ACTIVITY 7

Chemical Equations

BROWARD COUNTY ELEMENTARY SCIENCE BENCHMARK PLAN

Grade 5—Quarter 1
Activity 7

SC.A.1.2.5
The student knows that materials made by chemically combining two or more substances may have properties that differ from the original materials.

SC.H.1.2.3
The student knows that to work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions.

SC.H.1.2.4
The student knows that to compare and contrast observations and results is an essential skill in science.

SC.H.1.2.5
The student knows that a model of something is different from the real thing, but can be used to learn something about the real thing.

ACTIVITY ASSESSMENT OPPORTUNITIES

The following suggestions are intended to help identify major concepts covered in the activity that may need extra reinforcement. The goal is to provide opportunities to assess student progress without creating the need for a separate, formal assessment session (or activity) for each of the 39 hands-on activities at your grade.

1. Ask the class, *How can you tell by looking at a physical model if it represents an atom or a compound? What about a written equation?* Tell them they must use the following words at least once in their answer: *atom, element, compound,* and *model.* (In either model, an atom represents an element and is a pure substance so it appears alone. A compound always contains more than one type of atom.)

2. Use the Activity Sheet(s) to assess student understanding of the major concepts in the activity.

In addition to the above assessment suggestions, the questions in bold and tasks that students perform throughout the activity provide opportunities to identify areas that may require additional review before proceeding further with the activity.

ACTIVITY 7

Chemical Equations

OBJECTIVES

Students are introduced to chemical equations as a means of describing chemical reactions.

The students

- discuss reactants and products—the components of a chemical reaction
- discover how chemical equations are used to describe chemical reactions
- simulate chemical reactions with their models
- use their models to help them balance chemical equations

SCHEDULE

About 45 minutes

VOCABULARY

chemical equation
chemical reaction
product
reactant

MATERIALS

For each student

1	Activity Sheet 7
1 pr	safety goggles*

For each team of four

2	balls, foam, black
2	balls, foam, blue
4	balls, foam, green
4	balls, foam, red
6	balls, foam, white
20	pipe cleaners, 5-cm
1	trough, clear, plastic

For the class

DSR *Matter and Change*

PREPARATION

1. Make a copy of Activity Sheet 7 for each student.
2. Each team will need 2 black balls, 2 blue balls, 4 green balls, 4 red balls, 6 white balls, and 20 pipe cleaners. Place all the materials for each team in a trough for easier handling.
3. Each color ball represents a different element. Write the color code for the balls on the board (see Figure 6-1).

BACKGROUND INFORMATION

Chemical reactions occur when two or more substances interact with one another to produce one or more new substances. The substances that go into a reaction are called ***reactants.*** The substances that are produced by a reaction are called ***products.*** In some reactions, substances combine; in others, substances are broken down. In all cases, the products have properties different from those of the reactants, and in all cases, matter is conserved; that is, the mass of the reactants is equal to the mass of the products.

A ***chemical equation*** is a way to describe with symbols and numbers what is happening in a chemical reaction. Because a chemical reaction begins and ends with the same number of each kind of atom involved, a chemical equation has to balance. In this activity, students model molecules of definite numbers of atoms and then combine them to demonstrate how chemical equations are balanced.

▼ **Activity Sheet 7**

Chemical Equations

1. Use your model pieces to form as many molecules of H_2 as you can. Use your model pieces to form as many molecules of N_2 as you can. Use these molecules of H_2 and N_2 to form molecules of ammonia (NH_3). You may use as many N_2 and H_2 molecules as you want, but you may not have any single atoms of either element left over. Also, you cannot use any single atoms of H or N as reactants.

   Use what you learned from experimenting with the models to balance the following chemical equation:

   1 N_2 + 3 H_2 → 2 NH_3

2. Use your model pieces to make a molecule of Cu_2O. This chemical reacts with carbon to form CO_2 and copper metal (Cu). Use your models to show this reaction. Then balance the following equation:

   2 Cu_2O + 1 C → 4 Cu + 1 CO_2

3. If you needed to get six atoms of copper out of the reaction you modeled in step 2, how many molecules of Cu_2O would you need to start with?

