of burned steel wool:

Part B—Decomposition Reaction

1. Prediction of changes in heated baking soda:

2. Description of deposits inside heated test tube:

3. Observations of flaming splint:

Part C—Single Displacement Reaction

1. Prediction of changes in nail and CuSO₄ solution:
Laboratory Activity 2 (continued)

Table 1

<table>
<thead>
<tr>
<th>Observation time</th>
<th>Color of nail</th>
<th>Color of CuSO₄ solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before reaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>After reaction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions and Conclusions
1. Write a word equation to describe the reaction of the heated steel wool and oxygen.

________________ plus ________________, in the presence of heat,
yields ________________.

2. Write a balanced equation using chemical symbols for the synthesis reaction of iron and oxygen.

3. Write a word equation to describe the decomposition reaction of baking soda.

________________ yields ________________ plus ________________ plus water.

4. Write a chemical equation using symbols for the decomposition of sodium bicarbonate, or baking soda. ________________

5. Write a word equation to describe the single-displacement reaction of iron and copper sulfate.

6. Write a chemical equation using symbols for the single-displacement reaction of iron and copper(II) sulfate. __________________________

Strategy Check

____ Can you recognize the reactants and products of a chemical reaction?
____ Can you identify the type of chemical reaction you observe?
____ Can you write a word equation for a chemical reaction?
____ Can you write a balanced chemical equation using chemical symbols?
Chemical Reactions

Directions: Use this page to label your Foldable at the beginning of the chapter.

R → P
R → P
R → P
R → P

NiCl₂ + 2NaOH → Ni(OH)₂ + __________

HgO(s) → __________ + O₂

2H₂(g) + __________ → 2H₂O(g)

2Al₂O₃ → 4Al(l) + __________
Meeting Individual Needs
Overview

Chemical Reactions

Directions: Complete the concept map using the terms in the list below.

two or more substances  decomposition  compounds
single displacement  element  combine

Types of chemical reactions include

1. synthesis  in which substances break apart to form a new substance
2. double displacement  in which two positive ions replace each other to form two new compounds
3.  
4.  
5.  
6.  

Directions: Write the letter of the term or phrase that best completes the sentence.

7. In a balanced chemical equation, the number of atoms on the left side of the equation is ______ the number of atoms on the right side.
   a. less than    b. unrelated to    c. equal to    d. greater than

8. In the formula 2HgO, the coefficient is ______.
   a. 2    b. Hg    c. O    d. HgO
A 1. ___________ is a change in which one or more substances are converted into new substances. A chemical 2. ___________ is a way to describe a chemical reaction using chemical formulas and other symbols. In a chemical equation, the substances on the left side of the arrow that react are the starting substances called 3. ___________. The substances on the right side of the arrow are the substances produced from the reaction, called 4. ___________. The arrow means produces, or 5. ___________.

In a chemical equation, the numbers to the left of the formulas for reactants and products are called 6. ___________. They represent the number of units of each 7. ___________ taking part in a chemical reaction. Knowing the number of units helps chemists to add the correct 8. ___________ of reactants to a reaction.

A balanced chemical equation has the same number of 9. ___________ of each element on both sides of the equation. There are several rules of balancing an equation. First, describe the reaction in 10. ___________, putting the reactants on the left side and the products on the right side. Next, write a chemical equation for the reaction using 11. ___________ and 12. ___________. To balance the atoms in an equation, you must choose the correct coefficients. Never change 13. ___________ of a correct formula to balance an equation.
Directions: Decide if each statement below is true or false. If false, change the italicized term to make the statement correct and write your answer in the blank at the left. If the statement is correct, write true in the blank.

1. In a single-displacement reaction, water, a gas, or a precipitate forms when two ionic compounds in a solution are combined.

2. An insoluble compound formed during a double-displacement reaction is called a precipitate.

3. In a single-displacement reaction, one element replaces another element in a compound.

4. Most chemical reactions can be divided into five main groups.

Directions: Read the following passage. Then answer the questions on the lines provided.

