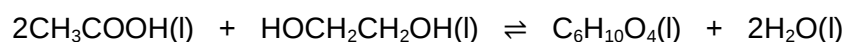


Name of the Student: _____

Max. Marks : 20 Marks

Time : 20 Minutes

Q1.

Ethanoic acid and ethane-1,2-diol react together to form the diester ($C_6H_{10}O_4$) as shown.

- (a) Draw a structural formula for the diester
- $C_6H_{10}O_4$

(1)

- (b) A small amount of catalyst was added to a mixture of 0.470 mol of ethanoic acid and 0.205 mol of ethane-1,2-diol.

The mixture was left to reach equilibrium at a constant temperature.

Complete **Table 1**.**Table 1**

Amount in the mixture / mol				
	CH_3COOH	$HOCH_2CH_2OH$	$C_6H_{10}O_4$	H_2O
At the start	0.470	0.205	0	0
At equilibrium	0.180			

Space for working

(3)

- (c) Write an expression for the equilibrium constant,
- K_c
- , for the reaction.

The total volume of the mixture does not need to be measured to allow a correct value for K_c to be calculated.

Justify this statement.

Expression

Justification _____

(2)

- (d) A different mixture of ethanoic acid, ethane-1,2-diol and water was prepared and left to reach equilibrium at a different temperature from the experiment in part (b)

The amounts present in the new equilibrium mixture are shown in **Table 2**.

Table 2

Amount in the mixture / mol				
	CH ₃ COOH	HOCH ₂ CH ₂ OH	C ₆ H ₁₀ O ₄	H ₂ O
At new equilibrium	To be calculated	0.264	0.802	1.15

The value of K_c was 6.45 at this different temperature.

Use this value and the data in **Table 2** to calculate the amount, in mol, of ethanoic acid present in the new equilibrium mixture.

Give your answer to the appropriate number of significant figures.

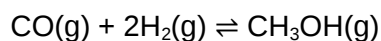
Amount of ethanoic acid _____ mol

(3)

(Total 9 marks)

Q2.

Methanol can be manufactured by the reaction of carbon monoxide with hydrogen



In an experiment, 0.73 mol of carbon monoxide was heated with 1.25 mol of hydrogen. An equilibrium mixture was formed that contained 0.43 mol of methanol.

- (a) Calculate the amount, in moles, of each reactant present at equilibrium.

Amount of carbon monoxide = _____ mol

Amount of hydrogen = _____ mol

(2)

- (b) Write an expression for the equilibrium constant, K_c , for this reaction.

(1)

- (c) In another experiment at a different temperature, the equilibrium mixture contained 0.452 mol of carbon monoxide, 0.106 mol of hydrogen and 0.273 mol of methanol in a flask of volume $9.40 \times 10^3 \text{ cm}^3$.

Calculate the value of the equilibrium constant, K_c , at this temperature and state the units.

K_c = _____ Units = _____

(4)

- (d) The total pressure of this equilibrium mixture in the flask was 482.9 kPa.

Calculate the temperature, in $^{\circ}\text{C}$, of the equilibrium mixture.

(The ideal gas constant $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$)

Temperature = _____ °C
(4)
(Total 11 marks)