

# Edexcel IAL Chemistry

## A-Level

### Topic 13 - Chemical Equilibria

#### Flashcards

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# What is a reversible reaction?



# What is a reversible reaction?

A reaction in which the products can react with each other to reform the reactants.



# What is $K_c$ ?



What is  $K_c$ ?

The equilibrium constant.

The magnitude indicates whether there are more reactants or products in an equilibrium system.



# How do you calculate $K_c$ ?



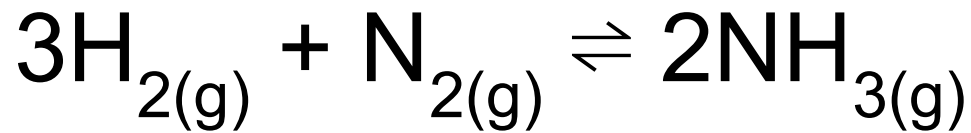
How do you calculate  $K_c$ ?

For the reaction:  $aA + bB \rightleftharpoons cC + dD$

$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

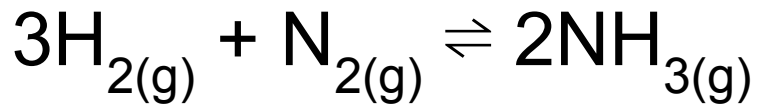


Deduce an expression for  $K_c$  for the equation below:





Deduce an expression for  $K_c$  for the equation below:



$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$



$K_c$  can be calculated for homogeneous and heterogeneous systems. How does the expression differ for heterogeneous systems?



$K_c$  can be calculated for homogeneous and heterogeneous systems. How does the expression differ for heterogeneous systems?

The  $K_c$  expression will not include values for solids in heterogeneous systems since the concentration of a solid can not change.



Deduce an expression for  $K_c$  for the equation below



Deduce an expression for  $K_c$  for the equation below

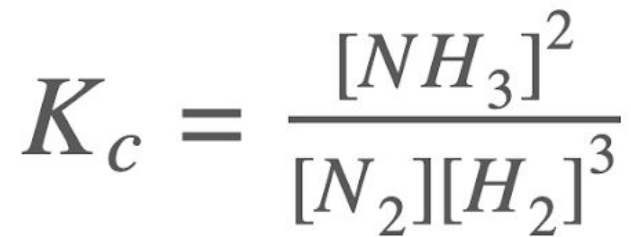


$$K_c = [\text{CO}_2]$$

The other reactants and products are in the solid phase and therefore are not used in the  $K_c$  calculation.



How do you work out the units for  $K_c$   
from the expression?



How do you work out the units for  $K_c$  from the expression?

Substitute in the units and cancel down:

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$K_c = \frac{(\text{mol dm}^{-3})^2}{\text{mol dm}^{-3} \times (\text{mol dm}^{-3})^3} = \frac{\text{mol}^2 \text{dm}^{-6}}{\text{mol}^4 \text{dm}^{-12}} = \text{dm}^6 \text{mol}^{-2}$$



# What is $K_p$ ?





What is  $K_p$ ?

$K_p$  is the equilibrium constant for gas phase reactions.

It takes partial pressures of reactants and products into account.



How do you calculate the mole fraction  
of a gas?



How do you calculate the mole fraction of a gas?

Mole fraction of gas A =

Number of moles of gas A  $\div$  Total number of  
moles of all species present



How do you calculate the partial pressure of a gas?



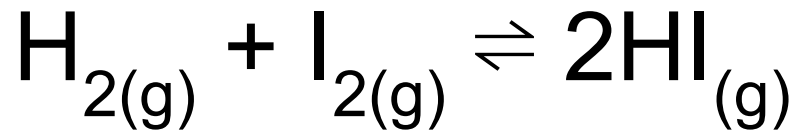
How do you calculate the partial pressure of a gas?

For gas A, partial pressure  $p(A) =$

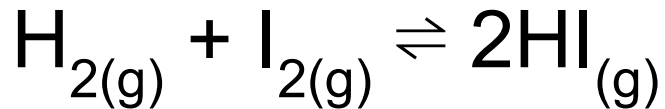
Mole fraction,  $X_A \times$  total pressure



Deduce an expression for  $K_p$  for the equation below:



Deduce an expression for  $K_p$  for the equation below:



$$K_p = \frac{p(\text{HI})^2}{p(\text{H}) \times p(\text{I})}$$

Where  $p$  is the partial pressure of the gas and the power is the balancing number in the equation.



How do you work out the units for  $K_p$  for the expression below?

$$K_p = \frac{p(HI)^2}{p(H) \times p(I)}$$





How do you work out the units for  $K_p$  from the expression?

