Ministry of Higher Education and Scientific Research
AL-Mustaqbal University College of Science
Department of Biochemistry

Physical Chemistry

Lecture 1

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First semester

Kinetic Chemistry

By

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General items

1. **Empirical chemical kinetics**
2. **The order of reaction**
3. **the molecularity of reaction**
4. **The rate of reaction**
5. **Reaction Order**

Empirical chemical kinetics

- The first stage: its discussing of the rate and mechanics of a reaction is the determination of the overall elements of the reaction and the determination of any side reaction.

- The second stage: its determination how the concentrations of the reactants and products change with time after the reaction. because the rates of chemical reaction are sensitive to temperature, the temperature of the reaction mixture must be held constant through out the course of the reaction.

What is the order of reaction?

The order of reaction is defined as

“ **the sum of the coefficients (or power) of the reacting species that are involved in the rate equation for the reaction**.”

The definition of order of reaction is valid both for elementary as well as complex reactions. The order of the reaction is always determined experimentally.

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Determination of order of reactions

Let us consider a general reaction:

$$\mathbf{aA + bB + cC \rightarrow Product}$$

Let active moles of A, B and C be α, β and γ respectively. Then the rate of reaction may be given as:

$$\mathbf{Rate = k [A]^{\alpha} [B]^{\beta} [C]^{\gamma}}$$

The order of the reaction is equal to the sum of power of concentration terms involved in rate law expression.

$$\mathbf{Order = \alpha + \beta + \gamma}$$

When $\alpha + \beta + \gamma = a + b + c$, then order of reaction = molecularity of reaction

What is the molecularity of reaction?

The number of reacting particles (**molecules, atoms, or ions**) that collide in a rate determining step to form a product is called **molecularity of a reaction.**

In general, the molecularity of simple reactions is equal to the sum of the number of molecules of reactants involved in the balanced equation.

Examples:

$PCl_5 \rightarrow PCl_3 + Cl_2$ (Unimolecular reaction)

$2SO_2 + O_2 \rightarrow 2SO_3$ (Trimolecular reaction)

$NO + O_3 \rightarrow NO_2 + O_2$ (Bimolecular reaction)

Difference between order and molecularity of reactions

Order	Molecularity
(a) Order of a reaction is the sum of the coefficients of the reacting species involved in the rate equation.	(a) Molecularity is the number of reacting species involved in simultaneous collisions in an elementary or simplest reaction.
(b) Order of a reaction is determined experimentally.	(b) The concept of molecularity is theoretical in nature.
(c) It is derived from the rate equation.	(c) It is derived from the mechanism of reaction.
(d) Order of a reaction may be fractional in some cases.	(d) Molecularity of the reaction is always a whole number.
(e) Order of a reaction can be zero.	(e) Molecularity of a reaction cannot be zero.
(f) The reaction order is applicable in all chemical reactions	(f) Is only applicable in simple reactions.

The rate of reaction

- It’s the amount of change that occurs in the concentration of the reactants during the reacting a certain degree heat during period of time.

- The rate of reaction = $\frac{\text{التغير في التركيز } d[c]}{\text{التغير في الزمن } d[t]}$

