

BC Science CONNECTIONS 10

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Unit 2: Chemical processes require energy change as
atoms are rearranged.

Topic 2.2: What happens to atoms in a chemical reaction?

- Atoms bond together to form ionic and covalent compounds.
- Bonds are broken, atoms are rearranged, and new bonds are formed.
- Mass cannot be created or destroyed in a chemical reaction.
- A chemical equation represents what happens to the atoms in a reaction.



Concept 1: Atoms bond together to form ionic and covalent compounds.

- A pure substance can be an element or a compound.
- A compound is made up of atoms of two or more different elements.

Ionic Compounds

- **Ionic compound:** a compound made of oppositely charged ions
- **Ionic bond:** a strong attraction that forms between oppositely charged ions
- Atoms lose or gain electrons to form ions that have full valence shells and are therefore more stable.

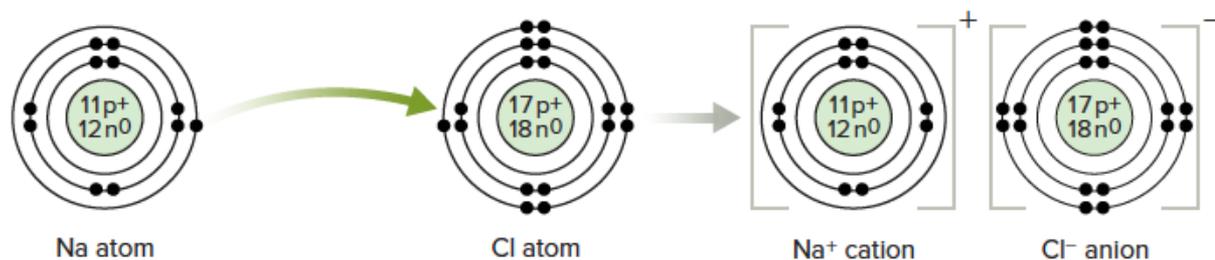


Figure 2.4: In binary ionic compounds such as sodium chloride, the transfer of electrons from metal atoms to non-metal atoms produces ions that are strongly attracted to each other.

Covalent Compounds

- **Covalent compound:** a compound that results when atoms of two or more non-metal elements bond covalently
- **Covalent bond:** a strong attraction between atoms that forms when atoms share valence electrons

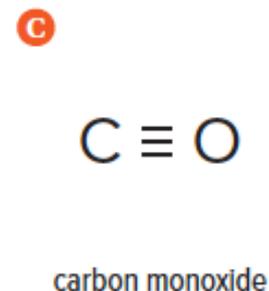
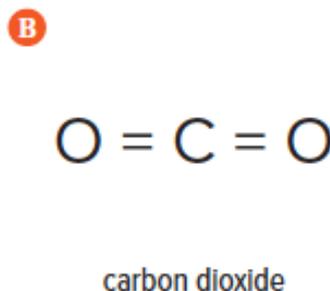
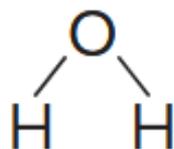
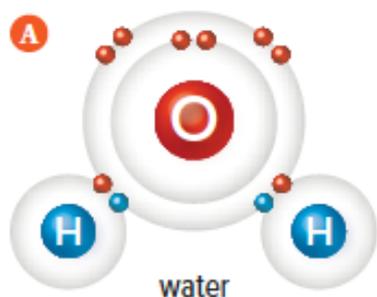


Figure 2.5: (A) In water, oxygen forms a covalent bond with each hydrogen atom. Single bonds may be represented with a single line. (B) Double bonds are shown using two parallel lines. (C) Triple bonds are shown using three parallel lines.

Covalent Compounds (cont'd)

- **Molecule:** a particle made up of two or more atoms bonded by covalent bonds
- Most compounds are molecules.

Discussion Questions

1. What type of bond is formed between two non-metal atoms? Describe how it forms.
2. Describe how a binary compound composed of sodium and bromine forms.

Concept 2: Bonds are broken, atoms are rearranged, and new bonds are formed.

- Elements combine to form compounds.
- Compounds break apart to form elements.
- Elements combine with compounds to form new compounds.

