New York

8

Science Companion

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To the Student

Welcome to **Science Companion,** Grade 8. This book provides review and practice on key skills and concepts in science. In addition, the lessons in this book will help you study the skills that are important to mastering your state test in science.
Here's how to use this book:

- Before you begin the first lesson, take the Tryout Test. This test will show you your strengths and weaknesses in the skills you will need to understand for your state test. Then you can use this book to focus on studying the types of questions that were hard for you to answer.
- Work through the units that follow the Tryout Test. The lessons in each unit provide instruction, example items, and unit tests based on the key skills. Take each unit test to see if you have mastered the skills from the unit.
- After completing all the lessons, take the Progress Test. Your score on this test will show your understanding of the key skills and concepts in science.
- Finally, take the Mastery Test, which will give you additional questions and assess the key skills you have mastered.

We hope you will enjoy using this book and that you will have a fun and rewarding year!

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UNIT THREE—EARTH AND SPACE

LESSON 2
Chemical Reactions

Review the Expectations
(MS-PS1-2, MS-PS1-3, MS-PS1-5, MS-PS1-6, MS-PS1-8)

- Mixtures are combinations of substances
- Substances are changed in chemical reactions
- Synthetic materials come from natural resources
- Mass is conserved in reactions

Q: Juanita tells you she can use heat to separate salt dissolved in water. How can that be?

A: When salt is stirred into water, the two substances form a **solution.** The salt is no longer visible to the eye. However, salt has a very high boiling point and water has a much lower one. A mixture of salt and water can be separated by boiling away the water.

Q: When camping, Toby's mom pulls out a glow stick and "cracks" it. Within a few minutes, it is releasing a green light that lights up the campsite. What's going on here?

A: Glow sticks generally have different substances that are kept separate in a tube. When a person cracks a glow stick, they break a barrier that separates the substances, allowing them to mix. This mixture causes a **chemical reaction** to occur, which results in the release of light.

Q: Some grocery stores pack foods using dry ice. Dry ice is frozen carbon dioxide, which quickly changes from a solid to a gas. Iolana says that this is a **physical change**. Is she right?

A: Physical changes occur when a substance changes, but no new substances are made. Although dry ice evaporates into carbon dioxide, dry ice is just another state of matter of carbon dioxide. The formula for both is CO_2.

Bright Ideas!

Tom opens a can of soda, and it fizzes. He takes a few sips and finds it highly carbonated before putting it back in the refrigerator. Tom comes back to his drink a few hours later and takes a few sips. It is no longer fizzy and tastes much sweeter. Talk with your classmates about what's going on. Then record your ideas in the boxes below.

Why did the can fizz when Tom opened it?	Why was there less carbonation after a few hours?	Why does the soda taste sweeter after a few hours?

Get Started

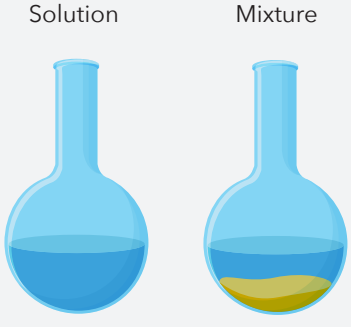
Directions: Read the following article. Then do a second read. During this read, highlight the definitions in context for the bolded vocabulary.

Mixtures and Solutions

How does a **mixture**, or a physical combination, of table salt and water differ from a mixture of sand and water? When table salt is mixed in water, the salt particles disappear, yet they can still be detected when tasting the mixture. A **solution** is a mixture in which the components, or parts, remain evenly distributed. Saltwater is a solution.

In a mixture of sand and water, the sand remains visible and settles at the bottom of the container. Sand in water is not a solution. The physical property that distinguishes sand from table salt is called **solubility**.

Salt dissolves in water to form a solution because salt is soluble in water. Sand does not dissolve in water because sand is insoluble in water. A solution generally has two parts, the **solute** and the **solvent**. The solvent does the dissolving, while the solute gets dissolved. When a solid dissolves in a liquid, the solid is the solute, and the liquid is the solvent. Gases or other liquids may also dissolve in liquids to form a solution.



Because mixtures are a physical combination, they can be separated using physical means. Some examples include filtration, evaporation, and even magnetism.

Key Concept: How could you design an investigation to determine if different materials are soluble?