Carlos was camping and getting cold as the sun went down. He wanted to light a fire for warmth and light. However, he discovered that the nearby wood was wet, and would not light. He had to look under some leaves and debris to find dry wood. He piled the wood and surrounded it with a circle of stones to keep the fire contained. Then he put some dry leaves around the logs to help the fire get started. He lit the leaves. Soon the leaves had burned away, his fire was burning nicely, and Carlos was getting warmer.

5. Is the chemical reaction produced by Carlos’s fire exergonic or endergonic? How do you know?

6. Is the reaction in Carlos’s fire endothermic or exothermic? Explain.

7. Do you think the leaves were a catalyst for the fire? Why or why not?
Key Terms
Chemical Reactions

Directions: Unscramble the terms in italics to complete the sentences below. Write the terms on the lines provided.

1. A sonoditecimpo reaction is one in which a substance breaks down into two or more substances.
2. A chemical noqituae describes a chemical reaction using chemical formulas and other symbols.
3. In an ingrocexe reaction, the amount of energy needed to break the original bonds is less than the energy released when new bonds form.
4. In a glinse-spladicetnm reaction, one element replaces another in a compound.
5. A lamcechi reaction is a change in which one or more substances are converted into new substances.
6. A snteshisy reaction is one in which two or more substances combine to form another substance.
7. In an icehomextr reaction, the energy given off is primarily in the form of heat.
8. The kind of reaction energy that requires energy in the form of heat is called remdothcine.
9. An orhibiint ties up a reactant and prevents it from undergoing the original reaction.
10. The insoluble compound that forms during a double-displacement reaction is called a treaticippe.
11. When more energy is required to break bonds than to form new ones, the reaction is called gonderince.
12. The numbers that represent the number of units of each substance taking part in a reaction are called isceffoticen.
13. A chemical reaction that has the same number of elements on both sides of the equation is deblanac.
**Instrucciones:** Completa el mapa conceptual usando los términos de la lista.

<table>
<thead>
<tr>
<th>dos o más sustancias</th>
<th>descomposición</th>
<th>nuevos compuestos</th>
</tr>
</thead>
<tbody>
<tr>
<td>desplazamiento simple</td>
<td>elemento</td>
<td>combinan</td>
</tr>
</tbody>
</table>

Tipos de reacciones químicas incluyen:

1. síntesis
   - en que las sustancias se separan para formar una nueva sustancia
2. 1.
   - en que una(s) sustancia(s) se separan para formar otro(a) compuesto
3. 2.
   - en que un(a) reemplaza otro(a) en un compuesto
4. 3.
   - en que dos iones positivos se remplazan mutuamente para formar dos nuevas(os)
5. 4.
   - se remplaza otro(a) en un compuesto
6. 5.
   - se remplazan mutuamente para formar dos nuevas(os)
7. 6.
   - se remplazan mutuamente para formar dos nuevas(os)

**Instrucciones:** Para cada una de las siguientes, escribe el término o frase que complete mejor cada oración.

7. En una ecuación química equilibrada, el número de átomos en el lado izquierdo de la ecuación ______ número de átomos en el lado derecho.
   - a. es menos que el
   - b. no se relaciona con
   - c. es igual a
   - d. es mayor que el

8. En la fórmula 2HgO, el coeficiente es ______.
   - a. 2
   - b. Hg
   - c. O
   - d. HgO
Un(a) 1. ___________ es un cambio en el cual una o más sustancias se convierten en sustancias nuevas. Un(a) 2. ___________ es una forma de describir una reacción química por medio de fórmulas y otros símbolos. En una ecuación química, las sustancias a la izquierda de la flecha las cuales reaccionan son las sustancias iniciales llamadas 3. ___________. Las sustancias a la derecha de la flecha son las sustancias producidas por la reacción y se llaman 4. ___________. La flecha significa produce o 5. ___________.

En una ecuación química, los números a la izquierda de las fórmulas de los reactantes y productos se llaman 6. ___________. Éstos(as) representan el número de unidades de cada 7. ___________ que toman parte en la reacción química. El conocer el número correcto de unidades ayuda a los químicos a agregar los(las) 8. ___________ correctos(as) a la reacción.

