

UNIT 6

THERMODYNAMICS

Answer the questions. (1 Score each)

1. Write the Mathematical statement of first Law of thermodynamics?

Ans : $\Delta U = q + W$

2. How is the enthalpy change related to internal energy change in the case of process involving gaseous reactants and Products?

Ans : $\Delta H = \Delta U + \Delta nRT$

3. The heat content of a system is same as

- a) Free energy b) Internal Energy c) Enthalpy d) Chemical Potential

Ans : C) Enthalpy

4. In an exothermic reaction the enthalpy change of reaction is

- a) Positive b) Negative c) Zero d) None of these

Ans : b) Negative

5. The relationship between enthalpy , internal energy, pressure and volume of a system is

- a) $U = H + pV$ b) $H = U + pV$ c) $pV = H+U$ d) $H = U + p+V$

Ans: b) $H = U + pV$

6. A property whose value depend on the quantity or size of matter present in the system is known as -----

Ans: Extensive Property

Answer the questions. (2 Score each)

7. The enthalpy change for the reaction $N_{2(g)} + 3 H_{2(g)} \rightarrow 2 NH_{3(g)}$ is $- 91.8 \text{ kJ mol}^{-1}$ at 298 K. Calculate the internal energy change of the reaction? ($R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$)

Ans : $\Delta H = \Delta U + p\Delta V$

$$pV = nRT$$

$$\Delta H = \Delta U + \Delta nRT$$

$$\Delta U = \Delta H - \Delta nRT$$

$$\Delta H = -91.8 \text{ kJmol}^{-1} = -91800 \text{ J mol}^{-1} \quad T = 298 \text{ K}$$

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

$$\Delta n = 2 - 4 = -2$$

$$\Delta U = -91800 - (-2 \times 8.314 \times 298) = -91800 + 4955.144 = -86844.856 \text{ J}$$

$$\Delta U = -86.844 \text{ kJ mol}^{-1}$$

8. The equilibrium constant for a reaction is 10 at 27^o C. What will be the value of ΔG° ?
($R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$)

Ans :

$$T = 27 + 273 = 300 \text{ K}, \quad R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}, \quad \text{Equilibrium constant, } K_c = 10$$

$$\Delta G^\circ = -2.303 RT \log K$$

$$\Delta G^\circ = -2.303 \times 8.314 \times 300 \times \log 10$$

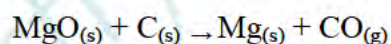
$$\Delta G^\circ = -5744.1 \text{ J}$$

9. Classify the following properties into Extensive and Intensive properties. [Heat Capacity, Enthalpy, Refractive index, Surface Tension]

Ans :

Extensive Property	Intensive Property
Heat Capacity	Refractive index
Enthalpy	Surface Tension

10. Find the temperature above which the reaction becomes spontaneous



$$\text{Given } \Delta H = 490 \text{ kJmol}^{-1} \text{ and } \Delta S = 198 \text{ JK}^{-1}\text{mol}^{-1}$$

Ans :

$$\Delta H = 490 \text{ kJmol}^{-1} = 490000 \text{ Jmol}^{-1}$$

$$\Delta S = 198 \text{ JK}^{-1}\text{mol}^{-1}$$

$$\Delta G = \Delta H - T\Delta S$$

$$\text{At Equilibrium, } \Delta G = 0$$

$$\Delta H = T\Delta S$$

$$T = \frac{\Delta H}{\Delta S} = \frac{490000}{198} = 2474 \text{ K}$$

Answer the questions. (4 Score each)

11. Match the following

A	B
1. Exothermic Reaction	A) Reversible Reaction
2. Isothermal Process	B) Isochoric Process
3. A process is carried out at constant volume	C) $\Delta H < 0$
4. A process carried out infinitesimally slow steps	D) $\Delta T = 0$

Ans: 1-C 2-D 3-B 4-A

12. Match the following

A	B
1. Isothermal	a) No exchange of heat between system and surroundings
2. Adiabatic	b) Constant Temperature
3. Isobaric	c) Constant Volume
4. Isochoric	d) Constant Pressure

Ans: 1-b 2-a 3- d 4-c

13. For the reaction $4\text{Fe}_{(s)} + 3\text{O}_{2(g)} \rightarrow 2\text{Fe}_2\text{O}_{3(s)}$ the entropy change is $-549 \text{ JK}^{-1}\text{mol}^{-1}$ at 298 K. In spite of the negative entropy change, why is the reaction spontaneous?
Given $\Delta H = -1648 \text{ kJmol}^{-1}$.

Ans:

$$\Delta H = -1648 \text{ kJmol}^{-1} = -1648000 \text{ Jmol}^{-1}$$

$$\Delta S = -549 \text{ JK}^{-1}\text{mol}^{-1}$$

$$T = 298 \text{ K}$$

$$\Delta G = \Delta H - T\Delta S$$

$$\begin{aligned} \Delta G &= -1648000 - (298 \times -549) = -1648000 + 163602 = -1484398 \text{ J mol}^{-1} \\ &= -1484.398 \text{ kJ mol}^{-1} \end{aligned}$$

Since ΔG is negative, the reaction is spontaneous.

- 14.A) What is the difference between System and Surroundings?
 B) What are the different types of systems?

Ans: The part of Universe which is under investigation and whose properties are being measured is called as system. Anything outside the system is called as surroundings.

Universe = System + Surroundings

b).

1. **Open System :** A system which can exchange both energy and matter with surroundings is called as Open system. Eg: Hot water in an open vessel

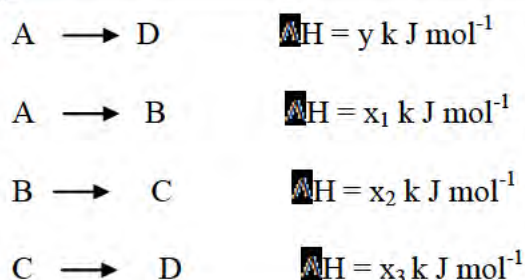
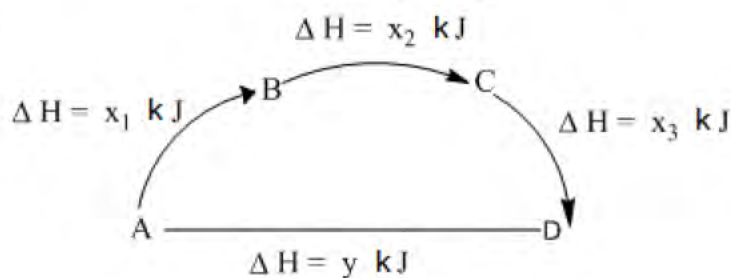
2. **Closed System :** A system which can exchange energy but not matter with surroundings is called as Closed System . Eg : Hot water in a closed vessel

3. **Isolated System :** A system which cannot exchange energy or matter with surroundings is called as Isolated System. Eg : Hot water in a thermos flask.

15. a) State Hess's Law

b) Give the illustration of Hess's Law

Ans: Hess's Law states that the enthalpy change in a chemical reaction is the same whether the reaction takes place in one step or in several steps



The total enthalpy change is $y = x_1 + x_2 + x_3 \text{ kJ mol}^{-1}$