EQUILIBRIUM

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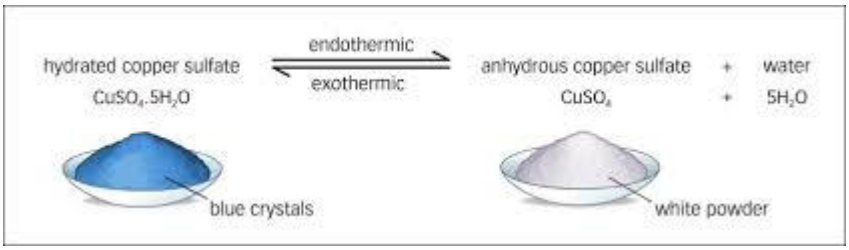
Reversible reactions :Reversible reactions are reactions which occur in both direcrtions ,forward and reverse.

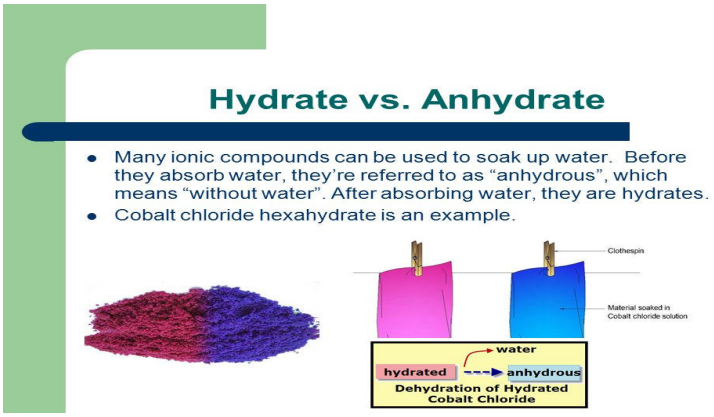
Equilibrium /Dynamic equilibrium: Rate of forward reaction is equal to rate of reverse reaction.Concentration of reactants and products is constant. Equilibrium establishes in closed system.

Examples of irreversible reactions: Combustion/Burning and neutralisation reactions are irreversible.

Examples of reversible reactions:



CuSO4.5H2O is blue
Anhydrous CuSO4 is white



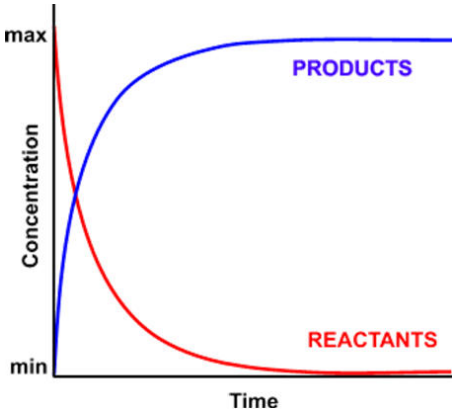
CoCl2.6H2O is pink
Anhydrous CoCl2 is blue

Water of crystallisation: Water of crystallisation is the number of water molecules attach with the formula unit of compound.

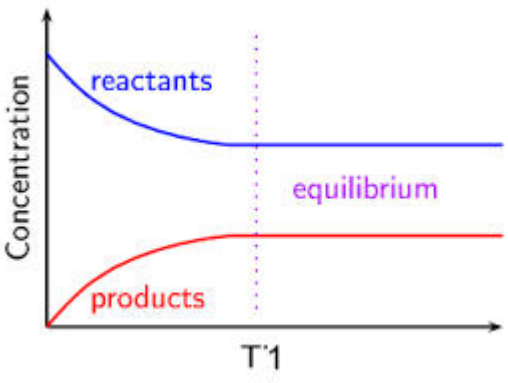
Cobalt Chloride is used for the identification of moisture.

Graph

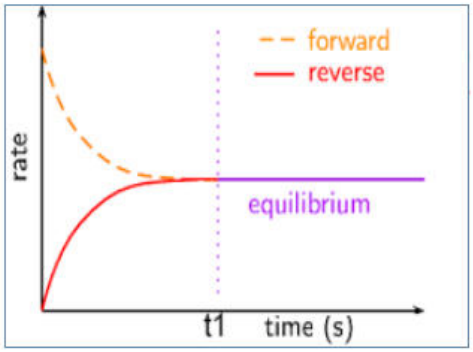
Irreversable reaction
Concentration Vs time



Reversible reaction
Concentration Vs time



Reversible reaction Rate Vs time Graph



Equilibrium: rate of forward reaction is equal to rate of reverse reaction. Concentration of reactants and products remain constant. It occurs in closed system.

Closed System: When none of the matter can escape out or enter in to the system.

LE CHATELIER'S PRINCIPLE:

" When a change is made to the conditions of a system in dynamic equilibrium, the system moves so as to oppose that change."

• Changing the concentration, temperature or pressure of reactants / products has an effect on the equilibrium reaction. The reaction tries to oppose the changes that are made.

• Catalysts do not affect the position of equilibrium – they just speed up the forward and reverse reactions equally.

