

Balancing Chemical Equations

Why?

Atoms are neither created nor destroyed in a chemical reaction, they are just rearranged. In other words, in a chemical reaction, what goes into the reaction must come out of the reaction. Using this knowledge and some bookkeeping skills, all unbalanced chemical equations can be balanced.

Learning Objective

- Learn the steps to balancing a chemical equation.

Success Criteria

- Demonstrate the ability to balance a chemical reaction.

Prerequisites

- Writing chemical formulas, chemical reaction nomenclature

New Concepts

- Coefficient
- Balanced reaction

Definitions

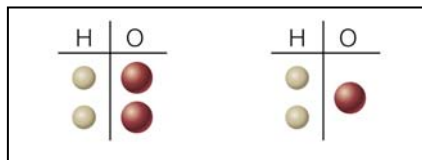
- In your own words, write definitions of the terms in the *New Concepts* section.

Model 1

The following figures show the combination of hydrogen and oxygen to produce water.

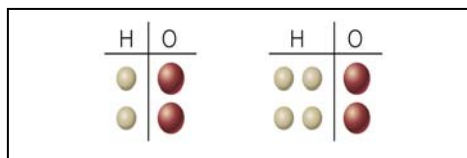
Illustrations from: http://wps.prenhall.com/wps/media/objects/439/449969/Media_Portfolio/ch10.html

Figure 1



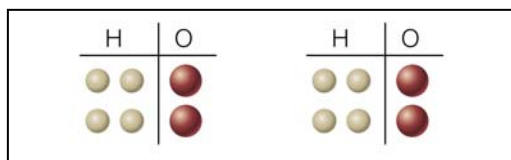
1 molecule of hydrogen + 1 molecule of oxygen \rightarrow 1 molecule of water

Figure 2



2 molecules of reactants \rightarrow 2 molecules of product

Figure 3



4 H atoms in reactants \rightarrow 4 H atoms in products

2 O atoms in reactants \rightarrow 2 O atoms in products

Key Questions

1. In Figure 1 there is one molecule of H₂ and one molecule of O₂ on the left side of the equation and one molecule of H₂O on the right. Even though there is 1 of everything, why is this reaction not balanced?
2. In Figure 2 there are two molecules on the left and two molecules on the right. Even though there are 2 on the left and 2 on the right, why is this reaction not balanced?
3. In Figure 3, how many reactant molecules and product molecules are shown in the model?

4. Does Figure 3 represent a balanced equation? Explain your answer.
5. What condition must be met in order for there to be a balance between reactants and products?

Exercises:

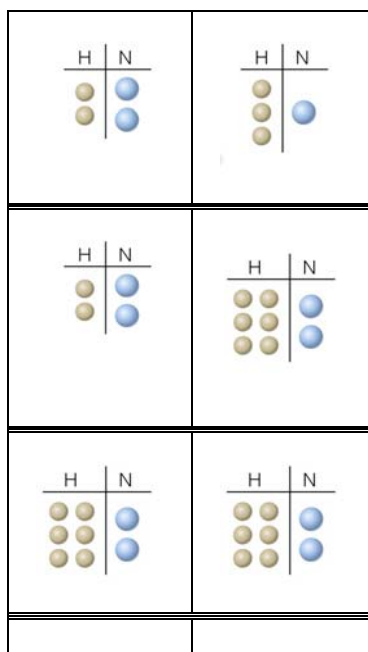
1. Write the balanced equation to show the reaction between hydrogen gas and oxygen gas to form water. (Hint: look at the model for guidance.)
2. Identify whether the following is a balanced chemical equation. Explain why or why not. If not, write the balanced equation.
$$\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{O}_2$$
3. If mercury (Hg) and oxygen (O₂) were reacted to form mercury (II) oxide (HgO), how many molecules of each reactant and product would be needed to balance the equation?

Information:

Figure 4 below illustrates the Haber process, a method (reaction) used to produce ammonia that was developed during World War I. When the Allies blocked off all trade routes going to and from Germany, the Germans lost access to their source of sodium nitrate and potassium nitrate which were needed to make explosives. In response to the need for a source of nitrates, chemist Fritz Haber developed what is now known as the Haber Process, which combines molecular nitrogen from the air with molecular hydrogen to form ammonia gas. (Note: air is 78% nitrogen, so this synthesis is very clever because air is free and abundant.). Using the Haber Process the Germans had an uninterrupted source of nitrogen in a form that could be used to make the nitrates needed for explosives. (<http://haberchemistry.tripod.com/>)

Model 2

Figure 4 shows the reaction between hydrogen and nitrogen to produce ammonia.

**Fig. 4****Key Questions**

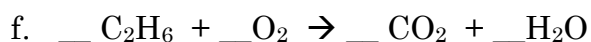
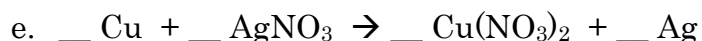
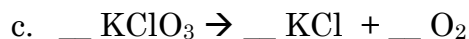
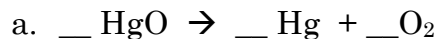
1. Describe what is depicted in the first diagram shown at the top of Figure 4.

2. Does the first diagram at the top of Figure 4 represent a balanced chemical equation? Why or why not? Explain your reasoning in terms the type and number of each atom present.
3. Describe what is depicted in the second diagram shown in the middle of Figure 4.
4. Does the second diagram in the middle of Figure 4 represent a balanced chemical equation? Why or why not? Explain your reasoning in terms the number and type of each atom present.
5. Describe what is depicted in the third diagram shown at the bottom of Figure 4.
6. Does the third diagram at the bottom of Figure 4 represent a balanced chemical equation? Why or why not? Explain your reasoning in terms the number and type of each atom present.

Exercises:

1. Write a balance reaction equation for hydrogen reacting with nitrogen to produce ammonia.

2. Using the smallest whole number coefficients, balance the following reactions. Draw diagrams like those in Figure 4 for Equations a, b, and f.



Problems

Write the formulas for the components in each reaction and, using the smallest whole number coefficients, balance each equation.

1. Zinc metal reacts with hydrochloric acid to produce hydrogen gas and aqueous zinc chloride.
2. Solid carbon reacts with oxygen gas to produce carbon dioxide gas.
3. Solid sodium chloride is broken down into its elements.