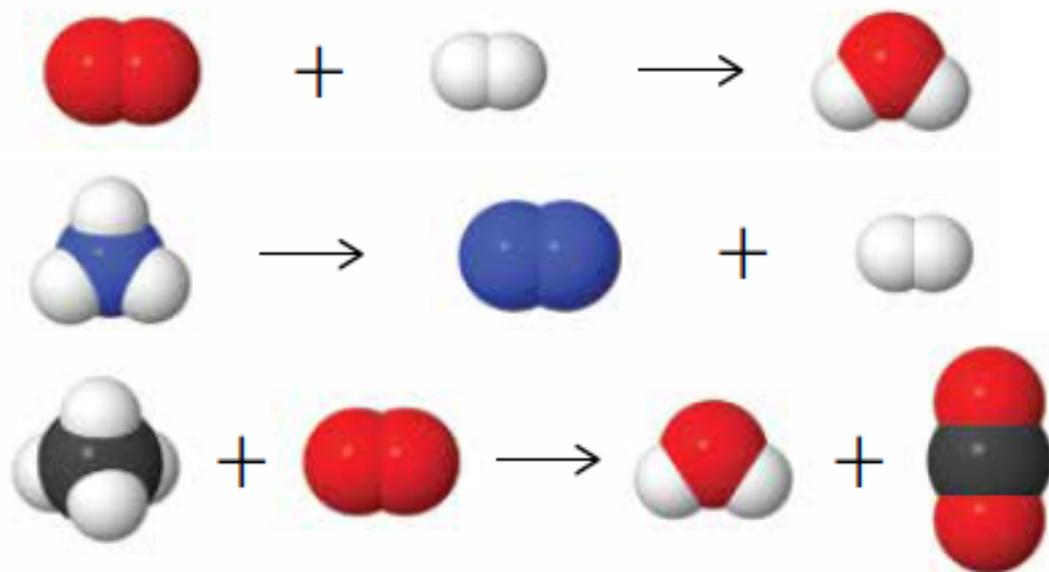


Figure 2.6: Examples of ways that elements and compounds can form new substances in chemical reactions.

Chemical Bonds and Energy

- Energy is required to break chemical bonds.

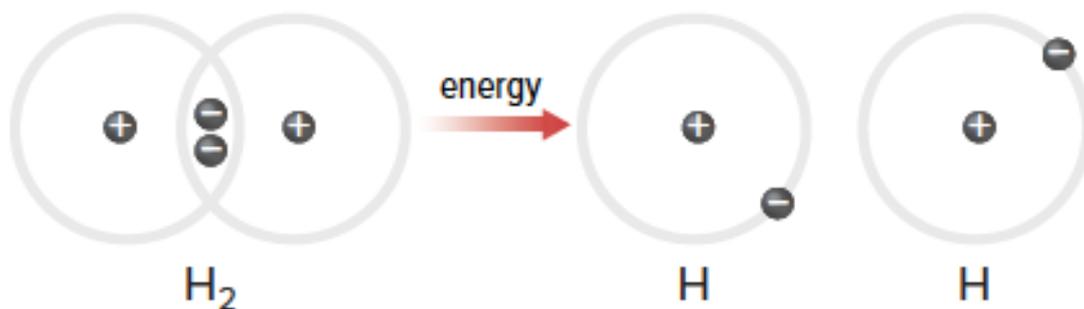


Figure 2.7: Energy must be added to break a chemical bond.

- Energy is released when chemical bonds form.



Figure 2.8: When a bond forms, energy is released.

Discussion Questions

1. Is it possible for a chemical reaction to occur without new chemical bonds forming?
Explain.
2. Describe how energy is involved in making and breaking chemical bonds.

Concept 3: Mass cannot be created or destroyed in a chemical reaction.

- Experiments are conducted in a *closed system* or an *open system*.

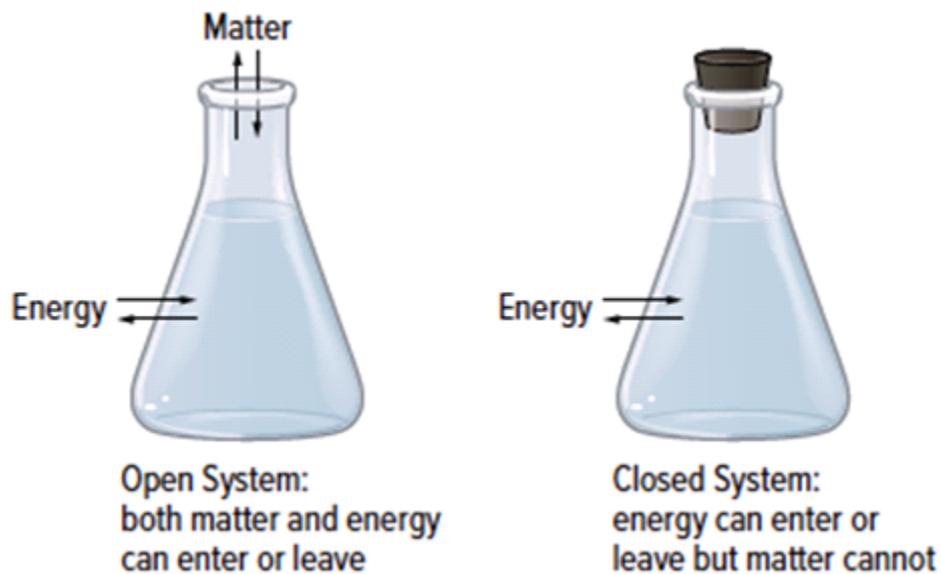


Figure 2.10: Reactions can occur in open or closed systems.

