

## Lesson 7: Classifying Matter

### ☐ Getting Started

In this lesson, you will look more closely at **chemistry**, the branch of science dealing with the structure, composition, properties, and reactive characteristics of substances, especially at the atomic and molecular levels. In this lesson you will be challenged to look at matter based on how it is used and where it occurs. You will also take into consideration differences based on whether an object is composed of simple elements in a pure form, compounds, or mixtures.

Remember from previous lessons that an element is the simplest form of matter in its pure form. **Compounds** are substances formed by the chemical combination of elements in **fixed proportions** (unchanging quantities). Compounds are pure chemical substances that can be separated into simpler substances by chemical reactions. **Mixtures** are a combination of two or more substances that are not chemically united and do not necessarily exist in fixed proportions to each other. The difference between a compound and a mixture is subtle, and in this lesson, we will look more closely at how the atoms that make up compounds and mixtures are packed together. We will also take your developing understanding of chemistry and use it to look at the variety of ways that elements, compounds, and mixtures make up all living and nonliving substances.

### Stuff You Need

- *Eyewitness Chemistry* by Ann Newmark
- measuring cups
- oven mitt or potholder
- safety goggles (kit)
- salt
- small cups (kit)
- sugar
- tablespoon
- tea light candle (kit)
- test tube clamp (kit)
- test tube holder (kit)
- test tubes (kit)

### Ideas to Think About

- What makes one piece of matter different from another?
- What patterns can be observed in elements?

### Things to Know

- **compounds**: substances formed by the chemical combination of elements in fixed proportions; pure chemical compounds can be separated into simpler substances by chemical reactions

- **chemistry**: a branch of science dealing with the structure, composition, properties, and reactive characteristics of substances, especially at the atomic and molecular levels
- **fixed proportions**: unchanging quantities of each element that are part of a compound
- **mixtures**: a combination of two or more substances that are not chemically united and do not exist in fixed proportions to each other

### ☐ Reading and Questions

Read p. 6, pp. 14-15, and pp. 20-21 in Eyewitness Chemistry. (Optionally, read pp. 7-11.) Then answer the following questions.

1. What is the difference between a mixture and a compound?

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2. Name 3 ways that the substances in a mixture can be separated.

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3. What does it mean if an element is unreactive? Give an example of an unreactive element.

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### Activities

#### ☐ Activity 1: What Is a Compound?

In this activity, you will explore the idea of a compound. A compound is a substance formed by the chemical combination of elements in fixed proportions. Compounds can be separated into simpler substances by chemical reactions. In this lesson, you will use some compounds common in your home — sugar and salt — and examine them more closely.

Remember that fixed proportions are unchanging quantities of an element that are part of a compound. For a compound to always be the same, the amount of each element must remain the same or else the compound changes into a different compound. Some examples of common household compounds are included in the "Compounds" table:

### Compounds

| Compound Name    | Chemical Name                            | Chemical Formula                                             |
|------------------|------------------------------------------|--------------------------------------------------------------|
| baking soda      | sodium bicarbonate                       | $\text{NaHCO}_3$                                             |
| bleach (liquid)  | sodium hypochlorite or hydrogen peroxide | $\text{NaClO}$ or $\text{H}_2\text{O}_2$                     |
| bleach (solid)   | sodium perborate                         | $\text{NaBO}_3$                                              |
| Borax            | sodium tetraborate decahydrate           | $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ |
| cream of tartar  | potassium hydrogen tartrate              | $\text{KHC}_4\text{H}_4\text{O}_6$                           |
| Epsom salt       | magnesium sulfate                        | $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$                    |
| Freon            | dichlorodifluoromethane                  | $\text{CF}_2\text{Cl}_2$                                     |
| grain alcohol    | ethanol                                  | $\text{C}_2\text{H}_5\text{OH}$                              |
| gypsum           | calcium sulfate dihydrate                | $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$                    |
| lime             | calcium oxide                            | $\text{CaO}$                                                 |
| limestone        | calcium carbonate                        | $\text{CaCO}_3$                                              |
| marble           | calcium carbonate                        | $\text{CaCO}_3$                                              |
| milk of magnesia | magnesium hydroxide                      | $\text{Mg}(\text{OH})_2$                                     |
| plaster of Paris | calcium sulfate 1/2 hydrate              | $\text{CaSO}_4 \cdot (1/2)\text{H}_2\text{O}$                |
| potash           | potassium carbonate                      | $\text{K}_2\text{CO}_3$                                      |
| quartz           | silicon dioxide                          | $\text{SiO}_2$                                               |
| rubbing alcohol  | isopropyl alcohol                        | $(\text{CH}_3)_2\text{CHOH}$                                 |