$$A+B \longrightarrow C+D$$

معدل سرعة التفاعل بدلالة المواد المتفاعلة يساوي

$$\text{The rate of reaction} = -\frac{d[A]}{d[t]} = -\frac{d[B]}{d[t]}$$

معدل سرعة التفاعل بدلالة المواد الناتجة يساوي

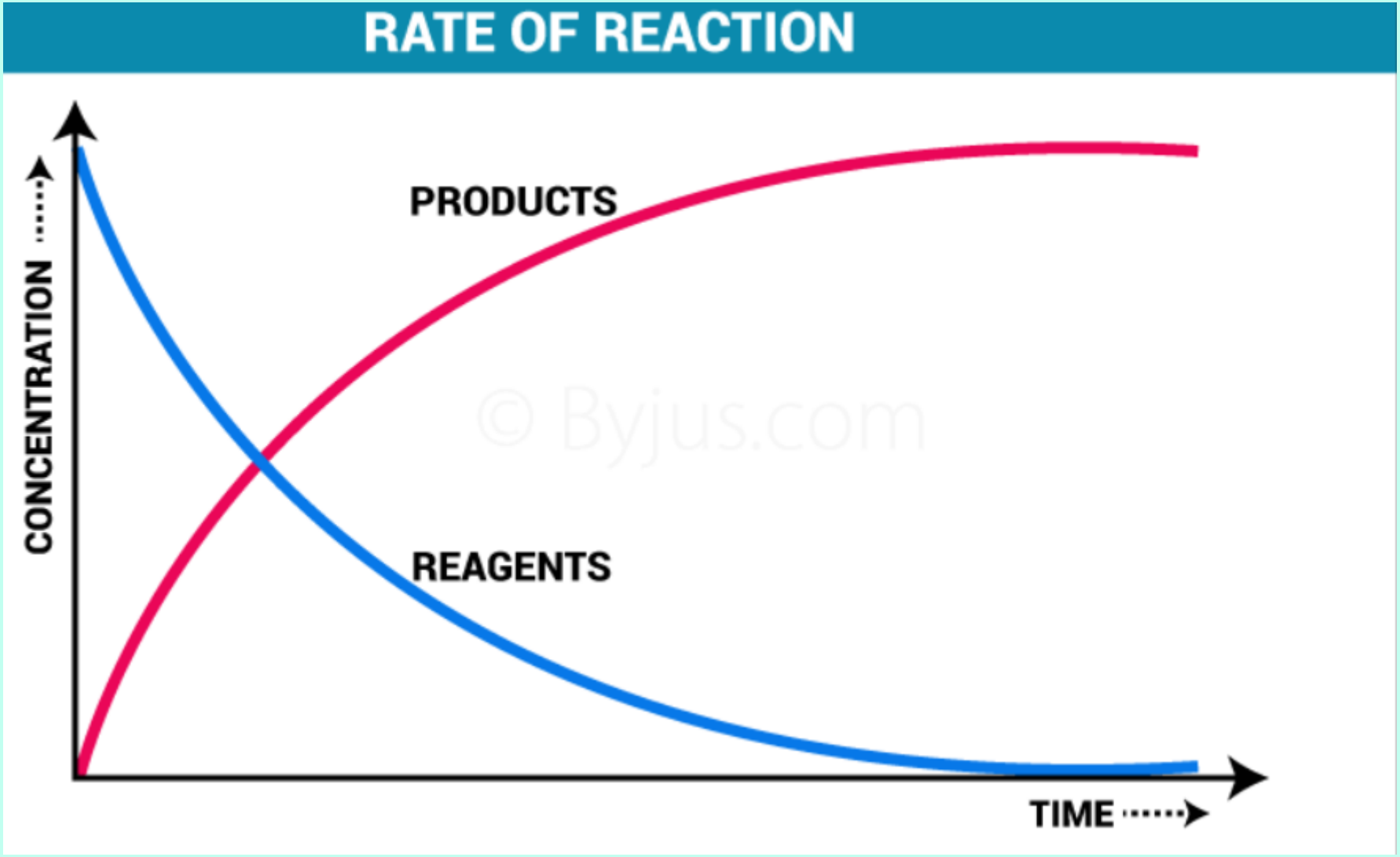
$$\text{The rate of reaction} = +\frac{d[C]}{d[t]} = +\frac{d[D]}{d[t]}$$

اما معدل سرعة التفاعل بدلالة عدد المولات المشتركة يساوي

$$aA + bB \longrightarrow cC + dD$$

$$\text{The rate of reaction} = -\frac{1}{a}\frac{d[A]}{d[t]} = -\frac{1}{b}\frac{d[B]}{d[t]}$$

$$\text{The rate of reaction} = +\frac{1}{c}\frac{d[C]}{d[t]} = +\frac{1}{d}\frac{d[D]}{d[t]}$$


RATE OF REACTION
CONCENTRATION
PRODUCTS
REAGENTS
TIME
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Reaction Order

تحدد درجة التفاعل بمجموع الأسس لحدود تراكيز المواد التي تعاني تغيرا في معادلة التفاعل.
فان سرعة التفاعل تكون

$$\frac{d C_1}{d t} = K C_1^{n1} . C_2^{n2} . C_3^{n3}$$

تشير $n_1\ n_2\ n_3$ الى القوى الخاصة بتراكيز المواد المتفاعلة $C_1\ C_2\ C_3$

ويكون التفاعل من الدرجة n1 بالنسبة للمادة ذات التركيز C1

ويكون التفاعل من الدرجة n2 بالنسبة للمادة ذات التركيز C2

ويكون التفاعل من الدرجة n3 بالنسبة للمادة ذات التركيز C3

وتكون الدرجة الكلية للتفاعل مساوية الى مجموع أسس التراكيز

$$n = n_1 + n_2 + n_3$$

فاذا كانت $n_1 = 1 , n_2 = 0 , n_3 = 0$ فان الدرجة الكلية للتفاعل هي $n = 1$

اذن التفاعل من الرتبة الأولى وهكذا

Example

1- $2N_2O_5 \longrightarrow 4NO_2 + O_2$

فان التفاعل يعتبر من الدرجة الاولى حسب معادلة السرعة

$$\text{The rate of reaction} = -\frac{d\,[N_2O_5]}{d\,[t]} = K\,[N_2O_5]^1$$

2- $(C_2H_5)_3N + C_2H_5Br \longrightarrow (C_2H_5)_4NBr$

$$\text{The rate of reaction} = -\frac{d[C_2H_5Br]}{d[t]} = K[C_2H_5Br]^1[(C_2H_5)_3N]^1$$

اذن التفاعل من الدرجة الثانية.

Thank you