Practice Question Set For A-Level

Subject : Chemistry

Paper-1 Topic: Physical 1_Equilibrium Constant Kp For Homogeneous Systems

Name of the Student:____

Max. Marks : 27 Marks **Time : 27 Minutes**

Q1.

Nitrogen and hydrogen were mixed in a 1:3 mole ratio and left to reach equilibrium in a flask at a temperature of 550 K. The equation for the reaction between nitrogen and hydrogen is shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) When equilibrium was reached, the total pressure in the flask was 150 kPa and the mole fraction of $NH_3(g)$ in the mixture was 0.80

Calculate the partial pressure of each gas in this equilibrium mixture.

Partial pressure of nitrogen ____________________ kPa

Partial pressure of hydrogen ____________________ kPa

Partial pressure of ammonia ____________________ kPa

(3)

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

K_p

(1)

(c) In a different equilibrium mixture, under different conditions, the partial pressures of the gases are shown in the table.

Gas	**Partial pressure / kPa**
N_2	1.20×10^2

H_2	1.50×10^2
NH_3	1.10×10^3

Calculate the value of the equilibrium constant (K_p) for this reaction and give its units.

K_p ____________________ Units ____________________

(2)

(d) The enthalpy change for the reaction is –92 kJ mol^{-1}

State the effect, if any, of an increase in temperature on the value of K_p for this reaction.
Justify your answer.

Effect on K_p ____

Justification ____

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(3)

(Total 9 marks)

Q2.

Which statement about K_p is correct for this reaction in the gas phase?

$$W + X + Y_2 \rightleftharpoons WXY + Y \qquad \Delta H = -46\ \text{kJ mol}^{-1}$$

A	The value of K_p is independent of pressure.	○
B	The value of K_p increases as pressure increases.	○
C	The value of K_p increases as temperature increases.	○
D	The value of K_p is independent of temperature.	○

(Total 1 mark)

Q3.

An equilibrium mixture is prepared in a container of fixed volume.

$$CO(g) \quad + \quad Cl_2(g) \quad \rightleftharpoons \quad COCl_2(g) \qquad\qquad \Delta H = -108 \text{ kJ mol}^{-1}$$

The temperature of this mixture is decreased and the mixture is allowed to reach a new equilibrium.

Which is greater for the new equilibrium than for the original equilibrium?

A The mole fraction of carbon monoxide ○

B The partial pressure of chlorine ○

C The total pressure of the mixture ○

D The value of the equilibrium constant, K_p ○

(Total 1 mark)

Q4.

Many chemical processes release waste products into the atmosphere. Scientists are developing new solid catalysts to convert more efficiently these emissions into useful products, such as fuels. One example is a catalyst to convert these emissions into methanol. The catalyst is thought to work by breaking a H–H bond.

An equation for this formation of methanol is given below.

$$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g) \quad \Delta H = -49 \text{ kJ mol}^{-1}$$

Some mean bond enthalpies are shown in the following table.

Bond	C=O	C–H	C–O	O–H
Mean bond enthalpy / kJ mol^{-1}	743	412	360	463

(a) Use the enthalpy change for the reaction and data from the table to calculate a value for the H–H bond enthalpy.

H–H bond enthalpy = _______________ kJ mol^{-1}

(3)

(b) A data book value for the H–H bond enthalpy is 436 kJ mol^{-1}.

Suggest **one** reason why this value is different from your answer to part (a).

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(1)

(c) Suggest **one** environmental advantage of manufacturing methanol fuel by this reaction.

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(1)

(d) Use Le Chatelier's principle to justify why the reaction is carried out at a high pressure rather than at atmospheric pressure.

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(3)

(e) Suggest why the catalyst used in this process may become less efficient if the carbon dioxide and hydrogen contain impurities.

(1)

(f) In a laboratory experiment to investigate the reaction shown in the equation below, 1.0 mol of carbon dioxide and 3.0 mol of hydrogen were sealed into a container. After the mixture had reached equilibrium, at a pressure of 500 kPa, the yield of methanol was 0.86 mol.

$$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g)$$

Calculate a value for K_p
Give your answer to the appropriate number of significant figures.
Give units with your answer.

K_p = ________________ Units = ________________

(7)

(Total 16 marks)