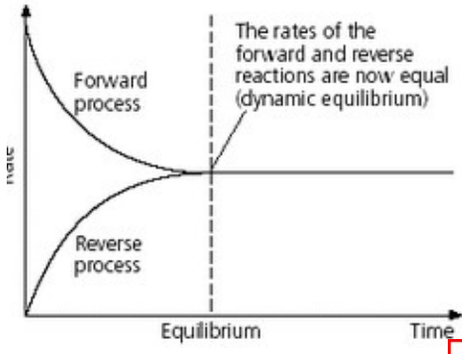
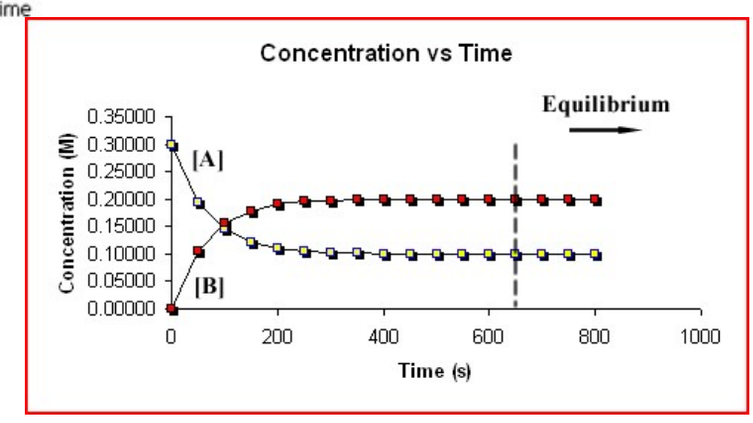
Chemical Equilibrium

-a chemical reaction in which the products can react to re-form the reactants is called a **reversible reaction**

-a reversible reaction is in **chemical equilibrium** when the rate of its forward reaction equals the rate of its reverse reaction and the concentrations of its products and reactants remain unchanged





Hypothetical reaction -

$nA + mB \rightleftharpoons xC + yD$

At a given temperature, the ratio of the concentrations of the products and reactants is constant and is represented by the equation:

$$K = \frac{[C]^x[D]^y}{[A]^n[B]^m}$$

K (the equilibrium constant) does not depend on the initial concentrations of products and/or reactants, but does depend on temperature.

Effects of Temperature on Equilibrium

When $H_{rxn} > 0$, the reaction is exothermic, so an increase in temperature will shift the equilibrium to the reactants.

When $H_{rxn} < 0$, the reaction is endothermic, so an increase in temperature will shift the equilibrium to the products.

Effects of Pressure on Equilibrium

Le Chatelier's principle

An increase in pressure will shift the equilibrium to the side that has fewer mols of gas.

A decrease in pressure shifts to the side with more mols of gas.

Pressure has no effect on equilibrium of non-gas reactants and products.

What is the equilibrium expression for the equation
$NH_4Cl(s) <==> NH_3(g) + HCl(g)$?

What is the equilibrium expression for the equation

$As_4O_6(s) + 6C(s) <==> As_4(g) + 6CO(g)$?

What is the equilibrium expression for the equation

$SnO_2(s) + 2CO(g) <==> Sn(s) + 2CO_2(g)$?

What is the equilibrium expression for the equation
$CaCO_3(s) <==> CaO(s) + CO_2(g)$?

In an experiment conducted at 74°C, the equilibrium concentrations of reactants and products were [CO] = 1.2×10^{-2} M, [Cl_2] = 0.054 M and [$COCl_2$] = 0.14 M.

Write a balanced equation, the equilibrium expression, and determine K_{eq}

For the reaction $N_2O_4(g) <==> 2NO_2(g)$, K_{eq} = 0.2. At a particular time, the following concentrations are measured: [N_2O_4]=2.0 M, [NO_2] = 0.2 M. Is this reaction at equilibrium? If not which direction will the reaction proceed?

One student performed an experiment in which nitrogen and hydrogen gas were mixed together to form ammonia. Equilibrium concentrations of the three species were [ammonia] = 0.157 M, [nitrogen] = 0.921 M and [hydrogen] = 0.763 M.

Write a balanced equation, determine the equilibrium expression, and find K_{eq}