Substitute the units into the  $K_p$  expression and cancel any common units. In this case all units cancel out.

$$K_p = \frac{p(HI)^2}{p(H) \times p(I)}$$

$$K_p = \frac{(kPa)^2}{kPa \times kPa} = \frac{kPa^2}{kPa^2} = \text{no units}$$



Deduce an expression for  $K_p$  for the equation below



Deduce an expression for  $K_p$  for the equation below



$$K_p = p(\text{CO}_2)$$

The other reactants and products are in the solid phase and therefore are not used in the  $K_p$  calculation.



What is the effect on  $K_c$  and  $K_p$  if the concentration of the reactants are increased?



What is the effect on  $K_c$  and  $K_p$  if the concentration of the reactants are increased?

Concentration has no effect on  $K_c$  and  $K_p$ .



What is the effect on  $K_c$  and  $K_p$  if the pressure of the system is increased?



What is the effect on  $K_c$  and  $K_p$  if the pressure of the system is increased?

Pressure has no effect on  $K_c$  and  $K_p$ .



Why does the addition of a catalyst not affect the value of  $K_c$  or  $K_p$ ?





Why does the addition of a catalyst not affect the value of  $K_c$  or  $K_p$ ?

A catalyst does not move the position of equilibrium, it only increases the rate at which the position of equilibrium is reached.



If the forward reaction of a reversible reaction is endothermic, what effect will increasing the temperature have on the position of equilibrium?

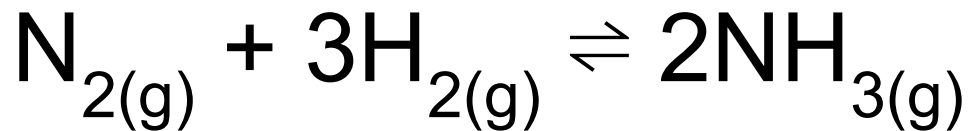


If the forward reaction of a reversible reaction is endothermic, what effect will increasing the temperature have on the position of equilibrium?

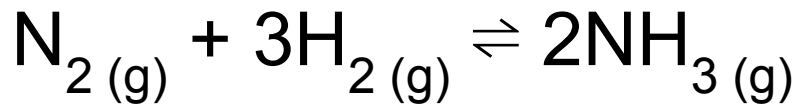
Increasing the temperature will favour the forward reaction so the position of equilibrium will shift to the right in order to oppose the change.



How does increasing the pressure affect the position of equilibrium of the following reaction?



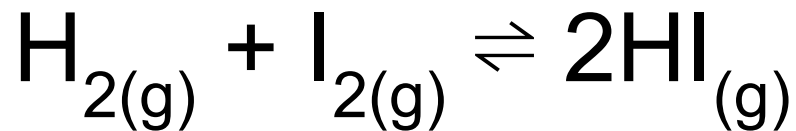
How does increasing the pressure affect the position of equilibrium of the following reaction?



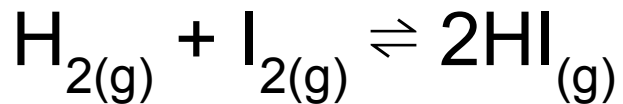
When there is an increase in pressure, the position of equilibrium shifts to the side with fewer moles of gas. Therefore the position of equilibrium will shift to the right.



How does decreasing the pressure affect the position of equilibrium of the following reaction?



How does decreasing the pressure affect the position of equilibrium of the following reaction?



There are equal molecules of gas on either side of the equation so the position of equilibrium is not affected by a change in pressure.



If the forward reaction is exothermic,  
what effect will increasing the  
temperature have on the value of  $K_c$ ?





If the forward reaction is exothermic, what effect will increasing the temperature have on the value of  $K_c$ ?

If the temperature is increased then the backwards endothermic reaction will be favoured. This means the position of equilibrium will move to the left and the concentration of reactants compared to products will increase. Therefore the value of  $K_c$  will decrease as the denominator of the  $K_c$  expression is increasing.



If the forward reaction is endothermic,  
what effect will increasing the  
temperature have on the value of  $K_p$ ?



If the forward reaction is endothermic, what effect will increasing the temperature have on the value of  $K_p$ ?

If the temperature is increased then the forwards endothermic reaction will be favoured. This means the position of equilibrium will move to the right and the concentration of products compared to reactants will increase. Therefore the value of  $K_p$  will increase as the numerator of the  $K_p$  expression is increasing.



What happens to the magnitude of the equilibrium constant as  $\Delta_{\text{tot}} S$  increases?



What happens to the magnitude of the equilibrium constant as  $\Delta_{\text{tot}} S$  increases?

It increases.



Why does the equilibrium constant increase as  $\Delta_{\text{tot}} S$  increases?



Why does the equilibrium constant increase as  $\Delta_{\text{tot}}S$  increases?

$$\Delta_{\text{tot}}S = R \ln K$$

Therefore:  $\Delta_{\text{tot}}S \propto \ln K$



How does temperature affect  $\Delta_{\text{tot}} S$ ?





How does temperature affect  $\Delta_{\text{tot}} S$ ?

As temperature increases, entropy increases, therefore entropy change is positive.

The opposite occurs with a decrease in temperature.