### Common Household Elements

|             |         |    |
|-------------|---------|----|
| brimstone   | sulfur  | S  |
| quicksilver | mercury | Hg |
| graphite    | carbon  | C  |

Look carefully at the "Sample Compounds" table and use the information presented to complete the table on the "What Is a Compound?" activity page. Not all cells will be filled with an element. If a cell is empty, put "n/a" or a dash (—) through the cell. When you are done, answer the questions at the bottom of the page. In the chemical formulas, if an element does not have a subscripted number, the quantity is understood to be one. If it does have a subscripted number, the quantity is that number.

| Sample Compounds |                    |                  |
|------------------|--------------------|------------------|
| Compound Name    | Chemical Name      | Chemical Formula |
| Baking soda      | sodium bicarbonate | $\text{NaHCO}_3$ |
| Limestone        | calcium carbonate  | $\text{CaCO}_3$  |
| Lime             | calcium oxide      | $\text{CaO}$     |

### ☐ Activity 2: Sweet and Salty

In Activity 1, you learned that compounds are made up of different elements in certain proportions. Keep in mind that changing the proportion or changing the elements means that a new compound is formed. In this activity you will learn that changing the conditions for a compound does not change the compound unless a chemical reaction occurs. In the final portion of condition three, you will see or taste, this.

#### Condition 1: Solution

Follow these steps:

1. Put a tablespoon of sugar and a tablespoon of water in a cup.
2. In a different cup, put in a tablespoon of salt and add a tablespoon of water.
3. Stir each solution until each the salt and sugar dissolve.
4. Taste the solution in each cup and note your observations on the "Sweet and Salty" activity sheet.
5. Keep the cups and their contents; you will use them in Conditions 2 and 3.

**NOTE:** You will need to use safety goggles for Condition 2 and Condition 3. You should also use an oven mitt or silicone potholder to hold the test tube clamp.

#### Condition 2: Applied Heat to Solution

Follow these steps:

1. Carefully light a tea light candle (or ask a parent to light it).

2. Put a small amount of the sugar water mixture into a test tube. Use the test tube clamp to hold it over the flame. NOTE: You should hold the test tube clamp using an oven mitt or silicone potholder; metal conducts heat well, and the handle could get very warm.
3. Keep applying heat until the water bubbles.
4. Place the test tube in the test tube rack and let it cool; don't spill any of the liquid.
5. Repeat Steps 2-4 for the salt water.
6. Once both liquids have cooled completely, taste each one and record your observation on the activity sheet.

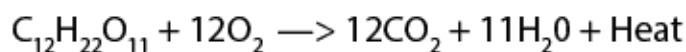
### Condition 3: Applied Heat to Solid

Follow these steps:

1. Put a small amount of sugar in a test tube and place it over the flame. Do NOT add water. (As with Condition 2, be sure to hold the test tube clamp with an oven mitt or pot holder.)
2. Keep applying heat until the sugar melts.
3. Place the test tube in the test tube rack and let it cool; don't spill any of the melted sugar.
4. Put a small amount of salt on another test tube and place it over the flame. Do NOT add water.
5. Keep applying heat; the salt may not bubble, and that is okay.
6. Place the test tube on the rack and let it cool; don't spill any of the salt.
7. Once both test tubes have cooled down until warm or cool to the touch, do a taste test and record your observations on the activity page.