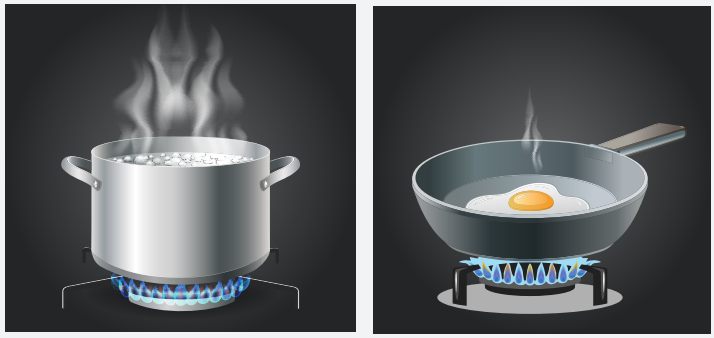
Patterns: What is the difference between a solution and a mixture?

Physical Changes and Chemical Changes

We see changes all the time. Some changes involve physical aspects of matter. Every water molecule is made up of two atoms of hydrogen and one atom of oxygen, so the chemical formula for water is H_2O. What is the formula for ice? When water freezes, the arrangement of its molecules changes, but the molecules themselves do not change. They are still H_2O.

A change of **phase**, such as freezing, does not produce new substances. The formula for water vapor is also H_2O. A change that does not form any new substances is a **physical change**. All phase changes are physical changes. Similarly, when you dissolve sugar in water, the sugar still tastes sweet, and the water is still wet. No new substances have formed, so dissolving is a physical change.

What happens if you forget to put milk back into the refrigerator? First, the milk gets warm. This is a physical change. However, if you leave the milk out too long, it turns sour. The sour taste is caused when lactose, a sugar in milk, changes into lactic acid. A change that produces one or more new substances is called a **chemical change**. When a chemical change occurs, we say there was a chemical reaction. Burning paper produces smoke and ash, both of which are new products. Burning is always a chemical change.



Boiling water is a physical change, but when foods, such as this egg, cook, they undergo a chemical change.

Key Concepts: What observations could you use to determine if a change is a physical or chemical change?

Patterns: What patterns would you expect to see when a substance goes from a liquid state to a solid state?

Get Started

Forming a compound always involves a chemical change, but forming a mixture involves only physical changes. Similarly, a chemical change is required to break a compound apart. Mixtures, however, can be separated through physical means. For example, salt water can be boiled, leaving the salt behind.

Chemical changes can be represented by chemical equations. A chemical equation uses formulas and numbers to keep track of a chemical change. The starting materials, called the **reactants**, are listed on the left side of the equation. The final materials, called the **products**, are listed on the right side. An arrow separates the two sides. The equation for the burning of coal, which is mostly carbon, would be written as

$$C + O_2 \rightarrow CO_2$$

A chemist reads this equation as, "Carbon plus oxygen yields carbon dioxide." Carbon and oxygen are reactants in this reaction, and carbon dioxide is the product. Notice how the number of carbon and oxygen molecules stays the same in the equation. Mass is always conserved like this in any reaction.

Properties of Chemical and Physical Changes

New substances produced by a chemical change have their own properties. These properties are different from those of the original substances that reacted since those substances are no longer present. For example, the element sodium is a soft metal that explodes on contact with water. The element chlorine is a poisonous, green gas. When sodium and chlorine combine in a chemical reaction, they produce sodium chloride, or table salt. The new substance formed has completely different properties from those of the original materials, which no longer exist as separate substances.

During a chemical reaction, atoms are rearranged to form new substances. This involves the breaking

Construct Explanations: Explain why a physical change would not be effectively described by a chemical equation.

Patterns: How might the patterns in atomic structures of a substance change during a chemical reaction? For example, during the burning of coal.

of existing chemical bonds and the formation of new bonds. Both physical and chemical changes occur in nature. The wearing away of a mountain by streams is a physical change.

But nature can also cause chemical changes. The Statue of Liberty in New York City is made of copper but does not look copper. This is due to a chemical reaction between the copper and the air. This reaction produces a new, green-colored substance called copper oxide. The chemical wearing away of a metal is called **corrosion**. Corrosion, which forms a new substance, is a chemical change. Erosion, which only moves substances around, is a physical change.

Copper is typically bronze colored but will become green when exposed to oxygen.

Synthetic Materials

The items we use daily are made from materials found in nature. These **natural resources** are used in many different forms. Some materials may be used in a form that is fairly close to how it is found in nature. Consider a wooden chair or table. The wood has undergone physical changes, such as in its shape or texture, but it is still wood. Natural resources can also be changed in chemical reactions to make **synthetic materials**. Consider plastic, which is sourced from petroleum, among other materials. Petroleum in its natural state has very different properties than the final product that we use. Many other items, such as medicine, foods, and alternative fuel sources, undergo chemical reactions to form the products we eventually use. The processes to form these synthetic materials may impact society.

