Lecture- 06 B
Factors affecting rate of reaction

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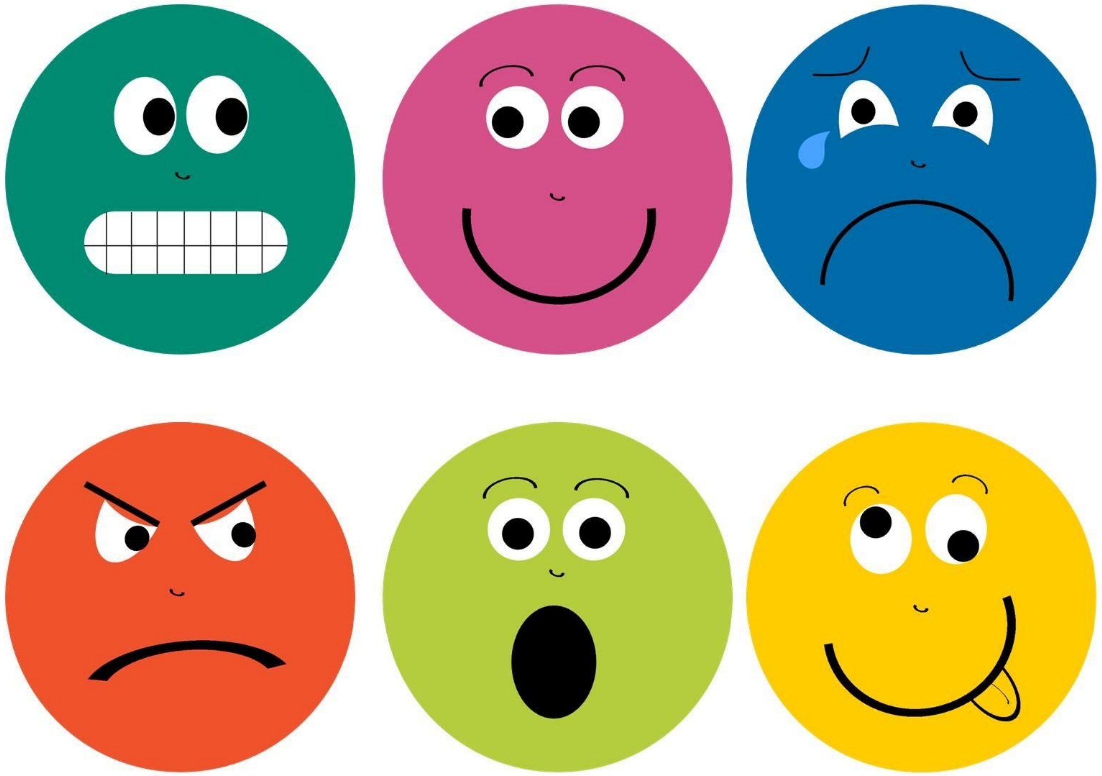
Factors affecting rate of reaction

1. Concentration
2. Pressure (in case of gases)
3. Temperature of reaction
4. Catalyst
5. Light (in some cases)
6. Surface area of solid reactant or catalyst)

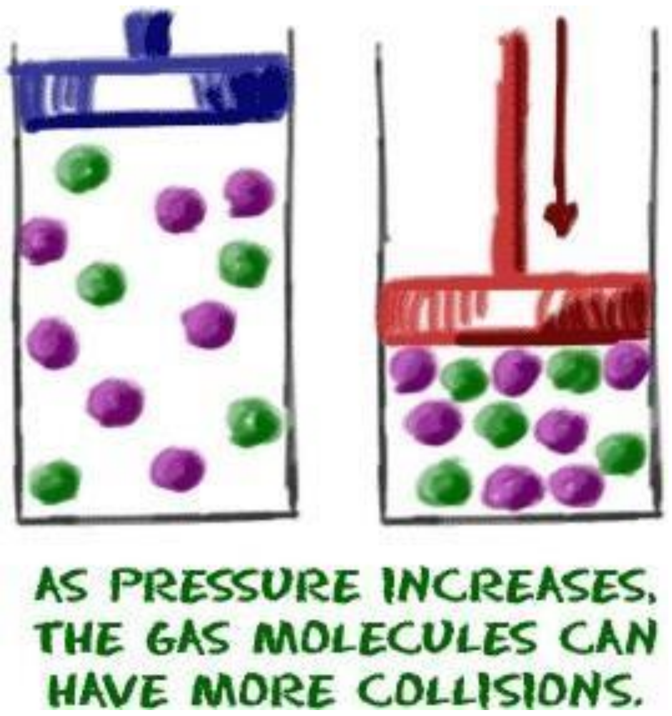


Concentration

- Often the rate of reaction increases when the concentration of a reactant is increased.
- As the concentration increases the number of molecules increases. As a result, collisions are more likely to occur and give the higher rate.

