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

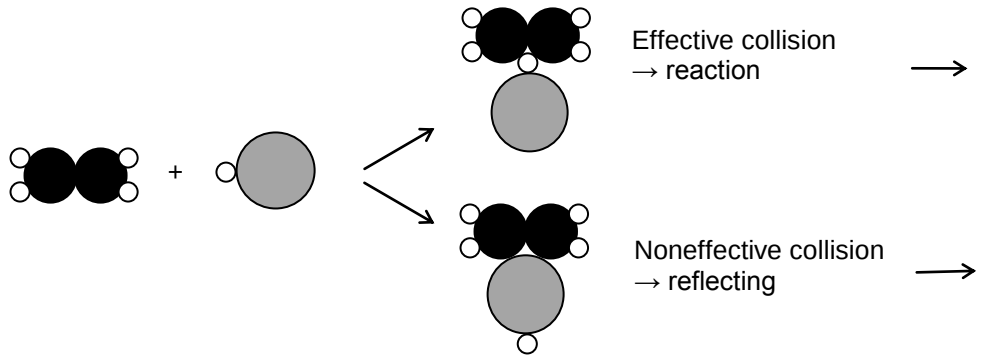
1. *Classify the following reactions as slow or fast:*
   a. *Neutralization*
   b. *Rusting*
   c. *Photosynthesis*
   d. *Burning*
   e. *Decomposition of H_2O_2*
   f. *Reaction between HCl and Mg*

2. *Suggest a way to make some of the above reactions faster.*

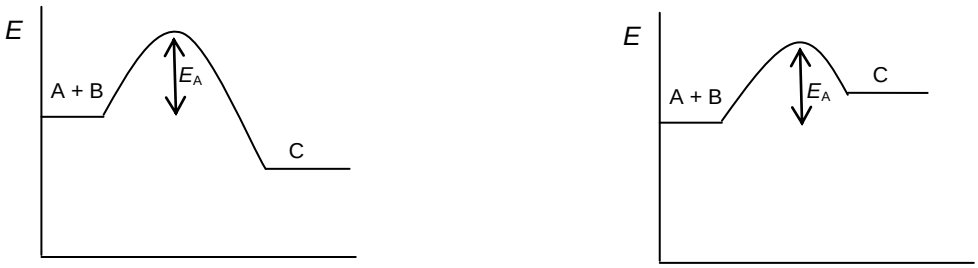
Collision theory:

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. $CH_2{=}CH_2 + HCl \rightarrow CH_3CH_2Cl$



3. *Draw the pictures of the results of the collisions above.*



4. *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

5. *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/slowlier* reaction.

2. **Surface area**

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

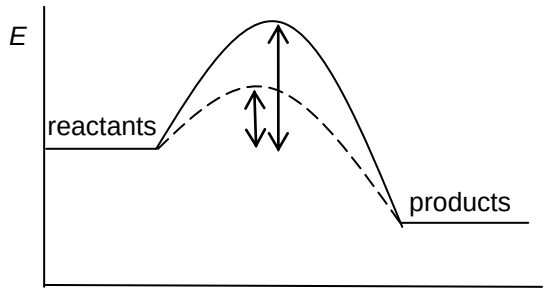
3. **Temperature:**

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

   a. They will move more ..... and there will be more collisions
   b. 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

$$HCOOH(aq) + C_2H_5OH(aq) \xrightarrow{H_2SO_4(l)} HCOOC_2H_5(aq) + H_2O(l)$$

- Heterogeneous – in a different phase

$$N_2(g) + 3\,H_2(g) \xrightarrow{Fe(s)} 2\,NH_3(g)$$

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 → 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* ∈ {0,1,2,…}

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

E.g. $N_2 + 3\ H_2 \rightarrow 2\ NH_3$ $\qquad v = k \times [N_2] \times [H_2]^3$

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) → 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°C is 7000 $mol^{-2} \cdot dm^6 \cdot s^{-1}$.*
   a. *Calculate the rate of this reaction at this temperature when the molar concentration of both NO and O_2 is 1 $mol \cdot dm^{-3}$.*
   b. *How will the rate of the reaction be changed if the concentration of NO is doubled?*
   c. *How will the rate of the reaction be changed if the concentration of O_2 is doubled?*