Una ecuación química equilibrada tiene el mismo número de 9. ___________ de cada elemento en ambos lados de la ecuación. Hay varias reglas para equilibrar ecuaciones. Primero, describe la reacción en 10. ___________, poniendo los reactantes en el lado izquierdo y los productos en el lado derecho. Luego, escribe una ecuación química para la reacción usando 11. ___________ y 12. ___________. Para equilibrar los átomos en la ecuación, debes escoger el número correcto para cada coeficiente. Nunca cambies 13. ___________ de una fórmula correcta cuando equilibles una ecuación.
Instrucciones: Decide si cada afirmación es falsa o verdadera. Si es falsa, cambia la palabra en bastardilla para que la afirmación sea correcta y escribe tu respuesta en el espacio en blanco a la izquierda. Si la afirmación es correcta, escribe verdadero en el espacio.

1. En una reacción de desplazamiento simple se forma agua, un gas o un precipitado cuando se combinan dos compuestos iónicos en solución.
2. Un compuesto insoluble que se forma durante una reacción de desplazamiento doble se llama precipitado.
3. En una reacción de desplazamiento simple un elemento reemplaza a otro elemento en un compuesto.
4. La mayoría de las reacciones químicas pueden dividirse en cinco grupos principales.

Instrucciones: Lee el siguiente párrafo y contesta las preguntas en los espacios dados.

Carlos estaba acampando y le dio frío cuando el Sol se ocultó. Quería encender una fogata para calentarse y tener luz. Sin embargo, descubrió que la leña cercana estaba húmeda y no se podía encender. Tuvo que buscar bajo las hojas y restos vegetales para encontrar leña seca. Apiló la leña y la rodeó con un círculo de rocas para contener el fuego. Luego puso algunas hojas secas alrededor de los leños para que ayudaran a prender el fuego. Prendió las hojas. Pronto las hojas se consumieron, el fuego ardía bien y Carlos comenzaba a calentarse.

5. ¿Es la reacción química que Carlos produjo exergónica o endergónica? ¿Por qué?
6. ¿Es la reacción en la fogata de Carlos endotérmica o exotérmica? Explica.
7. ¿Crees que las hojas actuaron como un catalizador? Explica.
Términos clave
Reacciones químicas

Instrucciones: Ordena las letras en bastardilla para completar las siguientes oraciones. Escribe los términos en los espacios a la izquierda.

1. Una reacción de *cpoómescdoinis* es una reacción en la cual una sustancia se descompone en dos o más sustancias.
2. Un(a) *cónicuae* química describe una reacción química por medio de fórmulas y otros símbolos.
3. En una reacción *gexeórcian*, la cantidad de energía que se necesita para romper los enlaces originales es menor que la energía que se libera cuando se forman los nuevos enlaces.
4. En una reacción de *mzaplaedseinot plesim*, un elemento remplaza a otro en un compuesto.
5. Una reacción de *icamqui* es un cambio en el cual una o más sustancias se convierten en sustancias nuevas.
6. Una reacción de *tsísines* es aquella en la cual dos o más sustancias se combinan para formar otra sustancia.
7. En una reacción *trxoéeicam* la energía que se produce aparece sobre todo en forma de calor.
8. El tipo de reacción que requiere energía en forma de calor se llama *témdenorica*.
9. Un *iohindibr* ocupa un reactante y evita que pase por la reacción original.
10. El compuesto insoluble que se forma durante una reacción de desplazamiento doble se llama *drepicaotpi*.
11. Cuando se requiere más energía para romper los enlaces que para formar enlaces nuevos, la reacción se llama *górednecian*.
12. Los números que representan el número de unidades de cada sustancia que toma parte en una reacción se llaman *fcetioeencsi*.
13. Una reacción química que tiene el mismo número de elementos en ambos lados de la ecuación está *brilaqieuda*. 
Directions: Use the equations below to answer the following questions.

