Chapter 7: Chemical Equations and Reactions

Chapter 7 learning targets
1. I can identify physical indicators of a chemical reaction.
2. I can explain the law of conservation of mass in terms of a chemical equation.
3. I can write and balance a chemical equation.
4. I can identify the 4 types of chemical reactions (synthesis, decomposition, single-displacement, double displacement) and predict the products when given the reactants.
5. I can calculate formula mass

I. Chemical reactions
A. Chemical reactions are described by chemical _______ equations _______.
   Example: \( H_2 + O_2 \rightarrow H_2O \)

B. Evidence of a chemical reaction.
   1. Color change
   2. Temperature change
   3. New odor
   4. Production of a gas
      Evidence is _______ bubbles _______ appearing when two substances mix
   5. Formation of a precipitate
      A solid produced as a result of a chemical reaction of two liquids

II. Chemical equations must satisfy the law of conservation of mass.
A. The equation must contain the correct ___________ Formulas _______ for the reactants and products.
B. The law of conservation of mass must be satisfied.
   In any chemical reaction, matter cannot be ________created______ or _______destroyed______ but it can change form.
   The same number of _______atoms______ of each _______element______ must appear on each side of a chemical equation.

III. Formula Mass
A. The mass of a _______chemical compound.
B. It is calculated using the number of atoms and the _______atomic mass______
C. Example: Find the formula mass of the following:
   \[ \text{CH}_4 \quad 1 \times 1 = 1 \]
   \[ \text{H}_2\text{SO}_4 \quad 1 \times 32 = 32 \]
   16 \quad 98
IV. Percent Composition

A. The percent by mass of each element in a compound.

B. Start by finding the formula mass.

C. Use the formula:

\[
\frac{\text{Mass of "element"}}{\text{Total mass of compound}} \times 100
\]

D. Example:

Find the percent of carbon (C) in CO₂.

\[
\frac{12}{44} \times 100
\]

Find the percent composition for each element in H₂O

\[
\frac{2}{18} \quad \frac{16}{18}
\]

V. Writing chemical equations.

A. General format of an equation

1. Reactants are on the left side and products are on the right side.

2. Example: Hydrogen reacts with oxygen to produce water.

\[
\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}
\]

3. 2Li + CaBr₂ → 2LiBr + Ca

List the reactants:

List the products
VI. Balancing a chemical equation

A. Balancing an equation is done by inserting **coefficients**
   A coefficient multiplies the number of **atoms** of each **element**
   in a chemical formula.
   Example: $3\text{H}_2\text{O}$ would have **6** H atoms and **3** O atoms.

B. **Symbols** are used.
   \[(s) = \text{solid} \quad (l) = \text{liquid} \quad (g) \quad \text{or} \quad (aq) = \text{aqueous} \quad \text{or} \quad \text{dissolved in water}\]

\[\Delta = \text{heat} \quad \rightarrow = \text{to produce} \quad + = \text{reacts with}\]

C. **Examples:**

1. Balance the following equations:

   $$3\text{Fe}(s) + 4\text{H}_2\text{O}(g) \xrightarrow{\Delta} 1\text{Fe}_3\text{O}_4(s) + 4\text{H}_2(g)$$

   $$1\text{BaF}_2 + 1\text{Na}_2\text{O} \rightarrow 1\text{BaO} + 2\text{NaF}$$

D. **Diatomic molecules**

   The following elements exist as diatomic molecules when they are alone (not combined with another element.) They have a **subscript** of **2**. Examples: Cl$_2$, H$_2$, Br$_2$

   **H, N, O, F, Cl, Br, I**

   Highlight these on your periodic table for reference

E. **Guidelines for balancing an equation.**

1. Balance the different types of atoms one at a time (use **coefficients**
   The number of **atoms** of any element on the left must be the same as the right.

2. Balance the **H** and **O** atoms last

3. Count the atoms to be sure it is **balanced**.
VII. Types of Chemical Reactions

A. Synthesis (composition, combination)
   1. 2 or more reactants \text{combine} to form a new \text{product}
   2. Example: \(2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}\)

B. Decomposition
   1. One reactant \text{breaks} into 2 or more products (opposite of combination)
   2. Example: \(2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2\)

C. Single displacement
   1. One substance \text{replaces} another in a compound.
   2. The reactants are one \text{element} and one \text{compound}
   3. Example: \(2\text{KBr} + \text{Cl}_2 \rightarrow 2\text{KCl} + \text{Br}_2\)

D. Double displacement
   1. The \text{positive} and \text{negative} parts of two compounds change places.
   2. Example: \(\text{BeBr}_2 + 2\text{NaOH} \rightarrow \text{Be(OH)}_2 + 2\text{NaBr}\)

E. Combustion reactions
   1. An element or compound reacts with \text{oxygen} releasing energy as heat or light.
   2. The combustion of hydrocarbons produces \text{water} and \text{CO}_2
   3. Examples:
      \(2\text{CH}_3\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 4\text{H}_2\text{O}\)
      \(2\text{C}_6\text{H}_6 + 15\text{O}_2 \rightarrow 12\text{CO}_2 + 6\text{H}_2\text{O}\)

VIII. Energy Changes in reactions

A. During a chemical reaction, energy is either \text{absorbed} or \text{released}
B. Reactions that release (give off) heat are \text{exothermic}
C. Reactions that absorb heat are \text{endothermic}
IX. Reaction Rates
A. Some reactions are fast and some are slow (iron rusting)
B. Factors that affect reaction rates

1. Temperature
Increasing temperature will usually increase the reaction rate.

Increasing temperature causes the particles to move faster which increases the number of collisions and therefore the rate.

2. Surface Area
Which has more surface area, a log or chopped up kindling wood? Kindling

Chopping or breaking a substance into smaller pieces increases the surface area.

Increasing surface increases the exposure of reactants to each other which increases the number of collisions.

Increasing the surface area increases the reaction rate.

3. Stirring (shaking, agitating)

Stirring increases the exposure of reactants to each other.

Stirring increases the reaction rate.

4. Concentration

Concentration refers to the number of particles in the solution.

Increasing the concentration increases the reaction rate.

5. Catalysts

Adding a catalyst increases the rate of the reaction.