Consider the following chemical formula for what you observed with the sugar:

#### Table Sugar Burning



This is a chemical formula that represents table sugar (sucrose) when it combusts or burns. Although your sugar did not combust (sugar burns at 325 degrees Fahrenheit), you should see some discoloration. That discoloration is the result of a chemical change. After you applied heat, did you have the same compound as before or did you have different ones? Answer that question at the bottom of the activity page.

## Wrapping Up

In this lesson, you have been introduced to the idea of mixtures and compounds. Keep in mind that compounds are made up of elements in fixed proportions and mixtures do not have fixed proportions. Also, compounds are chemically combined, but mixtures are not. This lesson served as a basic introduction to chemistry. In future units, you will look more closely at chemistry, and the new understandings that you are developing should expand further. Keep in mind that the world around you is made up of different compounds and that the complexity around you is the result of things that you cannot see with the naked eye.

# WHAT IS A COMPOUND?

Each of the compounds are common household agents. See if you can find them or ask a parent the state of matter of each element. Also, feel free to do some investigation utilizing the Internet.

| COMPOUND NAME | 1ST ELEMENT/<br>NUMBER PRESENT | 2ND ELEMENT/<br>NUMBER PRESENT | 3RD ELEMENT/<br>NUMBER PRESENT | 4TH ELEMENT/<br>NUMBER PRESENT |
|---------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| BAKING SODA   |                                |                                |                                |                                |
| LIMESTONE     |                                |                                |                                |                                |
| LIME          |                                |                                |                                |                                |

Answer the following questions:

-What is the state of matter for each compound? (Hint: They are all the same at normal room temperature)

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-What elements are common to all three compounds?

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-Consider the placement of each element in the chemical formula. What pattern do you recognize in the chemical formulas? (Hint: Consider the periodic table of elements and the location of each element)

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-What is the difference between lime and limestone?

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-What combination of elements do you find that is shared by at least two compounds?

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-What do you think would happen if you removed one of the elements from a compound?

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*Sweet* and **SALTY**

| Compound | Taste:<br>Condition One | Taste:<br>Condition Two | Taste:<br>Condition Three |
|----------|-------------------------|-------------------------|---------------------------|
| Sugar    |                         |                         |                           |
| Salt     |                         |                         |                           |

After applying heat, do you have the same compound as before or do you have different ones?

## Lesson 7: Classifying Matter

### Getting Started

#### ✿ Ideas to Think About

- What makes one piece of matter different from another?
- What patterns can be observed in elements?

#### 📖 Things to Know

- **compounds:** substances formed by the chemical combination of elements in fixed proportions; pure chemical compounds can be separated into simpler substances by chemical reactions
- **chemistry:** a branch of science dealing with the structure, composition, properties, and reactive characteristics of substances, especially at the atomic and molecular levels
- **fixed proportions:** unchanging quantities of each element that are part of a compound
- **mixtures:** a combination of two or more substances that are not chemically united and do not exist in fixed proportions to each other

#### 🕒 Skills

- Classify matter as elements, compounds, or mixtures based on how the atoms are packed together in arrangements. (S)
- Evaluate evidence that elements combine in a multitude of ways to produce compounds that account for all living and nonliving substances. (S)

### Introducing the Lesson

In this lesson, your child will receive a basic introduction to some ideas associated with chemistry, including understanding how compounds and mixtures differ at the atomic and/or molecular level. Hopefully, your child will gain a new awareness of how the world is held together and the subtle complexity that surrounds him whatever the environment.