For example, pollution may be released as a result of the processing of natural resources. Often, harmful gases can be released into the atmosphere and waste materials may be disposed of improperly. The removal of trees can also affect the animals and plants that live in different habitats. Human activities can have impacts on the environment.

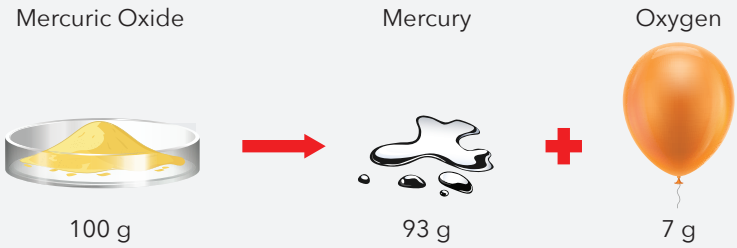
Energy and Matter: Explain how matter is conserved when natural materials are changed into synthetic materials.

Get Started

Conservation of Matter

Chemical changes form new substances, but no atoms are created, and no atoms are destroyed. Every atom that is present before a reaction takes place is still there after the reaction takes place. What has changed is the way the atoms are arranged. Chemical reactions only change the way atoms are bonded to one another.

The mass of the products remains the same as the mass of the reactants because no atoms were created or destroyed. This is an example of the **Law of Conservation of Matter**, which states that matter can be neither created nor destroyed in a chemical reaction. It can only be changed from one form to another. It is important to remember to account for all the substances before and after a reaction, including gases, which escape in the air.



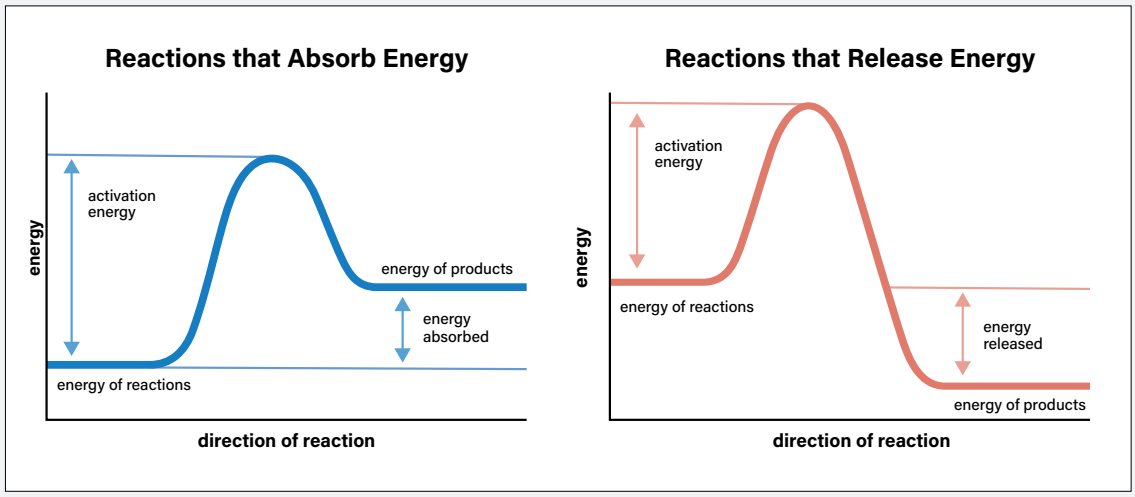
In this diagram, mercuric oxide undergoes a chemical reaction to form mercury and oxygen. The sum of the masses of mercury and oxygen equal the original mass of the mercuric oxide.

Energy and Chemical Changes

New substances are formed during a chemical change. An example is making table salt from sodium and chlorine. However, simply mixing sodium and chlorine together does not produce table salt. **Energy** is needed to start the chemical reaction. Likewise, a match does not start to burn until you strike it. The friction caused by striking the match provides the heat energy needed to start the chemical reaction of burning.

Developing Models: Develop a diagram to show the law of conservation of matter.

Key Concept: What is required to start a reaction?



All chemical changes must be started by adding energy in the form of heat, light, or electricity. This is called the **activation energy** of the reaction and can be seen in the diagram above. Some chemical changes need so little additional energy that they can absorb enough energy from their surroundings to get them started. The rusting of iron is an example of such a reaction.

As a chemical reaction proceeds, energy is either absorbed or released. For example, the burning of a match releases energy in the form of heat and light. The chemical reaction that occurs in a battery releases electrical energy. On the other hand, when food is cooked, heat energy is absorbed as the chemical changes occur.

