Chapter Fourteen: Changes in Matter

- 14.1 Chemical Reactions
- 14.2 Types of Reactions
- 14.3 Energy and Chemical Reactions
- 14.4 Nuclear Reactions

Chapter 14.1 Learning Goals

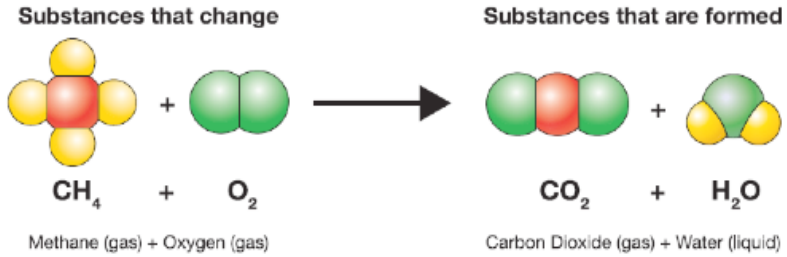
- Identify evidence that a chemical change has occurred.
- Relate a balanced chemical equation to the law of conservation of mass.
- Write and balance chemical equations.

14.1 Chemical Reactions

- A chemical reaction is the process of breaking of chemical bonds in one or more substances, and the reforming of new bonds to create new substances.
- When you make pizza, which changes are physical and which are chemical changes?

14.1 Chemical Reactions

- The process of making pizza involves some physical changes (like chopping vegetables).
- The processes used by yeast in the dough or by the gas stove to bake the pizza are chemical changes.



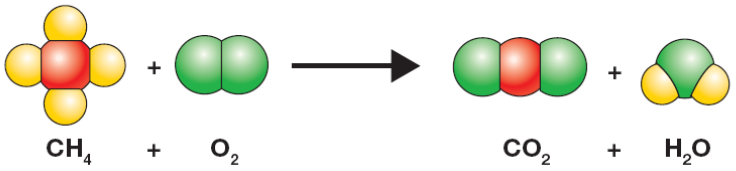
14.1 Evidence of chemical change

Four indicators of chemical change are:

1. **Formation of new gas**
2. **Formation of new solid**
3. **Release of energy (heat or light)**
4. **Color change**

Chemical Reactions

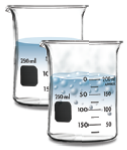
Substances that change → **Substances that are formed**



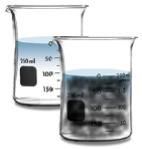
CH_4 + O_2 → CO_2 + H_2O

Methane (gas) + Oxygen (gas) → Carbon Dioxide (gas) + Water (gas)

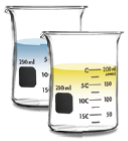
Bubbling
A new gas is forming



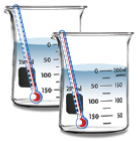
Turns cloudy
A new solid is forming



Color change
A new substance is forming



Temperature change
Energy is released or absorbed

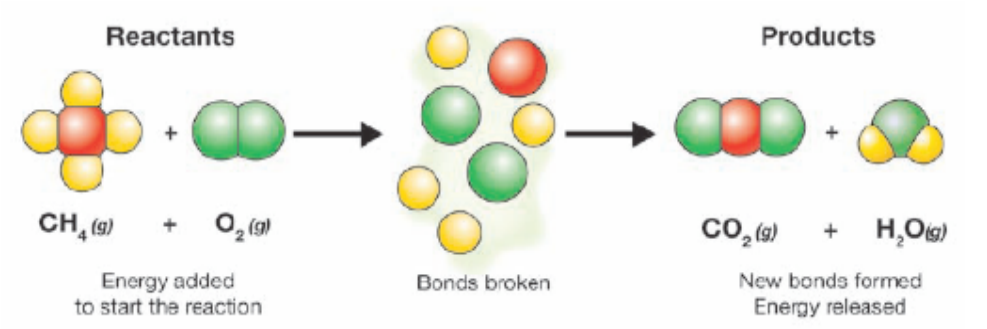


14.1 Reactants and products

- In chemical reactions, you start with reactants that are combined to make products.
  - The reactants are the starting substances.
  - The products are the new substances which result from the chemical reaction.

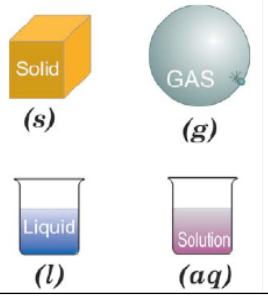
14.1 Reactants and products

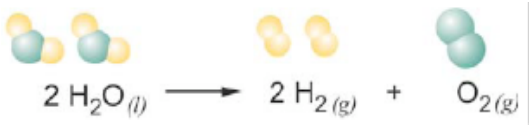
- In the reaction, methane (a natural gas) is burned or combusted.
- Some energy is added to get the reaction started.



