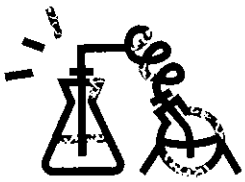
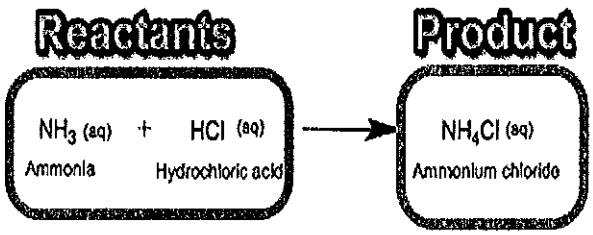
8.P.1.4

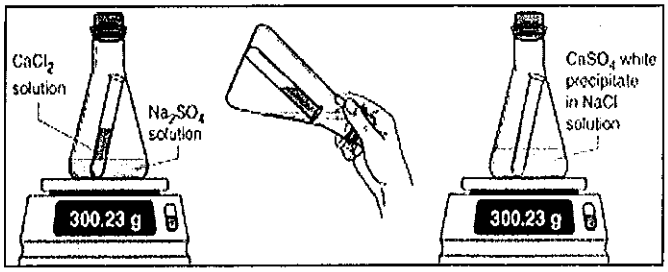
Describing Chemical Equations and the Law of Conservation of Mass and Matter



A chemical **equation** is a short, easy way to show a chemical reaction. Chemical equations use chemical formulas and other symbols instead of words to summarize a reaction. A chemical equation tells you the substances you start with in a reaction called **reactants** and the substances you get at the end are called **products**. The formulas for the reactants are written on the left side of the equation, followed by an arrow (→). You read the arrow as "yields."- or "this is what you get". The formulas for the products are written on the right side of the equation. When there are two or more reactants or products, they are separated by plus+ signs. C + O→ CO

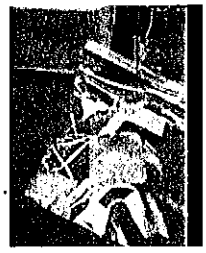


A chemical equation ***must show the same number of each type of atom on both sides of the equation.*** This is because of a very important **law** in science. It is known as the **law of conservation of mass.** This principle was first demonstrated in the late 1700s by Antoine Lavoisier. The *principle of conservation of mass* states that in a chemical reaction, *the total mass of the reactants must equal the total mass of the products*. This means if a scientist began an experiment with 300.23 grams of matter, the end results must be, 300.23 grams, the same amount of mass even though it will be a new substance or substances. For this to happen, the reaction has to be done in a closed system. A **closed system** is a system in which matter cannot enter from or escape to the surroundings.

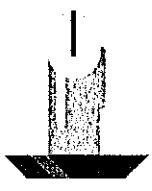


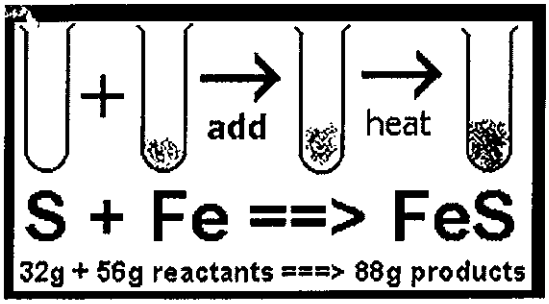
.avoisier and his wife worked ogether to prove matter annot be created or lestroyed.

It allows you to measure the mass of all reactants and products in a reaction. A sealed plastic bag is an example of a closed system. All the reactants are placed in the bag. It is sealed, and the reaction can take place. Nothing enters or escapes. The mass (weight) at the beginning must = the mass at the end of the reaction. But this is not the case if it is in an open system. In an **open system**, matter can enter from or escape to the surroundings. A burning candle is an example of an open system, where some of the products go up in smoke. You cannot measure the mass of all the reactants and products in an open system.



How is a plastic bag a closed system?





A similar law states that **matter can neither be created nor destroyed**, which is why whatever **type** elements are on one side of an equation must also be on the other side. No new matter is created. For example, if sulfur and iron (Fe) are on the reactant side, then sulfur and iron must be on the products side; however, they will be **rearranged** as **NEW SUBSTANCES with TOTALLY DIFFERENT PROPERTIES FROM THE ELEMENTS THAT FORMED THEM**. We refer to this as **the law of conservation of matter**.

We illustrate the law of conservation of mass and matter in a balanced chemical equation. A chemical equation is **balanced** when it ***accurately*** represents conservation of mass and matter by showing the same amount of mass (number of atoms) and the same type of matter (elements).

Here is an example: **$H_2O + CO_2 \rightarrow H_2CO_3$**

Count- How many H, O, C, are on right side? H_____, O_____ C_____

How many H, O, C, are on the left side? H_____ O_____C_____

The same amount of mass (number) and same type of matter (elements), right? It's all because of the laws of conservation of mass and matter. BUT remember- the end product is ***way different*** from the reactants.

H_2O *Water* + CO_2 *Carbon dioxide* → H_2CO_3 *Carbonic acid*

Sometimes chemical equations have to be balanced. T do this, scientist use coefficients. A **coefficient** is a number placed in **front** of a chemical formula. It tells you **how many atoms or molecules** of a reactant or a product take part in the reaction. In the example below, note **2** O_2 means you have 4 oxygens. To get that number you have to multiply the 2 coefficient times x the 2 subscript to get 4 O. On the right side, 2 H_2O- you have to multiply the coefficient 2 x 2 subscript after the H and then 2 x 1 (the understood subscript) to get 4 H and 2 O. The subscript only applies to the element it is next to. So CO_2 on the right side has 1 C and 2 O. Add all the oxygen atoms together and you have 4 on the right which matches the amount on the left side.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

C=1		**C=1**
H=4	**=**	**H=4**
O=4		**O=4**

The amount of mass is the same on both sides.
The types of matter are the same on both sides.

Name_____

Describing Chemical Equations and the Law of Conservation of Mass and Matter

1. What is a chemical equation?

_____

2. True or False? Chemical equations use symbols instead of words to summarize chemical reactions.

3. The substances you have at the beginning of a chemical reaction are called the _____.

4. The substances you have when a chemical reaction is complete are called the _____.

5. What do you read the arrow in a chemical equation as meaning? _____

6. Label each formula in the chemical equation as either a reactant or a product. $Fe + S \rightarrow FeS$

   a. Fe – b. S -

   c. FeS -

7. True or False? All the atoms present at the start of a reaction are present at the end.

8. At the end of a chemical reaction, what is the total mass of the reactants compared to the total mass of the products?

_____

9. What does the law of conservation of mass state? _____

_____

10. What happens in an open system? _____

_____

11. What is an example of a closed system? _____

12. What does the law of conservation of matter state? _____

_____

13. Who first stated this law? _____

14. When is a chemical equation balanced? _____

_____

15. How many atoms of oxygen are there on each side of the following chemical equation?

   $2\ Mg + 0_2 \rightarrow 2\ MgO$? _____

16. Circle the letter of each chemical equation that is balanced.

   a. $H_2 + 0_2 \rightarrow H20$ b. $Mg + 0_2 \rightarrow MgO$

   c. $Na + O_2 \rightarrow Na2$ d. $2\ H_20_2 \rightarrow 2\ H_20 + 0_2$

17. A number placed in front of a chemical formula in a chemical equation is called a(n) _____.

18. What does a coefficient tell you? _____

_____

19. Tell why this chemical equation is not balanced: $H_2 + 0_2 \rightarrow H_20$.

_____

Rewrite it so it is balanced. _____