**Equilibria – Homework 1**

1. For each of the following equilibria, write the expression for the equilibrium constant Kc and state its units:

1. 2NO2(g) == N2O4(g)
2. CH3CH2CO2H(l) + CH3CH2OH(l) == CH3CH2CO2CH2CH3(l) + H2O(l)
3. H2(g) + I2(g) == 2HI(g)
4. 2SO2(g) + O2(g) == 2SO3(g)
5. N2(g) + 3H2(g) == 2NH3(g)

2. For the equilibrium PCl5(g) == PCl3(g) + Cl2(g)

the equilibrium concentrations of PCl5, PCl3 and Cl2 are 1.0, 0.205 and 0.205 moldm-3 respectively. Calculate the value of Kc.

3. For the equilibrium 2N2O5(g) == 2N2O4(g) + O2(g)

The equilibrium concentrations are [N2O5] = 1.0 moldm-3, [N2O4] = 0.11 moldm-3, [O2] = 0.11 moldm-3.

Calculate the value of Kc.

4. The reaction for the formation of hydrogen iodide does not go to completion but reaches an equilibrium: H2(g) + I2(g) == 2HI(g)

A mixture of 1.9 mol of H2 and 1.9 mol of I2 was prepared and allowed to reach equilibrium in a closed vessel on 250 cm3 capacity. The resulting equilibrium mixture was found to contain 3.0 mol of HI. Calculate the value of Kc.

5. Consider the equilibrium: N2O4(g) == 2NO2(g).

1 mol of dinitrogen tetroxide, N2O4, was introduced into a vessel of volume 10 dm3. At equilibrium 50% had dissociated. Calculate Kc for the reaction.

6. In an experiment, 9.0 moles of nitrogen and 27 moles of hydrogen were placed into a vessel of volume 10 dm3 and allowed to reach equilibrium. It was found that two thirds of the nitrogen and hydrogen were converted into ammonia. Calculate Kc for the reaction.

N2(g) + 3H2(g) == 2NH3(g)

7. Hydrogen chloride can be oxidised to chlorine by the Deacon process:

4HCl(g) + O2(g) == 2Cl2(g) + 2H2O(g)

0.800 mol of hydrogen chloride was mixed with 0.200 mol of oxygen in a vessel of volume 10 dm3. At equilibrium it was found that the mixture contained 0.200 mol of hydrogen chloride. Calculate Kc for the reaction.

8. A 0.04 sample of SO3 is introduced into a 3.04 litre vessel and allowed to reach

equilibrium. The amount of SO3 present at equilibrium is found to be 0.0284 mole. Calculate the value of Kc for the reaction 2SO3(g) == 2SO2(g) + O2(g).

9. The reaction between carbon monoxide and hydrogen proceeds according to the equilibrium CO(g) + 2H2(g) == CH3OH(g) A 1 litre flask maintained at 700K contains 0.1 mole of carbon monoxide. After 0.3 mole of hydrogen is added, 0.06 mol of ethanol are formed. Calculate the equilibrium constant Kc.

10. When 1.0 mole each of ethanoic acid and ethanol were allowed to reach equilibrium in a sealed vessel of volume 500 cm3, the amount of ethanoic acid present at equilibrium was found to be 0.33 mole. Calculate the value of Kc for the reaction CH3COOH + CH3CH2OH == CH3COOCH2CH3 + H2O(l)

11. At 723K, hydrogen and iodine react together and the following equilibrium is established: H2(g) + I2(g) == 2HI(g)

The value of Kc for this equilibrium is 64. In an experiment, equal amounts of hydrogen and iodine were mixed together, and the equilibrium mixture of the three gases in a container of volume 1 dm3 at 723K was found to contain 1.5 moles of iodine. Calculate the concentration of hydrogen iodide in the mixture at 723K.

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