THE EFFECT OF CHANGING THE CONCENTRATION ON THE POSITION OF EQUILIBRIUM	
INCREASE CONCENTRATION OF A REACTANT	EQUILIBRIUM MOVES TO THE RIGHT
DECREASE CONCENTRATION OF A REACTANT	EQUILIBRIUM MOVES TO THE LEFT
INCREASE CONCENTRATION OF A PRODUCT	EQUILIBRIUM MOVES TO THE LEFT
DECREASE CONCENTRATION OF A PRODUCT	EQUILIBRIUM MOVES TO THE RIGHT

Effect of temperature:
Endothermic favours by high temperature.
Exothermic favours by low temperature.

Effect of pressure:

Pressure is caused by gas particles colliding with the walls of the container, the greater the number of mole of gas present , the higher the pressure.Also, if temperature of a gas is increased, particles hit the wall harder and more frequently so the pressure increases.

THIS ONLY APPLIES TO GASES.

Increase in pressure shifts equilibrium to the side with less number of moles.
Decrease pressure shifts equilibrium to the side with more number of moles.

Practice questions

(b) The plunger of the gas syringe is pushed in. The temperature does not change. The mixture initially turns darker brown. After a few seconds the mixture turns lighter brown because the equilibrium shifts to the left.

$$\underset{\text{colourless gas}}{N_2O_4(g)} \rightleftharpoons \underset{\text{brown gas}}{2NO_2(g)}$$

(i) Explain why the mixture initially turns darker brown.

increased pressure brings nitrogen di oxide NO2 molecules closer together. [1]

(ii) Explain why the position of equilibrium shifts to the left.

Less number of moles on left hand side/reactant side. [1]

(c) The forward reaction is endothermic.

(i) State what happens to the position of equilibrium when the temperature of the mixture is increased.

Equilibrium shifts to the right hand side. endothermic favours by high temperature [1]

(ii) State what happens to the rate of the forward reaction and the rate of the backward reaction when the temperature of the mixture is increased.

rate of the forward reaction ....increase/Faster.....

rate of the backward reaction ..increase/faster.....

[2]

[Total: 7]

1 Iodine reacts with chlorine to form dark brown iodine monochloride.

$$I_2 + Cl_2 \rightarrow 2ICl$$

This reacts with more chlorine to give yellow iodine trichloride.
An equilibrium forms between these iodine chlorides.

$$\underset{\text{dark brown}}{ICl(l)} + Cl_2(g) \rightleftharpoons \underset{\text{yellow}}{ICl_3(s)}$$

(a) What do you understand by the term *equilibrium*?

Equal rate of forward and reverse reaction.Concentration of reactants and products remain constant.

[2]

(b) When the equilibrium mixture is heated, it becomes a darker brown colour.
Suggest if the reverse reaction is endothermic or exothermic. Give a reason for your choice.

Endothermic reaction

Reverse reaction is endothgermic so favoured by high temperature

[1]

(c) The pressure on the equilibrium mixture is decreased.

(i) How would this affect the position of equilibrium? Give a reason for your choice.

It would move to the Left hand side

reason More moles on left hand side

[1]

(ii) Describe what you would observe.

More dark brown liquid / less yellow solid

[1]

Reversible reactions can come to equilibrium. The following are three examples of types of gaseous equilibria.

$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$ **reaction 1**

$A_2(g) + 3B_2(g) \rightleftharpoons 2AB_3(g)$ **reaction 2**

$2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$ **reaction 3**

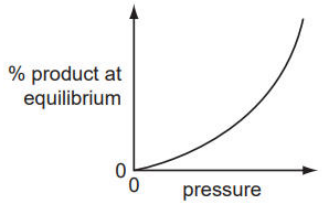
(a) Explain the term *equilibrium*.

Equal rate of forward and reverse reaction.Concentration of reactants and products remain constant.

..... [2]

(b) The following graphs show how the percentage of products of a reversible reaction at equilibrium could vary with pressure.
For each graph, decide whether the percentage of products decreases, increases or stays the same when the pressure is **increased**, then match each graph to one of the above reactions and give a reason for your choice.

(i)

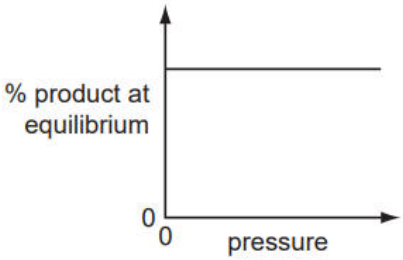


effect on percentage of products Increase

reaction reaction 2

reason less number of moles on product side than on reactant side

(ii)



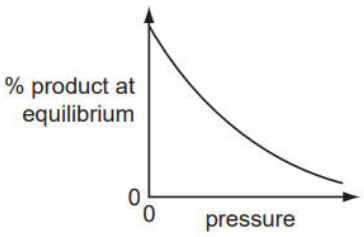
effect on percentage of products Same

reaction Reaction 1

reason Same number of moles on both sides

..... [3]

(iii)



effect on percentage of products Decrease

reaction Reaction 3

reason More number of moles on product side than on reactant side.

..... [3]