

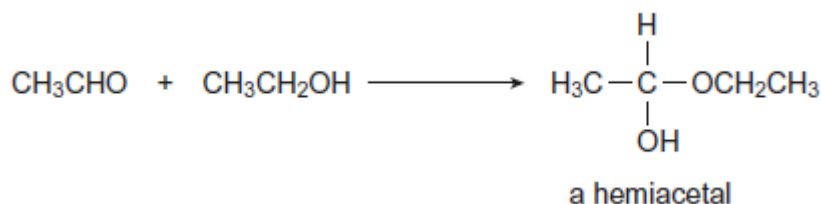
Name of the Student: \_\_\_\_\_

Max. Marks : 18 Marks

Time : 18 Minutes

Q1.

Hemiacetals and acetals are compounds formed by the reaction of aldehydes with alcohols, such as the reaction of ethanal with ethanol.



- (a) (i) Use your knowledge of carbonyl mechanisms to suggest the name of the mechanism of this reaction.

\_\_\_\_\_

(1)

- (ii) Outline how an ethanol molecule reacts with an ethanal molecule in the first step of this mechanism. Include two curly arrows to show the movement of electron pairs.

(2)

- (b) The reaction produces a racemic mixture of chiral molecules.

- (i) Explain the meaning of the term racemic mixture.

\_\_\_\_\_  
\_\_\_\_\_

(1)

- (ii) State the relationship between two chiral molecules with the same structural formula.

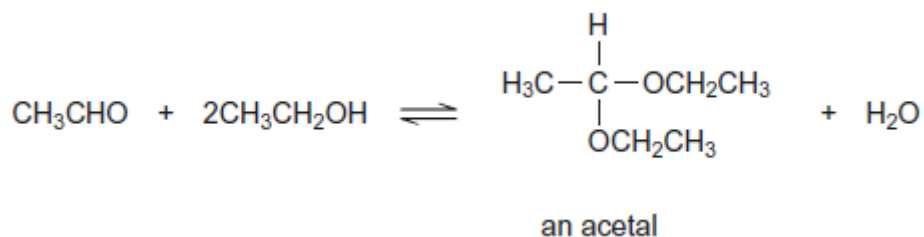
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(1)

- (c) In the presence of an acid catalyst such as dry hydrogen chloride, ethanal reacts with an

excess of ethanol to form an acetal.

The overall reaction of ethanal with an excess of ethanol forms an equilibrium mixture as shown. All reactants and products are liquids.



A mixture of 0.75 mol of ethanal and 5.00 mol of ethanol was left to reach equilibrium in the presence of dry hydrogen chloride at a given temperature. The equilibrium mixture contained 0.42 mol of the acetal.

- (i) Calculate the amount, in moles, of ethanal and of ethanol in this equilibrium mixture.

Amount of ethanal \_\_\_\_\_ mol

Amount of ethanol \_\_\_\_\_ mol

Space for working \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(2)

- (ii) In a different experiment using the same reaction as in part (c), an equilibrium mixture was established at a given temperature. This mixture contained 0.58 mol of ethanal, 3.76 mol of ethanol, 0.37 mol of the acetal and 0.65 mol of water in a total volume of 310 cm<sup>3</sup>.

Write an expression for the equilibrium constant  $K_c$  for this reaction.

Calculate a value for  $K_c$  at this temperature. Give units with your answer.

$K_c$  \_\_\_\_\_

\_\_\_\_\_

Calculation \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(4)

- (d) Draw the structure of the acetal ( $C_4H_8O_2$ ) formed by the reaction of ethanal with ethane-1,2-diol.

(1)

(Total 12 marks)

Q2.

This question is about magnesium chloride.

- (a) Write the equation, including state symbols, for the process corresponding to the enthalpy of solution of magnesium chloride.

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(1)

- (b) Use these data to calculate the standard enthalpy of solution of magnesium chloride.

Enthalpy of lattice dissociation of  $\text{MgCl}_2$  =  $+2493 \text{ kJ mol}^{-1}$

Enthalpy of hydration of magnesium ions =  $-1920 \text{ kJ mol}^{-1}$

Enthalpy of hydration of chloride ions =  $-364 \text{ kJ mol}^{-1}$

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(2)

- (c) Solubility is the measure of how much of a substance can be dissolved in water to make a saturated solution. A salt solution is saturated when an undissolved solid is in equilibrium with its aqueous ions.

Use your answer to part (b) to deduce how the solubility of  $\text{MgCl}_2$  changes as the temperature is increased.

Explain your answer.

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(3)

(Total 6 marks)