Pressure (in case of gases)

When pressure applies the volume of a gas is reduced. So in unit volume higher numbers of molecules are present at higher pressure. Therefore, the concentration is increased with the increase of pressure. As a result, the collisions between the molecules are increased which enhance the reaction rate. Example: production of ammonia from N2 and H2.



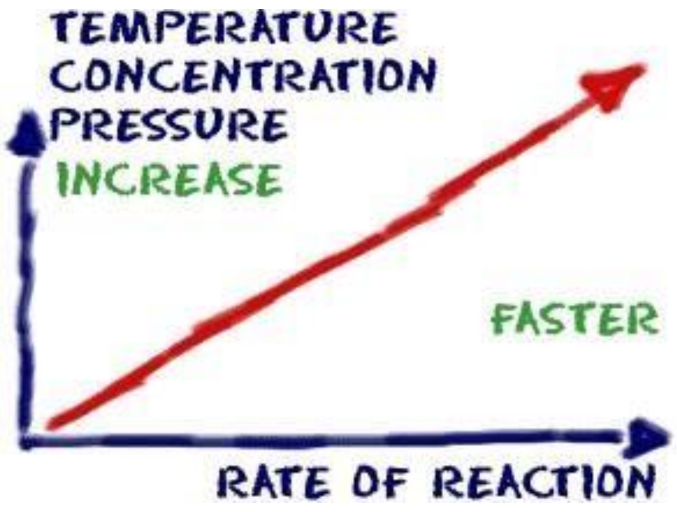
Temperature

Effect of temperature on the rate of a reaction is **two fold**.

Increase in temperature increases the kinetic energy of the reactant species bringing about an **increase in frequency of collision**.

At higher temperature more reactant species have the required **energy of activation**. That why the reactants become more successful to convert into product.

Both of the above factor increase rate when temperature increases.