\[ \text{Zn}(s) + \text{S}(s) \rightarrow \text{ZnS}(s) \]

1. What are the reactants in this chemical reaction?

2. What is the product?

3. What is the physical state of both the reactants and the products?

4. According to the law of conservation of mass, if the total mass of the product in this chemical reaction is 14 g, what must the combined masses of the reactants be?

\[ 2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(l) \]

5. What name describes the product in this reaction?

6. What names describe the reactants?

7. What are the physical states of the reactants in this reaction?

8. What is the physical state of the product?

9. What do the coefficients tell you about the ratio of the reactants?

10. How many units of the product are produced?

Directions: Write chemical equations for the following reactions.

11. One unit of methane gas, \( \text{CH}_4 \), plus two units of oxygen gas, \( \text{O}_2 \), produce one unit of carbon dioxide gas, \( \text{CO}_2 \), and two units of liquid water.

12. One unit of aqueous aluminum sulfate, \( \text{Al}_2\text{SO}_4 \), plus three units of aqueous barium chloride, \( \text{BaCl}_2 \), yield two units of aqueous aluminum chloride, \( \text{AlCl}_2 \), plus three units of solid barium sulfate, \( \text{BaSO}_4 \).

13. Two units of solid sodium, \( \text{Na} \), plus one unit of chlorine gas produce two units of sodium chloride, \( \text{Cl}_2 \), a solid.
28 Chemical Reactions

**Chemical Equations**

**Directions:** Answer the following questions using complete sentences.

1. Describe, in words, a balanced chemical equation. Give an example.

2. Use the law of conservation of mass to explain why a chemical equation must be balanced.

**Directions:** Balance the following equations. If you need help, review the steps for balancing equations in your textbook. Use the space below for your work.

3. \( \text{H}_2(g) + \text{Cl}_2(g) \rightarrow \text{HCl}(aq) \)

4. \( \text{N}_2(g) + \text{H}_2(g) \rightarrow \text{NH}_3(g) \)

5. \( \text{Li}(s) + \text{FeBr}_2(aq) \rightarrow \text{LiBr}(aq) + \text{Fe}(s) \)

6. \( \text{Al}(s) + \text{HCl}(aq) \rightarrow \text{AlCl}_3(aq) + \text{H}_2(g) \)

7. \( \text{Li}(s) + \text{N}_2(g) \rightarrow \text{Li}_3\text{N}(s) \)
Classifying Chemical Reactions

Directions: Match the types of chemical reactions in Column II with the description in Column I. Write the letter of the correct reaction in the blank at the left.

Column I

_____ 1. A precipitate, water, or a gas forms when two ionic compounds in solution are combined.

_____ 2. Two or more substances combine to form another substance.

_____ 3. One element replaces another in a compound.

_____ 4. One substance breaks down into two or more substances.

_____ 5. A type of synthesis reaction that produces heat and light.

Column II

a. synthesis reaction
b. decomposition reaction
c. combustion
d. single-displacement reaction
e. double-displacement reaction

Directions: Write the name of the type of chemical reaction in the space provided.

----------------------------- 6. 4Fe(s) + 3O₂(g)→2Fe₂O₃(s)

----------------------------- 7. Zn₂(s) + 2HCl(aq)→ZnCl₂(aq) + H₂(g)

----------------------------- 8. MgCO₃(aq) + 2HCl(aq)→MgCl₂(aq) + H₂O(l) + CO₂(g)

----------------------------- 9. NiCl₂(s)→Ni(s) + Cl₂(g)

----------------------------- 10. 4C(s) + 6H₂(g) + O₂(g)→2C₂H₆O(s)

----------------------------- 11. C₁₂H₂₂O₁₁(s)→12C(s) + 11H₂O(g)

----------------------------- 12. 2LiI(aq) + Pb(NO₃)₂(aq)→2LiNO₃(aq) + PbI₂(s)

----------------------------- 13. CdCO₃(s)→CdO(s) + CO₂(g)

----------------------------- 14. Cl₂(g) + 2KBr(aq)→2KCl(aq) + Br₂(g)

----------------------------- 15. BaCl₂(aq) + 2KIO₃(aq)→Ba(IO₃)₂(s) + 2KCl(aq)

----------------------------- 16. 2Mg(s) + O₂(g)→2MgO(s)

----------------------------- 17. AgNO₃(aq) + KI(aq)→AgI(s) + KNO₃(aq)

----------------------------- 18. 2Li(s) + H₂O(l)→2LiOH(aq) + H₂(g)

----------------------------- 19. C(s) + O₂(g)→CO₂(g)
Chemical Reactions and Energy

Directions: Answer the following questions using complete sentences.

