Effect of changing conditions on Kc

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Le Chatelier's Principle

We use Le Chatelier's principle to work out how changing conditions affect the position of equilibrium.

Le Chatelier's principle states that if an external condition is changed the equilibrium will shift to oppose the change (and try to reverse it).

However, Kc only changes with temperature.
It does not change if pressure or concentration is altered.
A catalyst also has no effect on Kc

Effect of Temperature on position of equilibrium and Kc

If temperature is increased the **equilibrium will shift to oppose** this and move in the **endothermic** direction to try and reduce the temperature by absorbing heat.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ ΔH = -ve exo

In the above example because the endothermic reaction is the backwards one the position of equilibrium will **shift towards the left**, giving a **lower yield** of ammonia.
(A low temperature would therefore give a high yield of ammonia)

Equilibrium shifts to the left and Kc gets smaller.

Effect of Temperature on Equilibrium

ΔH for reaction	Change in temperature	Shift of Equilibrium	Yield of Product	Equilibrium Constant
Exothermic	Increase	To the left	reduced	reduced
Exothermic	decrease	To the right	increased	increased
Endothermic	Increase	To the right	increased	increased
Endothermic	decrease	To the left	reduced	reduced

Effect of Changing Pressure

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Increasing pressure will cause the equilibrium to shift towards the side with **fewer moles of gas** to oppose the change and thereby reduce the pressure.

In the above case the equilibrium will **shift towards the right** because there are 4 moles of gas on the left but only 2 moles of gas on the right. This will **increase the yield of the ammonia.**

Be aware: when changing pressure and the position of equilibrium moves, Kc **does not change** because Kc only changes with temperature.

Effect of Pressure on Equilibrium

More gas molecules on	Change in pressure	Shift of Equilibrium	Yield of Product	Equilibrium Constant
Product side	Increase	To the left	reduced	unchanged
Product side	decrease	To the right	increased	unchanged
Reactant side	Increase	To the right	increased	unchanged
Reactant side	decrease	To the left	reduced	unchanged

Kc **does not change** with pressure.
Kc only changes with temperature.

Effect of Changing Concentration

$$A + B \rightleftharpoons C + D$$

If extra A is added to the equilibrium mixture the forward reaction occurs more to oppose the change and remove some of the extra A and form extra C and D. The equilibrium has moved to the right.

However when changing concentration and the position of equilibrium moves, Kc **does not change** because Kc only changes with temperature.

Effect of Changing Concentration

$$Co(H_2O)_6^{2+}{}_{(aq)} + 4Cl^-{}_{(aq)} \rightleftharpoons CoCl_4^{2-}{}_{(aq)} + 6H_2O(l)$$

pink blue

If the concentration of Cl^- ions is increased by adding extra HCl to an equilibrium mixture, the position of equilibrium will shift towards the products and thereby removing some the of the extra Cl^- ions added. So the colour will change from pink to blue.

Kc **does not change** with concentration.
Kc only changes with temperature.

Effect of a catalyst.

The catalyst has **no effect** on the position of equilibrium, but it will speed up the rate at which the equilibrium is achieved.

It does not effect the position of equilibrium because it speeds up the rates of the forward and backward reactions by the same amount.

Catalysts have no effect on the value of Kc