CHAPTERS: Thermodynamics, Equilibrium, Hydrogen, Boron Family

CLASS: XI

TIME =2 hrs. **Maximum marks =45**

Section - 1 [1 marks each] **2x1= 2**

1. What is the value of ΔG when ice and water are in equilibrium?
2. Name the isotope of hydrogen which finds use is nuclear reactor.

Section - 2 [2 marks each] **9x2 = 18**

3. At 700K, the equilibrium constant for the reaction

   $H_2(g) + I_2(g) \rightleftharpoons 2HI\ (g)$ is 58.4. If 0.5 mol L^{-1} of HI(g) is present at equilibrium at 700K, what are the concentration of $H_2(g)$ and $I_2(g)$ assuming that we initially started with HI(g) and allowed it to reach equilibrium at 700K?

4. Observe the given hydrogenation reaction :

   $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$.

   Calculate the enthalpy change for the reaction using the following combustion data :

   $C_2H_4(g) + 3O_2 \rightarrow 2CO_2(g) + 2H_2O(g)$; $\Delta H = -1401k\ J\ mol^{-1}$

   $C_2H_6(g) + \frac{7}{2} O_2 \rightarrow 2\ CO_2(g) + 3\ H_2O(l)$ $\Delta H = -1550k\ J\ mol^{-1}$

   $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(\ell)$; $\Delta H = -286.0k\ J\ mol^{-1}$

5. Answer the following as directed:

   (i) H – H, D – D, F – F (increasing bond dissociation enthalpy)

   (ii) NaH, MgH_2, and H_2O (decreasing reducing property)

6. Give reason :

   (i) NH_3 has a higher boiling point than PH_3.

   (ii) H_2O_2 cannot be stored for long.

7. (a) Why is entropy of a substance take as zero at 0 K ?

   (b) Calculate the standard Gibbs' free energy change for the reaction

   $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 298K

   The value of equilibrium constant for the above reaction is

   6.6×10^5 [R = 8.314 J K^{-1} mol^{-1}] [log 6.6 = 0.8195]

8. (i) Using the data given below, calculate the value of equilibrium constant for the reaction at 298 K.

   $3\ CH \equiv CH(g) \rightleftharpoons C_6H_6(g)$ assuming ideal gas behavior

   $\Delta_f G^o$ [$HC \equiv CH(g)$] = 2.09×10^5 J mol^{-1}

   $\Delta_f G^o$ [$C_6H_6(g)$] = 1.24×10^5 J mol^{-1}

   R = 8.314 JK^{-1} mol^{-1}

   (ii) The molar enthalpy of vapourisation of acetone is less than that of water. Why?

9. At 473 K, equilibrium constant, Kc for decomposition of phosphorus pentachloride PCl_5 is 8.3×10^3.

   If decomposition is depicted as :

   $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$; ΔrH^o = 124.0 kJ mol^{-1}

   (i) Writ an expression for Kc for the reaction ?

   (ii) What is the value of Kc for reverse reaction at the same temperature?

(iii) What would be the effect on Kc if (a) more $PC\ell_5$ is added (b) pressure is increased.

10. Complete and balance the following reactions :

(i) $CO(g) + H_2(g) \xrightarrow[\Delta]{Co}$

(ii) $Ca_3N_2(s) + H_2O\ (l) \longrightarrow$

(iii) $PbS\ (s) + H_2O_2\ (aq) \longrightarrow$

11. (i) Justify the following statement

(a) An exothermic reaction is always thermodynamically stable.

(b) The entropy of a substance increases on going from liquid to vapour state at any temperature

(ii) What is an isolated system?

Section - 3 [3 marks each] **5x3=15**

12. (i) Name the class of hydrides to which H_2O and NaH belong.

(ii) What is understood by hydride gap?

(iii) What do you mean by 15 volume H_2O_2 solution?

13. The solubility product of $A\ell(OH)_3$ is 2.7×10^{11}. Calculate its solubility is g L^{-1} and also find out the pH of this solution. (Atomic mass of $A\ell$ = 27)

14. (a) The reaction quotient of a reversible reaction is Qc and the equilibrium constant is Kc. What do you conclude for the reaction if Qc < Kc?

(b) State Le Chatelier's principle.

(c) In qualitative analysis, $NH_4C\ell$ is added before adding NH_4OH solution for testing of III group radical [Fe^{3+}, Cr^{3+} and $A\ell^{3+}$]. Explain.

15. (a) Why do takes freeze from top to bottom?

(b) Distinguish between ortho and para hydrogen

(c) What cause temporary & permanent hardness of water ?

16. (a) What happens to ionic product of water it temperature is increased?

(b) The value of Kw at a certain temperature is 9×10^{-14}. Calculate the $[H_3O^+]$ and pH of water at this temperature.

Section - 4 [5 marks each] **2x5=10**

17. (i) State Hess's Law of constant heat summation. How does if follow from the first Law of thermodynamics.

(ii) Determine $\Delta_r H^o$, at 298K for reaction:

$C(graphite) + 2H_2(g) \longrightarrow CH_4(g)$; $\Delta_r H^o = ?$

Given

a) $C\ (graphite) + O_2(g) \longrightarrow CO_2(g)$ $\Delta_r H^o = -393.51$ kJ mol^{-1}

b) $H_2(g) \frac{1}{2} O_2(g) \longrightarrow H_2O\ (l)$ $\Delta_r H^o = -285.8$ kJ mol^{-1}.

c) $CO_2(g) + 2H_2O(l) \longrightarrow CH_4(g) + 2O_2(g)$ $\Delta_r H^o = +890.3$ kJ mol^{-1}

(iii) (a) When 430 J of work was done on a system it lost 120J of energy as heat.

Calculate the internal energy of this process.

(b) What is internal energy ?

18. (i) For the reason :

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ the value of Kp is 3.6×10^{-2} at 500K. Calculate the value of Kc for the reaction at the same temperature [R = 0.083L bar K^{-1} mol^{-1}]

(ii) What do you understand by :

(a) Common ion effect

(b) Buffer solution.

(iii) Write the conjugate base for the species H_2O & NH_3.