Edexcel IAL Chemistry A-Level

Topic 13 - Chemical Equilibria

Flashcards

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?

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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:

$$3H_{2(g)} + N_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

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

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

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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

$$CaCO_{3(s)} \rightleftharpoons CO_{2(g)} + CaO_{(s)}$$

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$CaCO_{3(s)} \rightleftharpoons CO_{2(g)} + CaO_{(s)}$

$K_c = [CO_2]$

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?

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

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

Substitute in the units and cancel down:

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

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

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 ÷ 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 × total pressure

Deduce an expression for Kp for the equation below:

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$$

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$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

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

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

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Deduce an expression for K_p for the equation below

$CaCO_{3(s)} \rightleftharpoons CO_{2(g)} + CaO_{(s)}$

$K_p = p(CO_2)$

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?

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

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

$$N_{2\,(g)} + 3H_{2\,(g)} \rightleftharpoons 2NH_{3\,(g)}$$

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?

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$$

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

$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

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 $\Delta_{tot}S$ increases?

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

It increases.

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

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

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

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

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

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

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

The opposite occurs with a decrease in temperature.