14.1 Reaction symbols

symbol	meaning
(s)	substance is a solid
(l)	substance is a liquid
(g)	substance is a gas
(aq)	substance is dissolved in solution (aqueous)





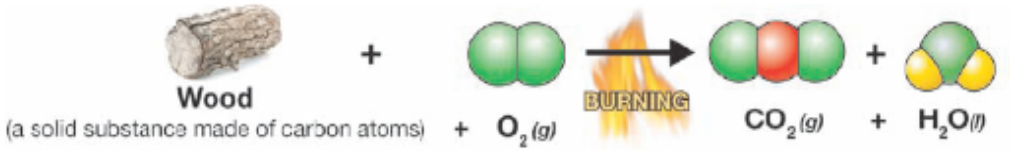
- **The small symbols in the parentheses (s, l, g, aq) next to each chemical formula indicate the phase of each substance in the reaction.**

14.1 Law of conservation of mass

- Antoine Laurent Lavoisier, established an important principal based on his experiments with chemical reactions.
- He stat tion is equal t
- The law burnin

14.1 Law of conservation of mass

- The combined mass of the burning wood and oxygen is converted into carbon dioxide and water.



14.1 Conservation of mass

- Lavoisier showed that a closed system must be used when studying chemical reactions.
- When chemicals are reacted in a closed container, you can show that the mass before and after the reaction is the same.

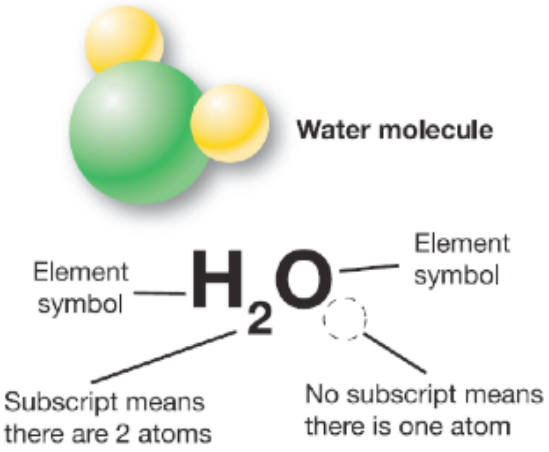
14.1 How are reactions written?

- When a chemical reaction is written using chemical formulas and symbols, it is called a chemical equation.

$$CH_4(g) + O_2(g) \longrightarrow CO_2(g) + H_2O(g)$$

Methane gas reacts with oxygen gas to produce carbon dioxide gas and water vapor.

14.1 Numbers in equations



14.1 Chemical equations

- An arrow is always included between reactants and products.
- It means "to produce" or "to yield."

"Methane combines with oxygen gas to produce carbon dioxide gas and water vapor."

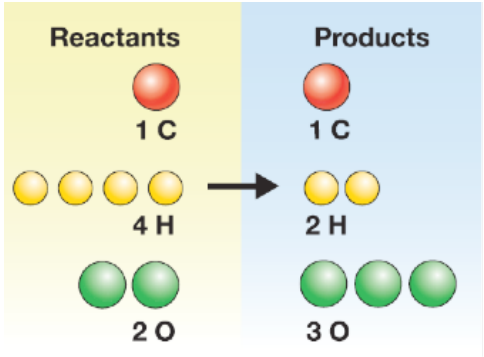
14.1 Balancing equations

- The law conservation of mass is applied by balancing the number and type of atoms on either side of the equation.

Type of Atom in Methane Reaction	Total on Reactant Side	Total on Product Side	Balanced?
C	1	1	yes
H	4	2(× 2) = **4**	yes
O	2(× 2) = **4**	2 + 1(× 2) = **4**	yes

14.1 Balancing equations

- Counting atoms is necessary to balance an equation.



How many carbon atoms?

How many hydrogen atoms?

How many oxygen atoms?

14.1 Balancing chemical equations

- A balanced chemical equation has the same number of each type of atom on the product side and the reactant side.
- To balance the equation, we add another water molecule to the product side and add another oxygen molecule to the reactant side.
- We can practice balancing equations using CPO periodic table tiles and pencil and paper.

Solving Problems

In this reaction, chalcocite (a mineral) reacts with oxygen in the presence of heat. The products are a type of copper oxide and sulfur dioxide. Balance this equation:

$$Cu_2S + O_2 \rightarrow Cu_2O + SO_2$$

Solving Problems

1. **Looking for:**
   - …the coefficients for each molecule
2. **Given**
   - … chemical formulas which show types and no. of atoms

Type of Atom	Reactants	Products	Balanced?
Cu	2	2	yes
S	1	1	yes
O	2	3	no

Solving Problems

3. Relationships

- Coefficients can be added in front of any chemical formula in a chemical equation.
- When a coefficient is added in front of a chemical formula, all atoms in that formula are multiplied by that number.
- Use common denominators to help choose coefficients to try.

Solving Problems

4. Solution- Trial and error

$$2Cu_2S + \mathbf{3}O_2 \rightarrow 2Cu_2O + \mathbf{2}SO_2$$

Atom	Reactants	Products
Cu	2(× 2) = **4**	2(× 2) = **4**
S	1(× 2) = **2**	1(× 2) = **2**
O	2(× 3) = **6**	1(× 2) + 2(× 2) = **6**