AQA – Chemical equilibria, Le Chatelier's principle and Kc – A2 Chemistry P2

1. June/ 2020/Paper_2/No.9

0 9 **A** and **B** react together to form an equilibrium mixture.

$$A(aq) + 2B(aq) \rightleftharpoons C(aq)$$

An aqueous solution containing 0.25 mol of **A** is added to an aqueous solution containing 0.25 mol of **B**.

When equilibrium is reached, the mixture contains 0.015 mol of **C**.

0 9 . 1 Calculate the amount of **A** and the amount of **B**, in moles, in the equilibrium mixture.

[2 marks]

Amount of **A** _____ mol

Amount of **B** _____ mol

0 9 . 2 At a different temperature, another equilibrium mixture contains 0.30 mol of **A**, 0.25 mol of **B** and 0.020 mol of **C** in 350 cm^3 of solution.

Calculate the value of the equilibrium constant K_c

Deduce the units of K_c

[4 marks]

K_c _____

Units _____

When an excess of water is added to chloroethanal, an equilibrium mixture is formed.

$$ClCH_2CHO(aq) + H_2O(l) \rightleftharpoons ClCH_2CH(OH)_2(aq)$$

An expression for an equilibrium constant (K) for the reaction under these conditions is

$$K = \frac{[ClCH_2CH(OH)_2]}{[ClCH_2CHO]}$$

0 9 . 3 Suggest why an expression for K can be written without the concentration of water.

[1 mark]

0 9 . 4 Distilled water is added to 4.71 g of chloroethanal (M_r = 78.5) to make 50.0 cm^3 of solution. The mixture is allowed to reach equilibrium.

The value of the equilibrium constant (K) is 37.0

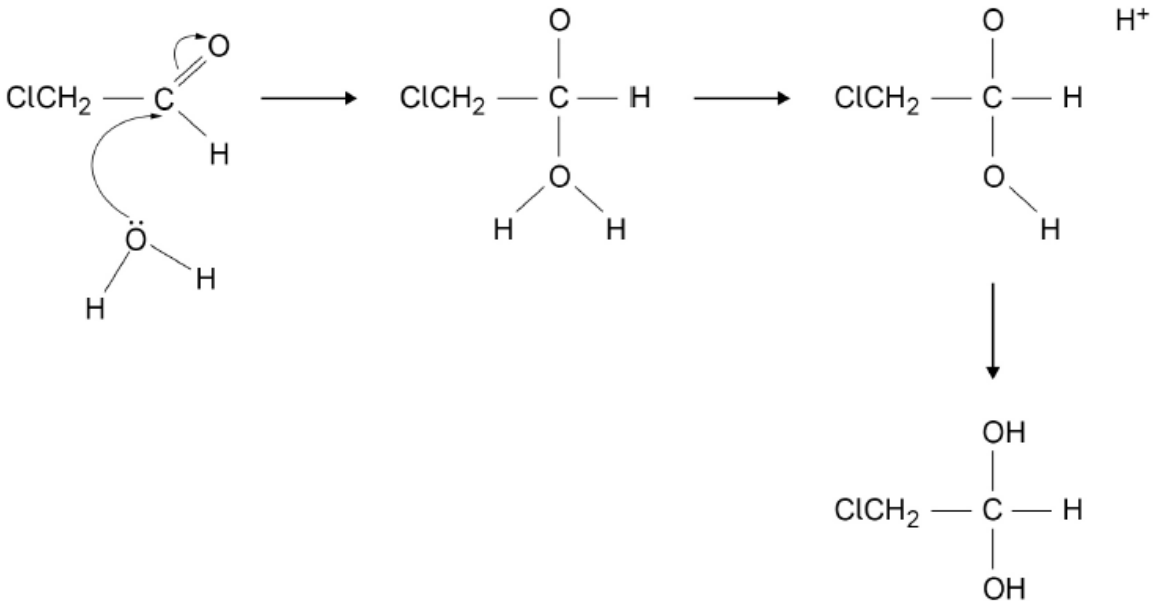
Calculate the equilibrium concentration, in mol dm^{-3}, of $ClCH_2CH(OH)_2$

[5 marks]

Concentration _____ mol dm^{-3}

0 9 . 5 **Figure 6** shows an incomplete nucleophilic addition mechanism for the reaction of water with chloroethanal.

Figure 6



Complete the mechanism in **Figure 6** by adding **two** curly arrows, all relevant charges and any lone pairs of electrons involved.

[3 marks]

0 9 . 6 When an excess of water is added to ethanal a similar nucleophilic addition reaction occurs.

$$CH_3CHO(aq) + H_2O(l) \rightleftharpoons CH_3CH(OH)_2(aq)$$

Suggest why this reaction is slower than the reaction in Question **09.5**.

[3 marks]

2. June/ 2019/Paper_2/No.5

0 5 The rate constant, k, for a reaction varies with temperature as shown by the equation

$$k = Ae^{-E_a/RT}$$

For this reaction, at 25 °C, $k = 3.46 \times 10^{-8}$ s^{-1}
The activation energy $E_a = 96.2$ kJ mol^{-1}
The gas constant $R = 8.31$ J K^{-1} mol^{-1}

Calculate a value for the Arrhenius constant, A, for this reaction.
Give the units for A.

[4 marks]

A _____ Units _____

3. June/2021/Paper_2/No.5

0 5 This question is about equilibrium.

0 5 . 1 1 mol of a diester with molecular formula $C_7H_{12}O_4$ is added to 1 mol of water in the presence of a small amount of catalyst.
The mixture is left to reach equilibrium at a constant temperature.

$$C_7H_{12}O_4(l) + 2\,H_2O(l) \rightleftharpoons 2\,CH_3COOH(l) + HO(CH_2)_3OH(l)$$

At equilibrium, x mol of ethanoic acid are present in the mixture.

Complete **Table 2** by deducing the amounts, in terms of x, of the diester, water and diol present in the equilibrium mixture.

[3 marks]

Table 2

	Amount in the mixture / mol			
	Diester	**Water**	**Acid**	**Diol**
At the start	1	1	0	0
At equilibrium			x	

0 5 . 2 Deduce the structure of the diester in Question **05.1**

[1 mark]

0 5 . 3 A new equilibrium mixture of the substances from Question **05.1** is prepared at a different temperature.

$$C_7H_{12}O_4(l) + 2\,H_2O(l) \rightleftharpoons 2\,CH_3COOH(l) + HO(CH_2)_3OH(l)$$

Table 3 shows the amount of each substance in this new equilibrium mixture.

Table 3

Amount in the mixture / mol				
	Diester	**Water**	**Acid**	**Diol**
At equilibrium	0.971	To be calculated	0.452	0.273

The value of the equilibrium constant, K_c is 0.161 at this temperature.

Calculate the amount of water, in mol, in this new equilibrium mixture.
Show your working.

[3 marks]

Amount of water _____ mol