Showing the Conservation of Mass

- **Law of conservation of mass:** in a chemical reaction, the total mass of the substances used is equal to the total mass of the substances produced

Discussion Questions

1. What is the law of conservation of mass?
2. What is the difference between an open and closed system?
3. What would you expect Lavoisier's results to be if he had used an open system? Explain your answer.

Concept 4: A chemical equation represents what happens to the atoms in a reaction.

- **Chemical equation:** the representation of a chemical reaction using words or chemical formulas
- **Reactant:** a substance that undergoes a chemical change
- **Product:** a substance formed in a chemical change

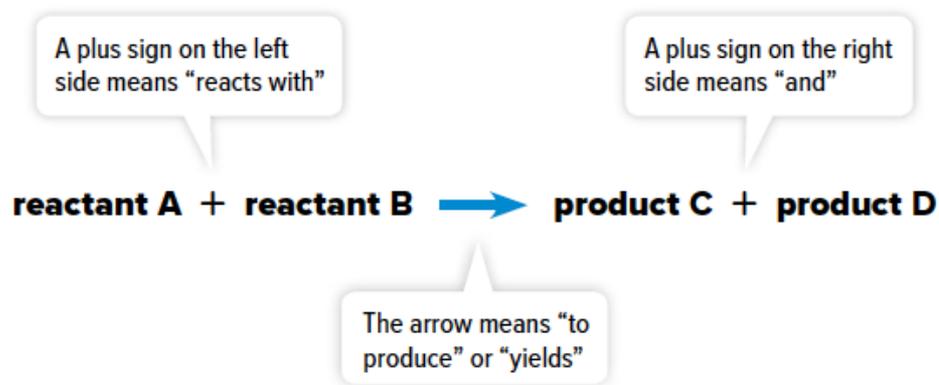


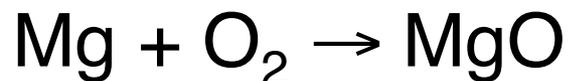
Figure 2.12: Reactants undergo chemical change to form products.

Using Chemical Equations

- A *word equation* shows the names of the chemical elements and compounds in a chemical reaction.

magnesium + oxygen \rightarrow magnesium oxide

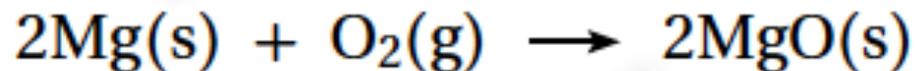
- A *skeleton equation* shows the chemical formulas in a chemical reaction.



Using Chemical Equations (cont'd)

- A *balanced chemical equation* shows the reactants and products in the chemical equation with *coefficients*.

A substance can be a gas (g), liquid (ℓ), or solid (s). Substances that are dissolved in water are aqueous solutions (aq).



The number placed in front of a chemical formula is called a coefficient. The coefficient applies to the whole formula that it is placed in front of. Coefficients not shown are assumed to be 1.

Diatomic and Polyatomic Elements in Chemical Equations

- Diatomic elements are two of the same elements joined by a covalent compound.
e.g., H_2 , N_2 , O_2 , F_2 , Cl_2 , Br_2 , I_2
- Polyatomic elements are many atoms of the same element joined by a covalent compound.
e.g., S_8 , P_4

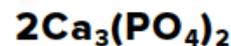
Figure 2.14: Except for hydrogen, diatomic elements are positioned in the periodic table in the shape of a “7.”

| | | | | |
|-----------------------|-----------------------|-----------------------|----------------------|-------------------------|
| | 1 H Hydrogen | | | 18 2 He Helium |
| 6 C Carbon | 7 N Nitrogen | 8 O Oxygen | 9 F Fluorine | 10 Ne Neon |
| 14 Si Silicon | 15 P Phosphorus | 16 S Sulfur | 17 Cl Chlorine | 18 Ar Argon |
| 32 Ge Germanium | 33 As Arsenic | 34 Se Selenium | 35 Br Bromine | 36 Kr Krypton |
| 50 Sn Tin | 51 Sb Antimony | 52 Te Tellurium | 53 I Iodine | 54 Xe Xenon |
| 82 Pb Lead | 83 Bi Bismuth | 84 Po Polonium | 85 At Astatine | 86 Rn Radon |

Coefficients versus Subscripts

- *Subscripts* in a chemical formula indicate how many atoms of each element are present in the chemical formula.
- *Coefficients* in front of a chemical formula indicate how many molecules are present.

A coefficient is written in front of a formula and multiplies the number of atoms of each element in the formula.



A subscript after an element in a formula indicates the number of atoms in a single molecule or formula unit.

A subscript outside a bracket multiplies all the elements inside the bracket.

Figure 2.15: Coefficients indicate the number of molecules or formula units.

Balancing Chemical Equations

- To balance a chemical equation, the number of atoms on the reactant side must equal the number of atoms on the product side.
- The law of conservation of mass is reflected in a balanced chemical equation.
- Use coefficients in front of the chemical formula.

Topic 2.2 Summary: What happens to atoms in a chemical reaction?

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