Q1. The following information concerns the equilibrium gas-phase synthesis of methanol.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa. The number of moles of CO, H_2 and CH_3OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

Substance	ΔH _f / kJ mol⁻¹	S / J K mol
CO(g)	-110	198
H ₂ (g)	0	131
CH₃OH(g)	-201	240

With pressures expressed in MPa units, the value of the equilibrium constant, $K_{\scriptscriptstyle p}$, under these conditions is

- **A** 1.37
- **B** 1.66
- **C** 2.82
- **D** 4.80

(Total 1 mark)

Q2.The following information concerns the equilibrium gas-phase synthesis of methanol.

$$CO(g) + 2H_2(g) \rightleftharpoons CH3OH(g)$$

At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa. The number of moles of CO, H_2 and CH_3OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

Substance	ΔH _€ / kJ mol⁻¹	S / J K mol	
CO(g)	-110	198	

H ₂ (g)	0	131	
CH₃OH(g)	-201	240	

Which one of the following statements applies to this equilibrium?

- **A** The value of K_p increases if the temperature is raised.
- **B** The value of K_{p} increases if the pressure is raised.
- **C** The yield of methanol decreases if the temperature is lowered.
- **D** The yield of methanol decreases if the pressure is lowered.

(Total 1 mark)

Q3. Hydrogen and carbon monoxide were mixed in a 2:1 mole ratio. The mixture was allowed to reach equilibrium according to the following equation at a fixed temperature and a total pressure of 1.75 × 10⁴ kPa.

$$2H_2(g) + CO(g) \rightleftharpoons CH_3OH(g)$$

- (a) The equilibrium mixture contained 0.430 mol of carbon monoxide and 0.0850 mol of methanol.
 - (i) Calculate the number of moles of hydrogen present in the equilibrium mixture.
 - (ii) Hence calculate the mole fraction of hydrogen in the equilibrium mixture.

(iii) Calculate the partial pressure of hydrogen in the equilibrium mixture.

(b)	carbo	different mixture of the three gases at equilibrium, the partial pressure of on monoxide was 7550 kPa, the partial pressure of hydrogen was 12300 kPa the partial pressure of methanol was 2710 kPa.	
	(i)	Write an expression for the equilibrium constant, K_p , for this reaction.	
	(ii)	Calculate the value of the equilibrium constant, K_0 , for the reaction under these	
	()	conditions and state its units.	
		Κ ,	
		Units	
(c)		Two isomeric esters E and F formed from methanol have the molecular formula $C_6H_{12}O_2$	
	Isom	er E has only 2 singlet peaks in its proton n.m.r. spectrum.	
	Isomer F is optically active. Draw the structures of these two isomers.		
	Isom	ner E	

(5)

(3)

Isomer **F**

Q4.

Summarised directions for recording responses to multiple completion questions				
(i), (ii) and (iii) only	B	C	D	
	(i) and (iii) only	(ii) and (iv) only	(iv) alone	

Which of the following statements about a catalyst is / are true?

- (i) It speeds up the forward reaction and slows down the reversere action.
- (iii) It increases the proportion of molecules with higher energies.
- (iii) A homogeneous catalyst usually acts in the solid state.
- (iv) It does not alter the value of the equilibrium constant.

(Total 1 mark)