We can use chemical reactions to supply us with heat when we need it. For example, campers often use chemical hand warmers in cold weather. When they open the packet, the chemicals in the hand warmer react with oxygen in the air to release heat.

Reactions that absorb heat are also useful. A cold pack contains two chemicals that absorb heat when they react with each other. You simply break the seal separating the two chemicals to start the reaction.

Energy and Matter: How might energy flow as a chemical reaction occurs?

Get Started

1. When held over a fire, a marshmallow turns brown and loses weight. Which statement is true about these observations?

A Some of the marshmallow dripped off, causing it to lose weight, which is a physical reaction.

B Burning a marshmallow is a chemical change because some of it has become a new substance.

C The chemical reaction that occurs releases energy from the marshmallow because it loses weight.

D A physical reaction has occurred because there has been a color change.

Analyze and Interpret Data

1. Objects can undergo either physical or chemical changes. Recall that in a physical change, no new substances are formed. However, during a chemical change, new substances are formed. Burning always indicates a chemical change, so choice D is incorrect.

Typically, a reaction that involves burning absorbs energy, and it does not release energy.

2. Which of the following is a synthetic material?

A Pure honey

B A plastic soda bottle

C An unpainted, wooden chair

D Fresh vegetables

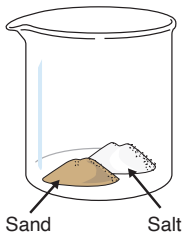
Think About It

3. Remember that synthetic materials come from natural resources but have to undergo a chemical process to form.

Consider the materials listed and whether or not they have undergone a

Write It Out

3. A mixture can be separated using physical properties. For example, a mixture of iron and silver can be separated with a magnet. Iron is magnetic, but silver is not.



Your teacher gives you a sample of salt and sand, and has you stir the two together. You have been tasked with planning and carrying out an investigation to show that this is a mixture. You will be expected to separate the sand and salt using any of their properties. By the end of the experiment, they should have the same properties that they began with.

Part A: What property of sand and salt could you use to separate the substances?

Part B: Is this property a physical or chemical change? Explain your answer.

Part C: Plan an investigation where you use the physical characteristics you listed in **Part A** to separate the salt and sand. Make sure to identify the tools you will use, your procedures, and the data you expect to collect.

Part D: What are the mixtures and solutions formed during your investigation?

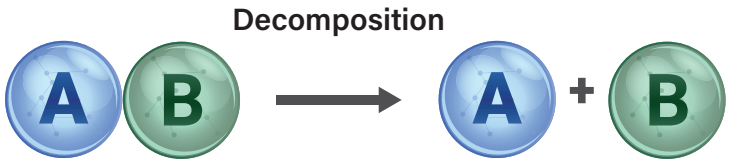
Plan and Carry Out Investigations

2. Investigations are used to gather evidence and data that can be use answer a scientific question.

On Your Own

Directions: Use this information to answer Questions 1–3.

A decomposition reaction occurs when a substance breaks down into two or more simpler substances. Decomposition reactions generally require a large amount of energy.



Hydrogen peroxide is a disinfectant used to clean minor cuts and scrapes. Hydrogen peroxide reacts to light. When exposed to light, it will break down into oxygen and water.

1. What kind of change is a decomposition reaction? Circle one word from each box to answer.

A decomposition reaction is a [physical | chemical] reaction that usually [absorbs | releases] energy.

2. A thermometer placed in a glass of hydrogen peroxide and exposed to light quickly increases in temperature. What does this observation suggest?

A Hydrogen peroxide releases water into the air.
B Hydrogen peroxide absorbs heat from its surroundings.
C The decomposition reaction releases energy.
D The decomposition reaction absorbs energy.

3. When hydrogen peroxide breaks down, it forms oxygen and water. The mass of the products will be

A greater than the mass of the hydrogen peroxide.
B equal to the mass of the hydrogen peroxide.
C less than the mass of the hydrogen peroxide that has reacted.
D greater than the mass of the reactants.

Explore and Learn

You are working with a group to develop a device that will release energy using a chemical reaction. To do this, you need to design a device that will keep the reactants separate before you want the reaction to occur. You and your group decide that you want to test the effectiveness of a mixture of baking soda and vinegar as possible reactants for the device.

When vinegar, a liquid, is added to baking soda, a solid, bubbles of carbon dioxide gas are produced.

4. What kind of reaction has occurred? Explain your answer using the properties of the substances.

5. Develop a model in the space below to show that the total number of atoms in the reaction does not change, and that mass is conserved. Write an explanation of your model.

6. You and your group determine that baking soda and vinegar release energy during their reaction. Use the space below to design a device that can be used to harness this energy.