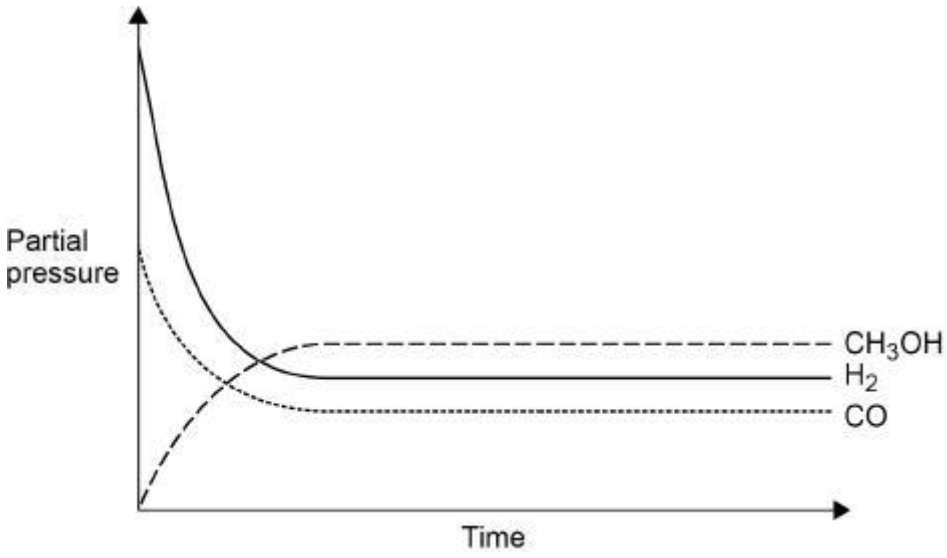
Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Q1.

Methanol can be manufactured in a reversible reaction as shown.

$CO(g) + 2\ H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H^{\ominus} = -91\ kJ\ mol^{-1}$

The graph below shows how the partial pressures change with time at a constant temperature.



(a) Draw a cross (x) on the appropriate axis of the graph when the mixture reaches equilibrium.

(1)

(b) A 0.230 mol sample of carbon monoxide is mixed with hydrogen in a 1:2 mol ratio and allowed to reach equilibrium in a sealed flask at temperature *T*.
At equilibrium the mixture contains 0.120 mol of carbon monoxide.
The total pressure of this mixture is 1.04×10^4 kPa

Calculate the partial pressure, in kPa, of hydrogen in the equilibrium mixture.

Partial pressure of hydrogen _____ kPa

(4)

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(c) Give an expression for the equilibrium constant (K_p) for this reaction.

State the units.

K_p

Units _____

(2)

(d) Some more carbon monoxide is added to the mixture in part (b). The new mixture is allowed to reach equilibrium at temperature *T*.

State the effect, if any, on the partial pressure of methanol and on the value of K_p

Effect on partial pressure of methanol _____

Effect on value of K_p _____

(2)

(e) State the effect, if any, of the addition of a catalyst on the value of K_p for this equilibrium. Explain your answer.

Effect on value of K_p _____

Explanation _____

_____

_____

(2)

(Total 11 marks)

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Q2.

Which statement about the addition of a catalyst to an equilibrium mixture is correct?

A The activation energy for the reverse reaction increases. ⬭

B The equilibrium constant for the forward reaction increases. ⬭

C The rate of the reverse reaction increases. ⬭

D The enthalpy change for the forward reaction decreases. ⬭

(Total 1 mark)

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Q3.

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.

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

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

Complete **Table 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.

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

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.

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Amount of water _____ mol

(3)

(Total 7 marks)

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