### Reading and Questions

1. What is the difference between a mixture and a compound?

*A mixture is a substance containing different kinds of molecules that can be physically separated from one another. A compound is a substance that contains more than one type of atom -- in a compound the atoms are bound together chemically. They cannot be physically separated from one another.*

2. Name 3 ways that the substances in a mixture can be separated.

*Answers could include the separatory (glass flask used to separate liquids that do not mix), filtering, evaporation, chromatography, or fractional distillation.*

3. What does it mean if an element is unreactive? Give an example of an unreactive element.

*Unreactive elements don't react with other elements and don't easily form compounds. The noble gases (helium, neon, argon, krypton, xenon, or radon) are unreactive elements.*

## Activities

## Activity 1: What Is a Compound?

In this activity, your child looked at the chemical formulas for baking soda, limestone and lime. In each compound, there are specific elements combined with other elements. For baking soda, they are sodium (Na), hydrogen (H), carbon (C), and oxygen (O). For limestone they are calcium (Ca), carbon (C), and oxygen (O); and for lime they are carbon (C) and oxygen (O). Each letter has a subscript that represents the number of these elements that are combined with specific amounts of each element present. Capital letters represent the first or only letter of the chemical symbol of an element.

Use the following answer key to check your child's answer:

## Answer Key

**WHAT IS A COMPOUND?**

Each of the compounds are common household agents. See if you can find them or ask a parent the state of matter of each element. Also, feel free to do some investigation utilizing the Internet.

| COMPOUND NAME | 1ST ELEMENT/<br>NUMBER PRESENT | 2ND ELEMENT/<br>NUMBER PRESENT | 3RD ELEMENT/<br>NUMBER PRESENT | 4TH ELEMENT/<br>NUMBER PRESENT |
|---------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| BAKING SODA   | (Na);1                         | (H); 1                         | (C); 1                         | (O); 3                         |
| LIMESTONE     | (Ca);1                         | (C); 1                         | (O); 3                         | N/A                            |
| LIME          | (Ca);1                         | (O); 1                         | N/A                            | N/A                            |

Answer the following questions:

-What is the state of matter for each compound? (Hint: They are all the same at normal room temperature)

**Solids**

-What elements are common to all three compounds?

**Carbon and oxygen**

-Consider the placement of each element in the chemical formula. What pattern do you recognize in the chemical formulas? (Hint: Consider the periodic table of elements and the location of each element)

**The element that appears first in the formula is the farthest left on the periodic table.**

-What is the difference between lime and limestone?

**One has carbon; limestone has more oxygens than lime.**

-What combination of elements do you find that is shared by at least two compounds?

**Carbonate (CO<sub>3</sub>)**

-What do you think would happen if you removed one of the elements from a compound?

**The compound would become something else because compounds are based on fixed proportions of certain elements.**

**Activity 2: Sweet and Salty**

Use the following answers to review your child's activity page:

| Answer Key: |                      |                      |                                                        |
|-------------|----------------------|----------------------|--------------------------------------------------------|
| Compound    | Taste: Condition One | Taste: Condition Two | Taste: Condition Three                                 |
| Sugar       | sweet                | sweet                | burned taste; has lost some sweetness, some dark color |
| Salt        | salty                | salty                | salty                                                  |

After applying heat, do you have the same compound as before or do you have different ones? *Salt will not change because its melting point is approximately 700 degrees Celsius and the temperature of the flame is not that high. Sugar should melt and has the potential to burn, creating a chemical reaction that changes sugar into different compounds. Sugar is not the same, but salt is.*

**NOTE:** The sugar may not break down in Condition 3 because the temperature was not hot enough. The flame on the wick would burn sugar, but that requires extra precautions to test.

**Wrapping Up****Questions to Discuss**

- What is the difference between a mixture and a compound? (A compound is a chemical combination of elements in fixed proportions. Mixtures are the result of elements or compounds that are not chemically combined but are mixed together in a various proportions that do not have to be fixed.)
- What is the difference between a compound and an element? (Compounds are combinations of elements in fixed proportions. Elements are the purest forms of matter that do not exist in combination with other elements.)
- Can compounds be changed into new compounds? (Yes, compounds can be changed as a result of stimuli that can cause a chemical reaction.)

**Things to Review**

- Compounds are substances formed by the chemical combination of elements in fixed proportions.
- Compounds can be separated into simpler substances by chemical reactions.
- Fixed proportions are unchanging quantities of elements that are part of a compound.
- Mixtures are a combination of two or more substances that are not chemically combined.