   3 molecules of Cu_2O

4. Complete this sentence:
   In a chemical reaction, the number of atoms of an element in the reactants must equal

   the number of atoms of that element in the products.

5. Which of the substances that you modeled today are atoms? Which are molecules?

   C and Cu are atoms.

   NH_3, CO_2, N_2, H_2, and Cu_2O are molecules.

Guiding the Activity

1 Introduce the activity by asking the students, **What are some events you have observed in which chemical reactions might be taking place?**

Typical answers might be: candles burning, antacid tablets dissolving, cars rusting, batteries at work, and so forth.

2 Write the term *chemical reaction* on the board. Ask, **How would you define a chemical reaction?**

*Students may give the correct answer, which is that a **chemical reaction** is a change that occurs when two or more substances interact with one another to produce one or more new substances with different properties. Make sure students understand that the chemical changes that occur during chemical reactions are different from the physical change that occurs when a substance changes state—for example, when a liquid turns to a solid.*

Additional Information

Guiding the Activity

Additional Information

Write the words *reactant* and *product* on the board. Ask students to think about what they observe when wood burns. Explain that the **reactants** are the chemicals that are present before a reaction (in this case, burning) occurs, and the **products** are the chemicals that are present after a reaction has taken place. The products have physical and chemical properties that are different from those of the reactants.

Ask, **What do you think are the reactants in the chemical reaction that occurs when wood burns? What are the products?**

The reactants are substances in the wood and oxygen in the air. The products include carbon dioxide and water vapor, as well as new substances in the ash or charred wood.

As appropriate, read or review pages 17–18 of the Delta Science Reader *Matter and Change*.

3

Write the term *chemical equation* on the board. Tell the students that a **chemical equation** is a written explanation, using symbols and numbers, of what occurs in a chemical reaction. In a chemical equation, the amount of product(s) has to equal the amount of reactant(s) that went into it. Write the following simple chemical equation on the board without balancing it:

$$CO + O_2 \rightarrow CO_2$$

Ask, **Which of these substances are the reactants and which are the products?**

The CO and O_2 are the reactants, and the CO_2 is the product. Reactants are always on the left-hand side of a chemical equation, and products are always on the right-hand side.

Borrowing the foam balls from one team's trough, demonstrate how to balance this equation. Assemble and hold up one molecule of CO and one molecule of O_2, and ask, **How many molecules of CO_2 can be made?**

With one molecule of CO and one molecule of O_2, only one molecule of CO_2 can be produced, with one atom of O left over. This cannot be a balanced equation because in a chemical reaction, no single atoms are left over.

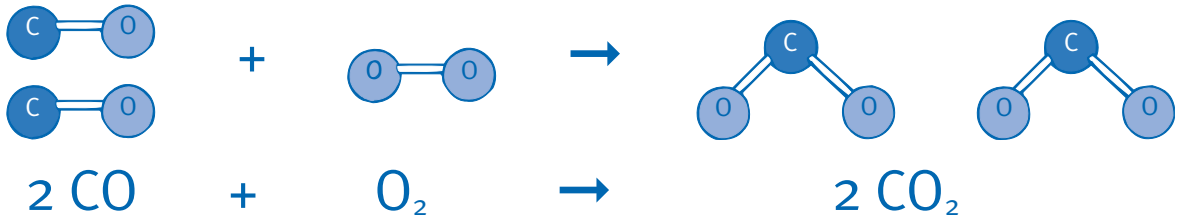
Guiding the Activity

Additional Information

Explain that in order to balance a chemical equation, it is possible to begin with different amounts of the various reactants—for example, one molecule of O2 and two molecules of CO. Ask, **How can this equation be balanced?**

The equation is balanced as follows:
$2CO + O_2 \rightarrow 2CO_2$

Assemble another CO molecule. Then physically remove the balls from the pipe cleaners and reassemble them into two CO2 molecules (Figure 7-1).



▲ ***Figure 7-1.*** *Using model pieces to balance a chemical equation.*

4 Give each student a copy of **Activity Sheet 7.** Distribute to each team a trough containing 2 black balls, 2 blue balls, 4 green balls, 4 red balls, 6 white balls, and 20 pipe cleaners. Instruct the teams to begin working on the activity sheet.

