

# Rate of Reaction

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## Collision theory

- during collision, particles transfer energy to one another.



- particles do not have same kinetic energy and are constantly changing.

According to collision theory;

→ Reactant particles must collide with one another for reaction to occur

→ Rate of reaction depends on the frequency of effective collisions.

How to produce effective collision?

Reactant particles have energy equal or more than activation energy  
In correct orientation

### Activation energy

- activation energy are required to start a reaction.

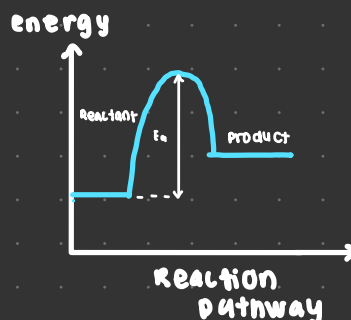
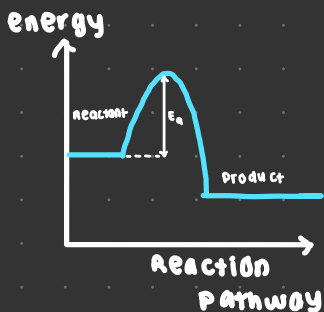
- activation energy needed to break the bonds in reactant particles and form new bonds in the products.

- represented by symbol  $E_a$ .

- activation energy is the difference in energy between reactant and the energy at the peak of the curve in graph below;

exothermic

endothermic



- Exothermic : Reactant > Product

- Endothermic : Reactant < Product

## Collision orientation

- Reactant particle must be in a specific orientation to allow old bond to be broken and new bond to form.

correct orientation ✓



wrong orientation ✗

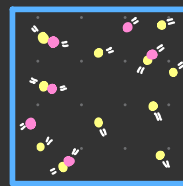


## effective collision and Rate of Reaction

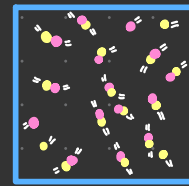
① Frequency of collision between reactant particles with enough  $E_a$

② Faster the reaction

## effect of concentration on the Rate of Reaction



low concentration



High concentration

when concentration of reactant ↑,

- number of particles per unit volume ↑
- frequency of collision between particles ↑
- frequency of effective collision ↑
- Rate of Reaction ↑

when gas pressure ↑

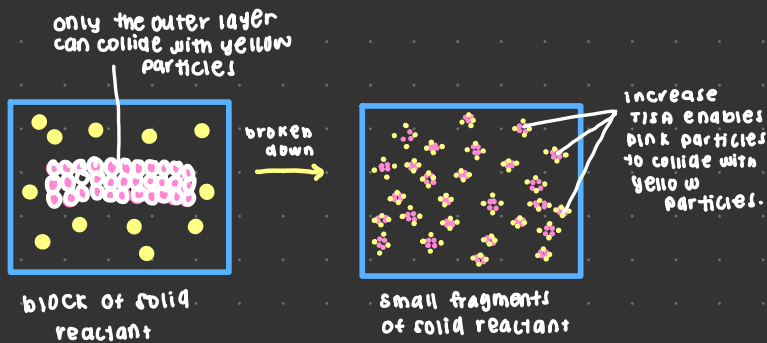
- number of particles per unit volume ↑
- frequency of collision between particles ↑
- frequency of effective collision ↑
- Rate of Reaction ↑

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## effect of size of reactant on Rate of Reaction

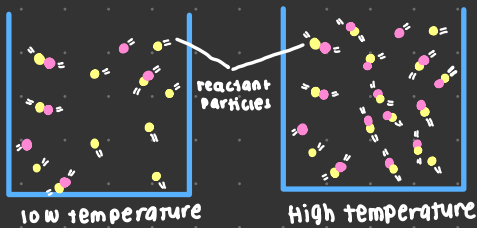
- the smaller the pieces, the higher the total surface area.



## When total surface area of reactant ↑

- total surface area exposed to collision ↑
- frequency of collision between particles ↑
- frequency of effective collision ↑
- Rate of Reaction ↑

## Effect of temperature on Rate of Reaction



## When temperature ↑

- kinetic energy of reactant particles ↑
- more particles have energy to overcome the activation energy.
- frequency of effective collision ↑
- Rate of reaction ↑

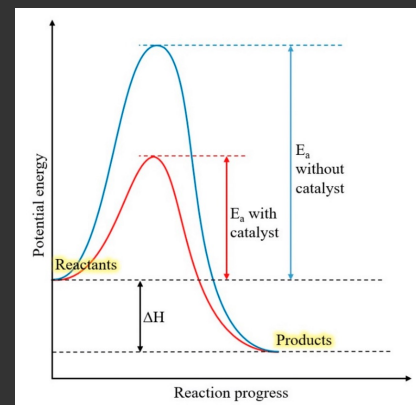
## extra :

- **exothermic reaction** : reaction that release heat to surrounding.
- **endothermic reaction** : reaction that absorbs heat to surrounding.

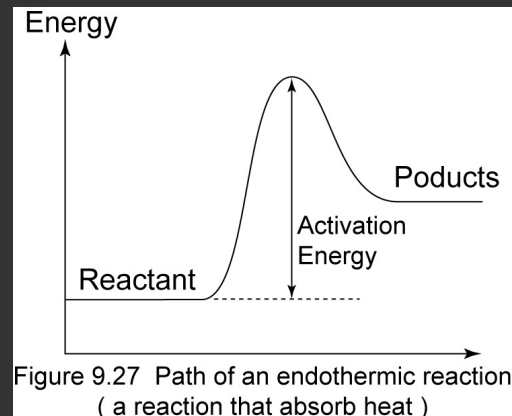
## effects of catalyst on Rate of Reaction

- Remains chemically unchanged at the end of the reaction.
- Allow reaction to occur by providing alternative pathway with **lower activation energy** as compared to original activation energy.

## exothermic



## endothermic



## with the presence of catalyst,

- catalyst provides an alternative pathway by **lowering the activation energy**.
- more reactant particles can achieve the activation energy.
- frequency of effective collision between particles ↑
- Rate of reaction ↑