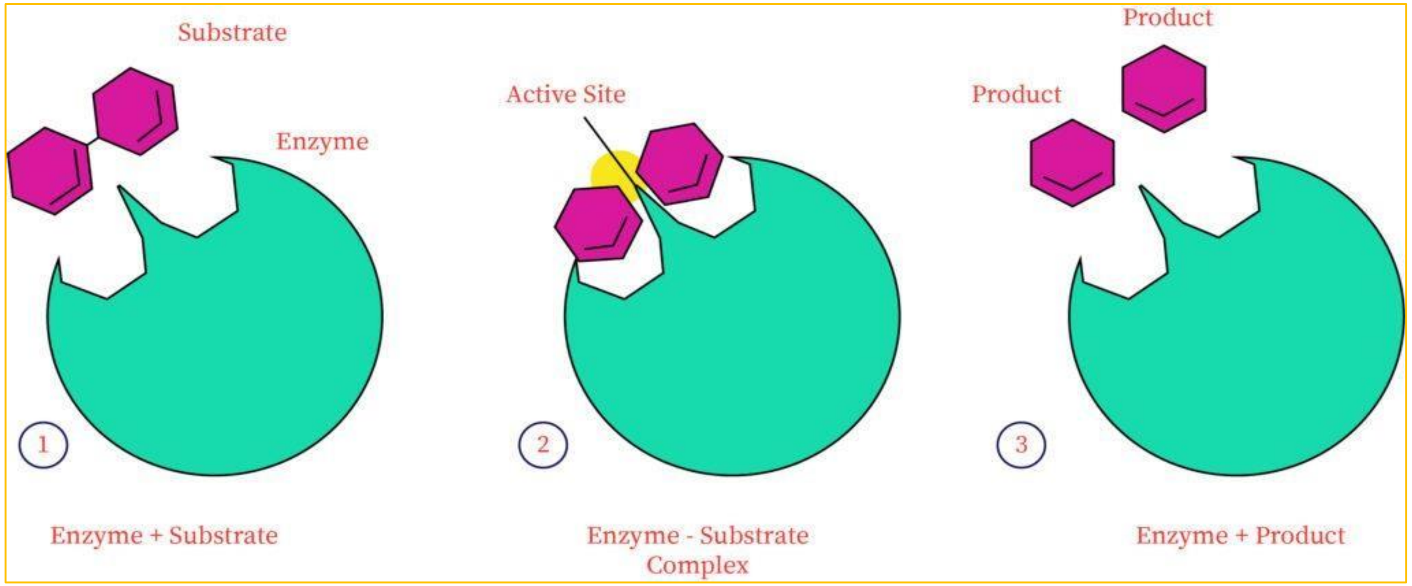


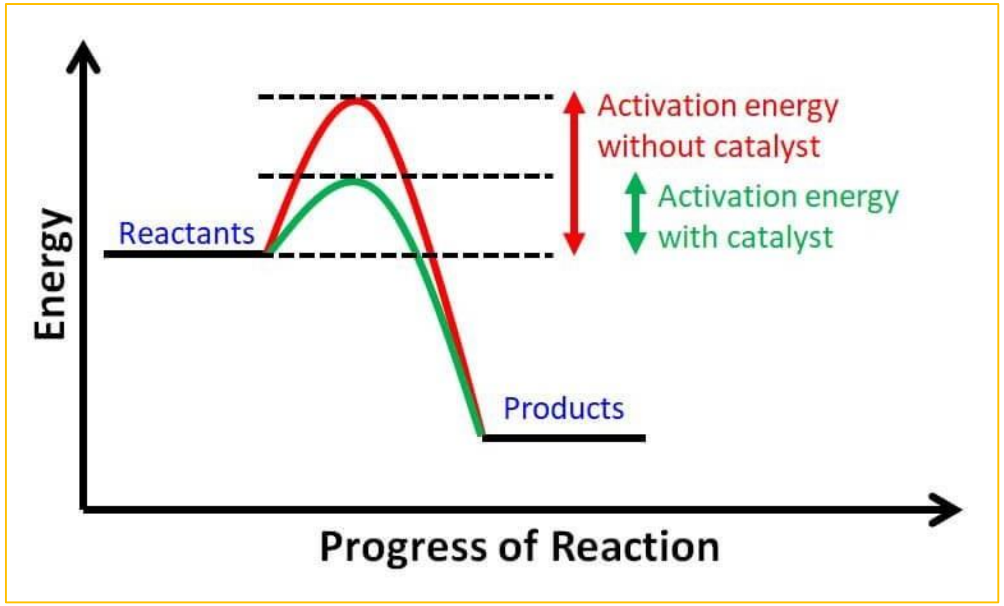
Light

- Light activates some of the reactant molecules producing free radicals.
- Since free radicals are very exited, therefore, they react immediately with other molecules to form products.
- We know that that light consists of photon. When photons strike the reactant molecule, they provide necessary activation energy to the reactant molecules.

Catalyst

- A catalyst is a substance that increases the rate of reaction without being consumed in the overall reaction.
- Catalysts are of enormous importance to the chemical industry, because they allow a reaction to occur with a reasonable rate at a much lower temperature than otherwise; lower temperatures translate into lower energy costs.
- The catalyst must participate in at least one step of a reaction and be regenerated in a later step.





Surface area of a solid reactant or catalyst

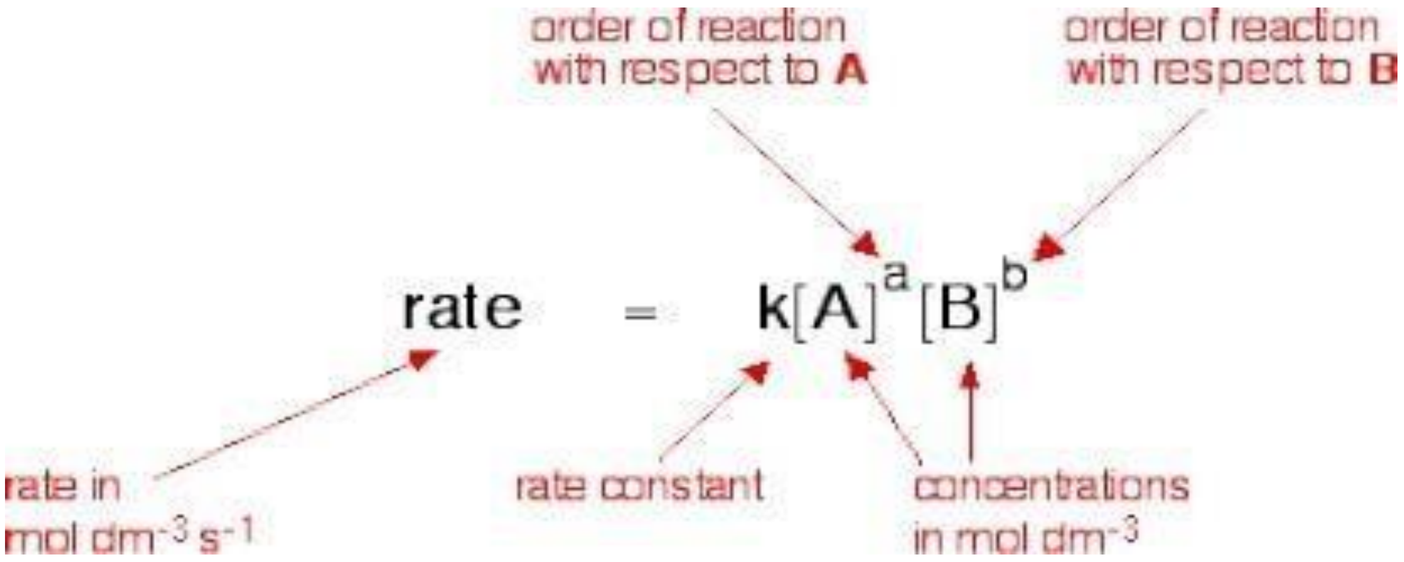
- If a reaction involves a solid with a gas or liquid, the surface area of the solid affects the reaction rate.
- Because the reaction occurs at the surface of the solid, the rate increases with increasing the surface area.
- A wood fire burns faster if the logs are chopped into smaller pieces.
- Similarly, the surface area of a solid catalyst is important to the rate of reaction. The greater the surface area per unit volume, the faster the reaction.