For steps 1 and 2 on the activity sheet, encourage the students to make multiple copies of each of the reactant molecules. Students may have to practice a few times before they balance the equations correctly, but reinforcement is part of the learning process and should be encouraged.

5 After all students have completed the activity sheet, review their answers as a class. Invite volunteers to demonstrate how to balance each equation. To wrap up, ask, **If you begin with ten atoms on the left-hand (or reactant) side of an equation, how many atoms do you need to end up with on the right-hand (or product) side of the equation?**

ten

Ask, **How can this be stated as a generalization about balancing equations?**

In a chemical reaction, the number of atoms of an element in the reactants must equal the number of atoms of that element in the products.

Reinforcement

To obtain iron from iron ore, iron oxide (Fe_2O_3) is heated in a blast furnace with carbon monoxide (CO) to produce iron (Fe) and carbon dioxide (CO_2). The balanced equation for this reaction is

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Have the teams pool their model pieces to make these molecules (redesignate the green balls as iron) and balance this equation.

Science Notebooks

Have students place their completed activity sheets in their science notebooks.

Cleanup

Have the students take their models apart and return the materials to the kit.

Science at Home

Have the students look up a recipe for something tasty that someone in their family makes. Tell them to think about this question: How is a recipe like a balanced equation?

Connections

Science Challenge

Introduce the concepts of endothermic and exothermic reactions. Explain that some chemical reactions release energy as they occur, whereas other reactions require energy in order to occur. Reactions that release energy are called *exothermic;* the prefix *exo-* means "outside" and *therm* means "heat." Reactions that require or absorb energy are called *endothermic;* the prefix *endo-* means "inside." Write equations on the board that represent each type of reaction, and tell students what the equations mean. Two examples are given below. Ask students to use high school chemistry textbooks or other sources to find and "translate" additional examples of equations representing endothermic and exothermic reactions.

Endothermic. When limestone (calcium carbonate) is heated, it breaks down and yields calcium oxide and carbon dioxide.

$$CaCO_3 + \text{Energy} \rightarrow CaO + CO_2$$

Exothermic. When gasoline is burned in an engine, each molecule of gasoline combines with 11 molecules of oxygen and yields 8 molecules of water and 7 molecules of carbon dioxide plus energy.

$$C_7H_{16} + 11O_2 \rightarrow 8H_2O + 7CO_2 + \text{Energy}$$

Science Extension

To help students understand that chemical equations represent actual reactions that they can observe, guide them through the following hands-on activity: Have each student or team put 2 or 3 spoonfuls of baking soda in a clear container. Tell students that the chemical name for baking soda is sodium monohydrogen carbonate, and write its formula on the board: $NaHCO_3$. Point out (or ask a student volunteer to point out) each element in the chemical formula.

Then give each student or team a small paper cup containing 2 or 3 spoonfuls of vinegar. Tell students that vinegar is a solution of acetic acid and water, and write its formula, $HC_2H_3O_2$, on the board to the right of the first formula. Add a plus sign between the two formulas, and tell students to add the vinegar to the baking soda. Students most likely will have done this experiment in their earlier science studies and will know what to expect—the bubbling of the mixture as gas forms and is released. Draw an arrow after the second formula on the board, then write the formulas for the products to complete the equation:

$$CO_2 + NaC_2H_3O_2 + H_2O$$

Name (or have students name) each product—carbon dioxide, sodium acetate, and water. Explain that carbon dioxide was the gas in the bubbles and that sodium acetate is in solution in the water. Show students that each molecule in the reactants on the left-hand side of the equation is included in the products on the right-hand side; nothing is "lost" in the reaction.

Science and Math

On the board or an overhead transparency, write equations with a missing part in each, and have students balance the equations. Several examples are given below. Ask students to create additional unbalanced equations for the rest of the class to balance, or provide the equations yourself. If necessary, use a high school chemistry textbook as a source.

$$2H_2 + O_2 \rightarrow ?H_2O$$
$$[? = 2]$$

$$3Fe + ?H_2O \rightarrow Fe_3O_4 + 4H_2$$
$$[? = 4]$$