Lecture 5
Chemical reaction

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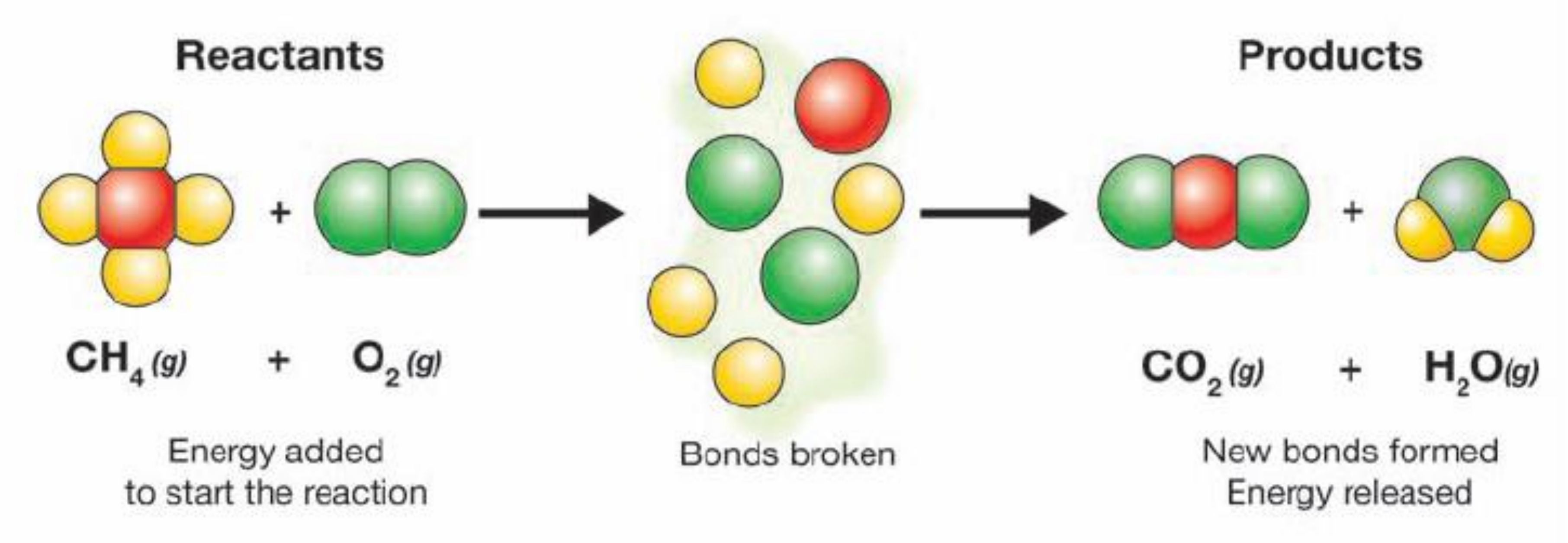
Chemical Reactions

- 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.
- The reactants are the starting substances.
- The products are the new substances



