

CHAPTERS: Thermodynamics, Equilibrium, Hydrogen, Boron Family**CLASS: XI****TIME =2 hrs.****Maximum marks =45****Section - 1 [1 marks each]****2x1= 2**

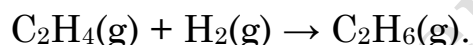
1. What is the value of ΔG when ice and water are in equilibrium?
2. Name the isotope of hydrogen which finds use in nuclear reactor.

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

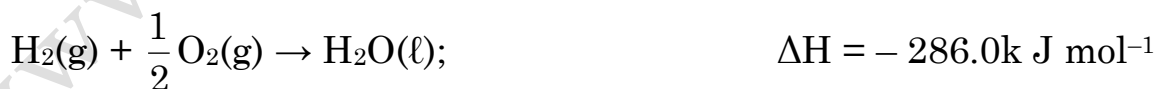
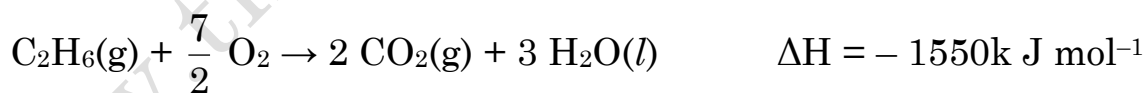
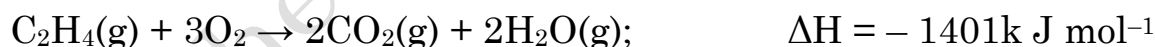
3. At 700K, the equilibrium constant for the reaction

$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ is 58.4. If 0.5 mol L^{-1} of $\text{HI}(\text{g})$ is present at equilibrium at 700K, what are the concentration of $\text{H}_2(\text{g})$ and $\text{I}_2(\text{g})$ assuming that we initially started with $\text{HI}(\text{g})$ and allowed it to reach equilibrium at 700K?

4. Observe the given hydrogenation reaction :



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



5. Answer the following as directed:

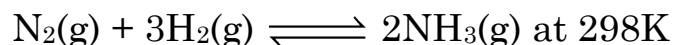
- (i) $\text{H}-\text{H}$, $\text{D}-\text{D}$, $\text{F}-\text{F}$ (increasing bond dissociation enthalpy)
- (ii) NaH , MgH_2 , and H_2O (decreasing reducing property)

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



The value of equilibrium constant for the above reaction is

$$6.6 \times 10^5 \quad [R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}] \quad [\log 6.6 = 0.8195]$$

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



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

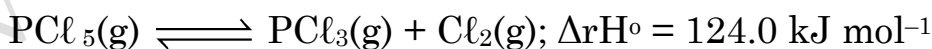
$$\Delta_f G^\circ [\text{C}_6\text{H}_6(\text{g})] = 1.24 \times 10^5 \text{ J mol}^{-1}$$

$$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$$

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

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

If decomposition is depicted as :



- (i) Write an expression for K_c for the reaction ?
- (ii) What is the value of K_c for reverse reaction at the same temperature?

- (iii) What would be the effect on K_c if (a) more PCl_5 is added (b) pressure is increased.
10. Complete and balance the following reactions :
- (i) $\text{CO(g)} + \text{H}_2\text{(g)} \xrightarrow[\Delta]{\text{Co}}$
- (ii) $\text{Ca}_3\text{N}_2\text{(s)} + \text{H}_2\text{O (l)} \longrightarrow$
- (iii) $\text{PbS (s)} + \text{H}_2\text{O}_2 \text{(aq)} \longrightarrow$
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 Al(OH)_3 is 2.7×10^{-11} . Calculate its solubility in g L^{-1} and also find out the pH of this solution. (Atomic mass of $\text{Al} = 27$)
14. (a) The reaction quotient of a reversible reaction is Q_c and the equilibrium constant is K_c . What do you conclude for the reaction if $Q_c < K_c$?
- (b) State Le Chatelier's principle.
- (c) In qualitative analysis, NH_4Cl is added before adding NH_4OH solution for testing of III group radical [Fe^{3+} , Cr^{3+} and Al^{3+}]. Explain.

15. (a) Why does it freeze from top to bottom?
(b) Distinguish between ortho and para hydrogen
(c) What causes temporary & permanent hardness of water?
16. (a) What happens to the ionic product of water if temperature is increased?
(b) The value of K_w 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 it follow from the first Law of thermodynamics.
(ii) Determine $\Delta_r H^\circ$, at 298K for reaction:



Given

- a) $C(\text{graphite}) + O_2(g) \longrightarrow CO_2(g) \Delta_r H^\circ = -393.51 \text{ kJ mol}^{-1}$
b) $H_2(g) + \frac{1}{2} O_2(g) \longrightarrow H_2O(l) \Delta_r H^\circ = -285.8 \text{ kJ mol}^{-1}$
c) $CO_2(g) + 2H_2O(l) \longrightarrow CH_4(g) + 2O_2(g) \Delta_r H^\circ = +890.3 \text{ kJ mol}^{-1}$
- (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 :

$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ the value of K_p is 3.6×10^{-2} at 500K. Calculate the value of K_c for the reaction at the same temperature [$R = 0.083 \text{ L bar K}^{-1} \text{ mol}^{-1}$]

(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 .