

Name of the Student: _____

Max. Marks : 22 Marks

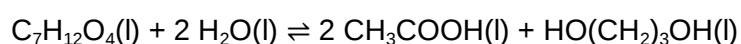
Time : 22 Minutes

Q1.

This question is about equilibrium.

- (a) 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.



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

Complete **Table 1** by deducing the amounts, in terms of x, of the diester, water and diol present in the equilibrium mixture.

Table 1

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

(3)

- (b) Deduce the structure of the diester in part (a)

(1)

- (c) A new equilibrium mixture of the substances from part (a) is prepared at a different temperature.

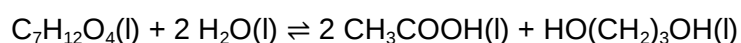
**Table 2** shows the amount of each substance in this new equilibrium mixture.

Table 2

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.

Amount of water _____ mol
(3)
(Total 7 marks)

Q2.

This question is about isomers with the molecular formula $C_5H_{10}O$

- (a) Draw the skeletal formula of a branched chain aldehyde with molecular formula $C_5H_{10}O$ that is optically active.

(1)

- (b) Describe how you distinguish between separate samples of the two enantiomers of the branched chain aldehyde $C_5H_{10}O$

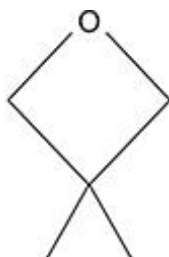
(2)

- (c) Draw the *E* and *Z* forms of a structural isomer of $C_5H_{10}O$ that shows **both** optical and geometric isomerism.

<i>E</i> isomer	<i>Z</i> isomer

(2)

- (d) Isomer J is cyclic and has an ether functional group (C–O–C)
Isomer J has only three peaks in its ^{13}C NMR spectrum.



Isomer J

Draw **two** other cyclic isomers of $C_5H_{10}O$ that have an ether functional group and only three peaks in their ^{13}C NMR spectra.

Q3.

This question is about ethanedioic acid ($\text{H}_2\text{C}_2\text{O}_4$) which is a dicarboxylic acid.

- (a) Draw the skeletal formula of ethanedioic acid.

(1)

- (b) Ethanedioic acid is formed by the oxidation of ethane-1,2-diol ($\text{HOCH}_2\text{CH}_2\text{OH}$).

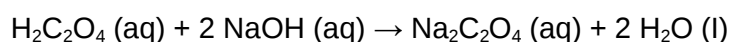
State suitable reagent(s) and a condition for this reaction.

Reagent(s) _____

Condition _____

(2)

- (c) Ethanedioic acid reacts with an excess of sodium hydroxide to form sodium ethanedioate.



A student mixes 10.0 cm^3 of $0.400 \text{ mol dm}^{-3}$ ethanedioic acid with 50.0 cm^3 of $0.200 \text{ mol dm}^{-3}$ sodium hydroxide.

Show that the sodium hydroxide is in excess.

Calculate the mass, in mg, of sodium ethanedioate that can be formed in this reaction.

Mass of sodium ethanedioate _____ mg

(5)

(Total 8 marks)