1. What is a catalyst?

2. What is an exothermic reaction?

3. What is an inhibitor?

4. What is an endothermic reaction?

Directions: Decide if each reaction below involves a catalyst, an inhibitor, or neither. Write C for catalyst, I for inhibitor, or N for neither in the blank at the left.

5. Brushing the cut edges of fruits with lemon juice can prevent the darkening effect that contact with air can cause.

6. In the human body, proteins called enzymes help to speed up chemical processes. The proteins are not changed during these chemical processes.

7. Aluminum oxide, which forms on exposed aluminum, protects the aluminum from further reaction with the air.

8. Food preservatives called BHT and BHA slow down the spoilage of certain foods.

9. Nickel is used to increase the rate of methane formation from the addition of hydrogen and carbon monoxide. Nickel does not permanently change.

Directions: Decide if each reaction below is endergonic or exergonic. In the blank at the left, write EN for endergonic or EX for exergonic.

10. When a lit match is placed in alcohol, the alcohol ignites producing heat and light.

11. Energy in the form of electricity can be added to water to break apart the water molecules into hydrogen gas and oxygen gas.

12. A piece of coal placed in a furnace gives off heat and light before turning to ash.

13. When ammonium chloride mixes with water, the solution formed feels cold.
**Home Chemistry**

**Directions:** For each of the following chemical reactions, identify the reactants. Use library references and chemistry books to help you identify the products and answer the questions. Write a chemical equation for each reaction.

**Materials**
- gloves
- chicken meat (white meat)
- 3 small glasses
- hydrogen peroxide (3% solution)
- water
- vinegar (white)
- sodium bicarbonate (baking soda)

1. Chicken meat contains the enzyme catalase. Catalase helps to break down hydrogen peroxide into water and oxygen. From fresh chicken meat, cut two pieces of white meat about the size of a pea. Place each piece in a separate small glass. To one glass, add enough fresh 3% hydrogen peroxide (sold as an antiseptic in drugstores) to cover the meat. Cover the other piece with water. Observe for 5 min. What are your observations?

2. Write the chemical reaction. **CAUTION:** Immediately after handling the chicken, thoroughly wash your hands.

3. Maybe you use natural gas for cooking, heating your home, or heating water. The main component in natural gas is methane. Write the chemical equation for the combustion of methane. Assume all of the methane is burned.

4. Suppose your furnace or stove is not very efficient. What harmful products can be the result of the incomplete combustion of methane?

5. a. Add 5 mL of vinegar (HC₂H₃O₂) to a small glass. Add a tablespoon of sodium hydrogen carbonate (baking soda) to the vinegar. What do you observe?

   b. Write the chemical equation for this reaction.

   c. Why is baking soda used in baking?
Mass Relationships in Chemical Equations

Directions: Use the concept of conservation of mass in chemical reactions to solve the following problems.

Example:
Write the balanced equation for the reaction of hydrogen with oxygen to form water. The molecular weight of H₂ is 2 g/m (two grams per mole). The molecular weight of H₂O is 18 g/m (eighteen grams per mole). Calculate the mass of water that is produced from 32 g of hydrogen gas.

\[
2H_2 + O_2 \rightarrow 2H_2O
\]

\[
2(2g)H_2 \rightarrow 2(18g)H_2O
\]

\[
32gH_2 \rightarrow xgH_2O
\]

\[
\frac{2(2g)H_2}{32gH_2} = \frac{2(18g)H_2O}{xgH_2O}
\]

\[
x = 288gH_2O
\]

1. How many grams of carbon react with oxygen to produce 88 g of carbon dioxide? First, write the balanced question.

2. Ammonia gas (NH₃) is made by reacting nitrogen gas with hydrogen gas. Write the balanced equation. How many grams of nitrogen gas are needed to produce 34 g of ammonia?