Rate constant, k

The rate constant, k is defined as the proportionality constant between the rate and the concentration term (**concentration with its power**). Units of rate constant varies with values of 'n' (order of the reaction)

Order of a reaction (n)

The order of a reaction can be defined as the power to which the concentration is to be raised in order to make the concentration term proportional to the rate.
So it may be defined as the **sum of power of concentration** in the rate law.



Order of a reaction (n)

Order of a reaction can be 0,1,2,3, fraction value or negative. It is experimentally determined. It cannot be guessed by looking at the reaction.

In a general reaction, $A + B \longrightarrow$ product

$$\textbf{rate} = k\,[A]^m\,[B]^n \quad \text{or } k\,C_A{}^m\,C_{B_n}$$

Where, m = order with respect to A
n = order with respect to B
k = rate constant
C_A or [A] is concentration of A
C_B or [B] is concentration with respect to B

Overal order of the reaction = m + n

m + n = 1; 1st order reaction

m + n = 2; 2nd order reaction
m + n = 3; 3rd order reaction

Order of a reaction VS Rate

m +n = 1; 1st order reaction; rate is proportional to concentration
m + n = 2; 2nd order reaction; rate is proportional to (concentration)2
m +n =3; 3rd order reaction; rate is proportional to (concentration)3

- ❑ **Most of the reactions are1st order reaction**
- ❑ **0 and 3rd order reactions (A+A+A >Product) are very rare**

Factor affecting rate constant

1. It is independent of the concentration of reactants at particular temperature.

2. Greater the value of K , greater will be the rate of reaction.

3. It increases with increasing the temperature

4. Larger the value of rate constant, faster is the reaction and vice-versa.

For the non- stotiometric reaction,

$$2A(g) + B(g) \longrightarrow C(g) + D(g)$$

the following kinetic data were obtained in three separate experiments , all at 298K.

Initial concentration [A]	Initial concentration [B]	Initial Reaction rate of formation of C ($mol\ L^{-1}\ s^{-1}$)
0.1 M	0.1 M	1.2×10^{-3}
0.1 M	0.2 M	1.2×10^{-3}
0.2 M	0.4 M	2.4×10^{-3}

Find the rate law for the formation of C.

For the reaction,

$$2NO(g) + Cl_2(g) \longrightarrow 2NOCl(g)$$

The experimentally obtained results are as follows:

Experiment No.	[NO] ($mol\ L^{-1}$)	[Cl_2] ($mol\ L^{-1}$)	Reaction rate ($mol\ L^{-1}\ s^{-1}$)
1.	0.01	0.02	2.4×10^{-4}
2.	0.03	0.02	2.16×10^{-3}
3.	0.03	0.04	4.32×10^{-3}

Determine : i) the order of the reaction with respect to Cl_2 and NO

ii) the rate equation of the reaction

iii) the rate constant of the reaction

For an elementary reaction:

$$2A + B \longrightarrow 2AB$$

if the volume of the vessel is reduced to one-third of it's original volume, then the rate of the reaction will be…. ?

In a reaction between A and B, the rate of the reaction becomes $1/4^{th}$ of it’s initial reaction-rate if the concentration of B is doubled. Determine the order of the reaction with respect to B.

Thank You