

## RATE OF A REACTION – REACTION KINETICS

Reaction kinetics is the study of the speed with which a chemical reaction occurs and the factors that affect this speed.

**Rate of a reaction** = change of concentrations of reactants in a unit of time

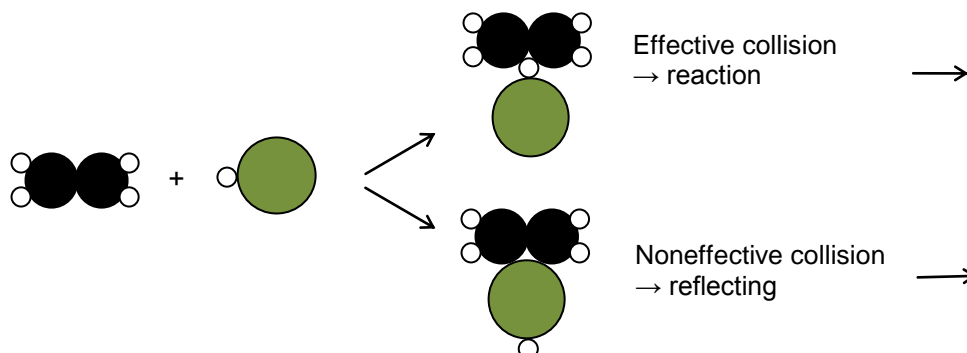
- Classify the following reactions as slow or fast:
  - Neutralization
  - Rusting
  - Photosynthesis
  - Burning
  - Decomposition of  $H_2O_2$
  - Reaction between HCl and Mg
- Suggest a way to make some of the above reactions faster.

### Collision theory:

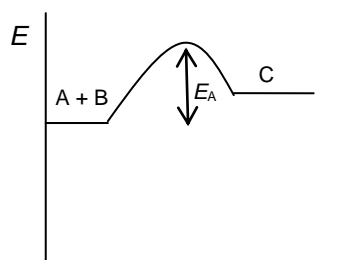
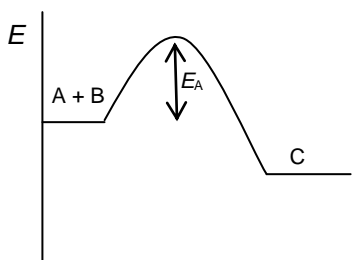
There is a reaction between particles if they collide with sufficient energy and with suitable orientation.

This minimum energy is known as activation energy  $E_a$  and such collision = effective collision.

E.g.  $CH_2=CH_2 + HCl \rightarrow CH_3CH_2Cl$



- Draw the pictures of the results of the collisions above.



- The graphs above show energy conditions of two reactions. Which of them is endothermic and which of them is exothermic?

### Factors affecting the rate of a reaction

- Use the collision theory to explain how and why the following factors influence the rate of a reaction.

### 1. Concentration of reactants:

An increasing concentration of reactants makes ..... collisions occur – *faster/slower* reaction.

### 2. Surface area

The increased surface area of a solid allows more ..... to occur.

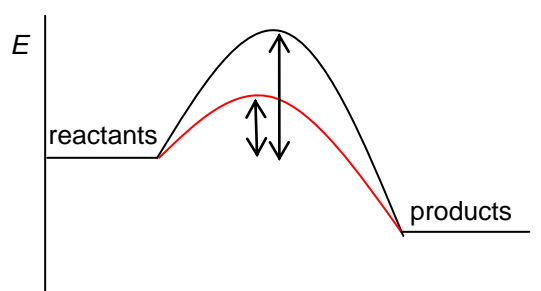
### 3. Temperature:

At high temperature the particles have more .....

- They will move more ..... and there will be more collisions
- More particles have sufficient ....., there will be more ..... collisions.

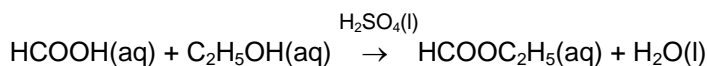
### 4. Catalyst:

= a substance that alters the .....of a reaction without itself being used up. It drives the reaction different ways - ways with *lower/higher*  $E_a$  – more particles have sufficient energy.

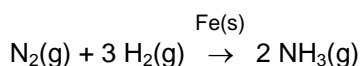


#### Types of catalysts:

- Homogeneous – in the same phase as reactants



- Heterogeneous – in a different phase



Positive catalysts: decrease the activation energy and *speed/slow down* the reaction

Negative catalysts =.....: *speed/slow down* the reaction

Catalytic .....: substances that deactivate the catalyst

Autocatalysis: the reaction ..... is a catalyst for that reaction

## Rate equation

The rate equation for a reaction  $A + B \rightarrow C + D$  is as follows:

$$v = k \times [A]^m \times [B]^n$$

$v$ ... reaction rate

$[A]$  ... concentration of a reactant A

$[B]$  ... concentration of a reactant B

$k$ ... rate constant (for given  $t$  and  $p$ , includes temperature and activation energy))

$m$ ... order of a reaction with respect to A

$n$ ... order of a reaction with respect to B

$m + n$  ... overall order of a reaction

$m, n \in \{0, 1, 2, \dots\}$

In simple reactions  $m, n$  are the coefficients in the equation.



In more complicated reactions the orders of the reaction must be found by an experiment.

6. The rate of the reaction  $2 NO(g) + O_2(g) \rightarrow 2 NO_2(g)$  may be calculated with the help of the rate equation  $v = k \cdot [NO]^2 \cdot [O_2]$ . The value of the rate constant at the temperature of  $25^\circ C$  is  $7000 \text{ mol}^{-2} \cdot \text{dm}^6 \cdot \text{s}^{-1}$ .
- Calculate the rate of this reaction at this temperature when the molar concentration of both  $NO$  and  $O_2$  is  $1 \text{ mol} \cdot \text{dm}^{-3}$ .
  - How will the rate of the reaction be changed if the concentration of  $NO$  is doubled?
  - How will the rate of the reaction be changed if the concentration of  $O_2$  is doubled?