3. Iron ores contain oxides such as iron (III) oxide, (Fe₂O₃). In a blast furnace, the iron ore is made into iron metal by heating it with carbon monoxide. Carbon dioxide is the other product. Write a balanced equation for this reaction. How much carbon monoxide is required to produce 504 g of iron metal?

4. Why is it necessary to use a balanced chemical equation when solving a conservation of mass problem?
Materials
- Plain steel wool
- Glass or plastic dish
- Tongs
- Scale
- Candle

Procedure

Part A—Fast Reaction
1. Measure the mass of your piece of steel wool to the nearest 0.01 g. Record the mass in the data table below.
2. Predict what you think will happen to the mass of the steel wool when it is heated in a flame. Record your prediction and reasons in the data table. **WARNING:** Use care around open flames.
3. Use the tongs to hold the steel wool in the candle flame for several minutes. Take the steel wool out of the flame and let it cool. Record your observations.
4. Measure the mass of the steel wool and record it in the data table.
5. Repeat steps 3 and 4 until you do not detect any further change in mass.

Part B—Slow Reaction
1. Measure the mass of the second piece of steel wool to the nearest 0.01 g. Record the mass in the data table.
2. Wet the steel wool thoroughly with water. Place the steel wool in the dish for several days at room temperature.
3. Predict what you think will happen to the mass of steel wool. Record your prediction and reasons in the data table.
4. After the steel wool has completely dried, measure and record its final mass.

**Table 1**

<table>
<thead>
<tr>
<th></th>
<th>Part A</th>
<th>Part B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial mass</td>
<td></td>
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<tr>
<td>Prediction</td>
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<tr>
<td>Reasons</td>
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<tr>
<td>Observations</td>
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<td></td>
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<tr>
<td>Final mass</td>
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</tbody>
</table>

**Conclude and Apply**

1. What happened to the mass of the steel wool in Part A?
2. What happened to the mass of the steel wool in Part B?
3. Explain your results for Parts A and B.
4. Why do you think the reaction was more rapid in Part A?
Hot Chemical Packs

Have your muscles ever felt sore after work or exercise? If so, a chemical hot pack may be just the thing to make your sore muscles feel better.

A hot pack utilizes heat given off during a chemical reaction or during a solution process.

Materials
- sodium thiosulfate hydrate (500 g)
- measuring spoon (Tablespoon)
- scale
- large pan
- 500-mL glass measuring cup
- stove or burner
- water
- self-locking, or sealable, plastic bags (2, of different sizes)

Procedure
1. Put about 440 g of the crystal sodium thiosulfate hydrate into the measuring cup. Add about 2 tablespoons of water.
2. Place the cup in a pan of water at room temperature. (The water can’t be too deep, or the cup will tip over.)
3. Heat the water to a gentle boil. Stir until the crystals completely dissolve. Then heat and stir a few more minutes.
4. Turn off the heat. Let the liquid stand in the water bath until it cools to room temperature.
5. Pour the liquid into a self-locking plastic bag and seal the bag. Place this bag inside a second self-locking bag.
6. Place a few crystals of sodium thiosulfate hydrate in the second bag between the two bags. Your pack may be stored like this.
7. To use the hot pack, open the outer bag and get two or three crystals. Open the inner bag and drop the seed crystals into different areas of the liquid. Reseal both bags. Your pack should produce heat at a steady temperature of 48° Celsius (118.4°F) for about an hour.
8. To recharge your hot pack, remove the solid sodium thiosulfate hydrate from the bag and melt it as before. Pour the liquid into a fresh inner bag. You can recycle the sodium thiosulfate hydrate indefinitely.