Reaction symbols

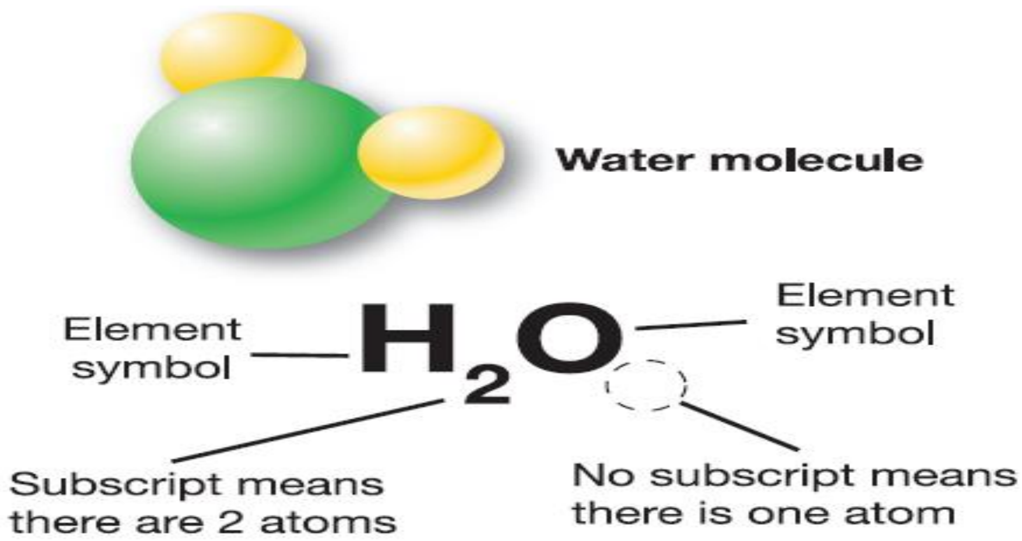
symbol	meaning
(s)	substance is a solid
(l)	substance is a liquid
(g)	substance is a gas
(aq)	substance is dissolved in solution (aqueous)

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

chemical equation

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

Numbers in equations



Balancing equations

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

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

Factors affecting the rate of chemical reactions

Factors that affects the rate of the chemical reactions are:

1. The nature of the reactants
2. The Temperature
3. The presence of a catalyst
4. The surface area
5. Change in concentration

The equilibrium constant (K)

Consider the following general balanced equation:

$$a\,A + b\,B \rightleftharpoons c\,C + d\,D$$

$$K = \frac{[C]^c \times [D]^d}{[A]^a \times [B]^b}$$

The equilibrium constant K is the ratio of the product of the concentration of the substances formed at equilibrium to the product of the concentrations of the reacting substances, each concentration being raised to the power that is the coefficient of that substance in the chemical equation.

Factors that disturb equilibrium

- Le Chatalier’s principle states:

If a system at equilibrium is subjected to a stress, the equilibrium is shifted in the direction that relieves the stress.

Equilibrium Constant of Weak Acids (Ka)

$$Ka = \frac{[A^-][H_3O^+]}{[HA]}$$

$$Ka = c\ \alpha^2$$

$$[H_3O^+] = \sqrt{Ka\ .\ c}$$

Ka= acid-ionization constant

c =initial concentration

α= ionization percentage

Equilibrium Constant of Weak bases (Kb)

$$\mathbf{K_b = c\ \alpha^2}$$

$$\mathbf{[H_3O^+] = \sqrt{K_b\ .\ c}}$$

c =initial concentration

K_b= the base-ionization constant

Exercise :

a) Find the acid-ionization constant of a solution of 0.1M acetic acid that has an ionization percentage of 1.4%.

b) Find the pH of the solution.

a) $c = 0.1$ M ; $\alpha = 1.4 \times 10^{-2}$; Ka = ????

$Ka = c\,\alpha^2 = (0.1)\,(1.4 \times 10^{-2})^2 \rightarrow$ $\boxed{Ka = 1.96 \times 10^{-5}}$

b) $pH = -\log [H_3O^+]$

$[H_3O^+] = \sqrt{Ka\ .\ c} = \sqrt{(1.96 \times 10\text{-}5)\,(0.1)} \rightarrow$ $\boxed{[H_3O^+] = 2.744 \times 10^{-3}\ M}$

$pH = -\log [H_3O^+] = -\log (2.744 \times 10^{-3}) \rightarrow$ $\boxed{pH = 2.56}$

Solubility equilibrium

Solubility is defined as the amount of salt (in grams) that can be dissolved in 100 g of water.

$$AgCl\ (s) \rightleftharpoons Ag^{+} + Cl^{-}$$

$$Ksp = [Ag^{+}]\ [Cl^{-}]$$

Ksp = solubility-product constant

$$Ksp = [Ag^{+}]\ [Cl^{-}] = c\ .\ c = c^{2}$$

- c = molarity (mole/l)

Thank you