MEGA LECTURE

**Topic 11 Exercise 4 – $K_p$**

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

i) $2NO_2(g) == N_2O_4(g)$

ii) $H_2(g) + I_2(g) == 2HI(g)$

iii) $2SO_2(g) + O_2(g) == 2SO_3(g)$

iv) $N_2(g) + 3H_2(g) == 2NH_3(g)$

2. For the equilibrium $PCl_5(g) == PCl_3(g) + Cl_2(g)$
the equilibrium moles of $PCl_5$, $PCl_3$ and $Cl_2$ are 1.0, 0.205 and 0.205 respectively at a constant pressure of 100 kPa. Calculate the value of $K_p$.

3. For the equilibrium $2N_2O_5(g) == 2N_2O_4(g) + O_2(g)$
The equilibrium moles are $N_2O_5$ = 1.0, $N_2O_4$ = 0.11, $O_2$ = 0.11 at a constant pressure of 200 kPa
Calculate the value of $K_p$.

4. The reaction for the formation of hydrogen iodide does not go to completion but reaches an equilibrium: $H_2(g) + I_2(g) == 2HI(g)$
A mixture of 1.9 mol of $H_2$ and 1.9 mol of $I_2$ was prepared and allowed to reach equilibrium at 30 atm. The resulting equilibrium mixture was found to contain 3.0 mol of HI. Calculate the value of Kp.

5. Consider the equilibrium: $N_2O_4(g) == 2NO_2(g)$.
1 mol of dinitrogen tetroxide, $N_2O_4$, was introduced into a vessel. At equilibrium at a constant pressure of 100 kPa, 50% had dissociated. Calculate Kp for the reaction.

6. In an experiment, 9.0 moles of nitrogen and 27 moles of hydrogen were p and allowed to reach equilibrium at a constant pressure of 25 Mpa. It was found that two thirds of the nitrogen and hydrogen were converted into ammonia. Calculate Kp for the reaction.
$N_2(g) + 3H_2(g) == 2NH_3(g)$

7. Hydrogen chloride can be oxidised to chlorine by the Deacon process:
$4HCl(g) + O_2(g) == 2Cl_2(g) + 2H_2O(g)$
0.800 mol of hydrogen chloride was mixed with 0.200 mol of oxygen at a constant pressure of 100 kPa. At equilibrium it was found that the mixture contained 0.200 mol of hydrogen chloride. Calculate Kp for the reaction.

8. A 0.04 sample of $SO_3$ is allowed to reach equilibrium at a constant pressure of 200 kPa. The amount of $SO_3$ present at equilibrium is found to be 0.0284 mole. Calculate the value of $K_p$ for the reaction $2SO_3(g) == 2SO_2(g) + O_2(g)$.

9. The reaction between carbon monoxide and hydrogen proceeds according to the equilibrium $CO(g) + 2H_2(g) == CH_3OH(g)$ A vessel contains 0.1 mole of carbon monoxide. After 0.3 mole of hydrogen is added, 0.06 mol of methanol are formed. The pressure was kept constant at 300 kPa. Calculate the equilibrium constant $K_p$.

10. Hydrogen and iodine react together and the following equilibrium is established:
$H_2(g) + I_2(g) == 2HI(g)$
The value of $K_p$ 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 at a constant pressure of 100 kPa was found to contain 1.5 moles of iodine. Calculate the partial pressure of hydrogen iodide in the mixture at 723K.