Conclude and Apply
1. What type of chemical reaction is occurring to make your hot pack work?
2. What are some possible uses for a hot pack?
3. Use the law of conservation of mass to explain why your hot pack can be recharged by recycling the sodium thiosulfate hydrate indefinitely.
Section 1 Chemical Changes

A. Describing _________________—change of one or more substances converted into new substances
   1. _______________ are substances that combine or change.
   2. New substances that are produced are called ______________.

B. __________________——a law which states that, in a chemical reaction, matter is not created or destroyed; it stays the same.
   1. _______________—experimented with mercury (II) oxide and heat
   2. Found mass of products (liquid mercury and oxygen gas) ___________ mass of reactants

C. Writing equations—a _________________ uses chemical formulas and symbols to describe a chemical reaction and the product(s) it produces.
   1. Chemical formula expresses the relationship between elements in the compounds and molecules they make up
   2. _______________—numbers which represent the number of units of each substance in a reaction
   3. Knowing coefficients of chemical reactions allows chemists to use the _______________ of reactants to predict the amounts of products.
   4. Subscripts—numbers which represent the number of ________ in a molecule of a particular element.
   5. Symbols used to show state of reactants: (s)_____, (aq)_____, (g)___, (clear)_____.

D. __________ react with atmosphere in different ways.

Section 2 Chemical Equations

A. Checking for _______________—law of conservation of mass requirement
   1. A _______________ chemical reaction—both sides of equation have same number of atoms of each element
   2. Choosing coefficients—becomes easier with practice; trial and error at first
Note-taking Worksheet (continued)

B. ________ balanced chemical equations—a four-step process
   1. Describe the reaction in ________.
   2. Write the __________ using formulas and symbols.
   3. Check for __________.
   4. Add ___________ where needed for balance.

Section 3   Classifying Chemical Reactions

A. __________ reaction—two or more substance form a new substance; A + B → C

B. One substance breaks down into two or more substances in a __________ reaction;
   AB → A + B

C. ______________ reaction—one element replaces another one in a compound;
   A + BC → AC + B or D + BC → BD + C

D. A _______________ reaction results if a precipitate, water, or a gas forms when two
   ionic compounds in solution are combined; AB + CD → AD + CB

Section 4   Chemical Reactions and Energy

A. Chemical reactions involve energy __________.
   1. Breaking chemical bonds __________ energy.
   2. __________ chemical bonds releases energy.

B. More energy ________
   1. ______________——energy required to break bonds is less than the energy
      released from new bonds; energy given off is usually light.
   2. __________ reactions—energy given off in the form of heat

C. More energy ________
   1. __________ reactions—more energy is required to break bonds than to form new
      ones; need energy for the reaction to occur
   2. If energy needed is heat, the reaction is ______________.
   3. A __________ speeds up a chemical reaction without itself being permanently changed.
   4. An ___________ prevents or slows a chemical reaction or interferes with a catalyst’s action.
Assessment
Part A. Vocabulary Review

Directions: Complete the following sentences using the terms listed below.

synthesis  exothermic  catalyst  decomposition  coefficients
endothermic  single-displacement  inhibitor  reactants
precipitate  chemical  double-displacement  products  balanced

1. A change in which one or more substances are converted into a new substance is called a(n) __________________ reaction.

2. If a precipitate, water, or a gas forms when two ionic compounds in solution are combined, the reaction is a(n) __________________ reaction.

3. A substance that prevents certain chemical reactions is a(n) __________________.

4. When two or more substances combine in a chemical reaction to form another substance, a(n) __________________ reaction has taken place.

5. The breakdown of a substance into two or more simpler substances is a(n) __________________ reaction.

6. In a chemical equation, the substances that react are called __________________.

7. A substance that speeds up a chemical reaction without itself being permanently changed is a(n) __________________.

8. A reaction that requires energy in the form of heat is a(n) __________________ reaction.

9. When one element replaces another in a compound, a(n) __________________ reaction has occurred.

10. If the energy released in a chemical reaction is primarily in the form of heat, that reaction is a(n) __________________ reaction.

11. Numbers in front of the symbols and formulas in an equation are called __________________.

12. If the number of atoms of each element on the left side of an equation is equal to the number of atoms of each element on the right side of the equation, the equation is __________________.

13. In a chemical equation, the substances that are produced are called __________________.

14. An insoluble solid that forms when two ionic compounds in solution are combined is a(n) __________________.
Chapter Review (continued)

Part B. Concept Review

Directions: Study the following equation, then answer questions 1–5 on the lines provided.

\[ \text{Al}(s) + \text{HCl}(aq) \rightarrow \text{AlCl}_3(aq) + \text{H}_2(g) \]

1. What are the products in this reaction?

2. What are the reactants?

3. Balance the equation.

4. What type of reaction is this?

5. What do the symbols indicate about the states of the products?

Directions: In the blanks at the left, write the symbols used in an equation to show each of the following physical states.

6. solid

7. aqueous solution

8. gas

9. liquid

Directions: For each situation below, decide if the chemical reaction is endothermic or exothermic. Write your answer in the blank at the left.

10. The temperature of the beaker holding the reacting substances increased.

11. The temperature of the beaker holding the reacting substances decreased.

12. Frost formed on the outside of the beaker holding the reacting substances.

Directions: Answer the following questions using complete sentences.

13. Why is it important to show chemical reactions in a balanced form?

14. How can a table listing of metals in an activity series be useful for predicting whether a chemical reaction will occur?

15. Compare the energy required to break the bonds of the reactants and the energy released when products form in an exergonic reaction.
Transparency Activities
A Changing World

This family is not only having fun, they’re doing chemistry! Toasting marshmallows, burning wood, and getting energy from food all involve changes in substances.

1. Describe what you see in this campfire scene.
2. How do some of the things you named look different than they did before the fire was lit?
3. How will the marshmallows continue to change if kept in the fire?
A Balanced Viewpoint

Balances have been used for a very long time to compare the weights of different objects. Usually, an unknown weight is put in one pan and known weights are put in the other until the two pans are even. Chemical equations are balanced in a similar fashion.

1. How is the arrow in a chemical equation like the fulcrum of a balance?
2. If you could put all the reactants of a chemical reaction in one pan of a balance and all the products in the other pan, would the two pans be even? Explain.
Nitrogen is the most abundant gas in the atmosphere. However, in the atmosphere, nitrogen is held in molecules by very strong triple bonds. In order to be used by living things, these triple bonds need to be broken. Lightning can supply energy that frees nitrogen atoms to form new compounds.

1. Do the nitrogen atoms freed by lightning undergo a chemical or physical change?
2. Describe what happens to the atoms in the reaction \( \text{N}_2 + \text{O}_2 \rightarrow 2\text{NO} \).
The animal you see below is a comb jelly. Most comb jellies are capable of giving off light.

1. What type of reaction do you think allows the comb jelly to give off light? Why?
2. Why is it important that the comb jelly generates light without heat?
Teaching Transparency
Activity

Reaction Equation

Ni(OH)$_2$ $\rightarrow$ NiCl$_2$

2NaOH $\rightarrow$ 2NaCl
1. What happens to mass in an equation?

2. What are the reactants in the chemical equation shown?

3. What are the products in the chemical equation shown?

4. Is the equation balanced? How do you know?

5. What are coefficients?
Directions: Carefully review the diagrams and answer the following questions.

1. From the results of the experiment above, it is reasonable to assume that the production of ethene ____.
   A has no effect on the rotting of a peach in its immediate area
   B slows the rotting of a peach in its immediate area
   C quickens the rotting of a peach in its immediate area
   D slows the rotting process in the peach producing the gas

2. According to the information in the diagram, we can conclude that ethene consists of ____.
   F hydrogen and helium       H carbon and oxygen
   G carbon and hydrogen       J calcium and carbon

3. George wanted to use the peaches that he picked from the tree in his backyard to bake a pie. However, some were not quite ripe. George could best speed the ripening process by placing the peaches ____.
   A in the refrigerator       C inside an enclosed space
   B outside by the tree       D near a breezy window