

Total number of printed pages-4

3 (Sem-2/CBCS) CHE HC 2

2024

CHEMISTRY

(Honours Core)

Paper : CHE-HC-2026

(Physical Chemistry-II)

Full Marks : 60

Time : Three hours

***The figures in the margin indicate
full marks for the questions.***

1. Answer the following questions: $1 \times 7 = 7$
- (a) What do you mean by thermodynamics state function?
 - (b) Why is the first law of thermodynamics necessary?
 - (c) What is meant by $\Delta U = -P\Delta V$?
 - (d) Define molar heat capacity at constant volume.
 - (e) What do you mean by available energy?
 - (f) Write the S.I. unit of chemical potential.
 - (g) Write the statement of second law of thermodynamics given by Kelvin-Planck.

Contd.

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Contd.

2. Answer the following questions : $2 \times 4 = 8$

- (a) Define thermodynamic equilibrium.
- (b) Show that ΔG is a measure of total non-mechanical work.
- (c) How does chemical potential of an ideal solution change with temperature?
- (d) Define state function with an example.

3. Answer **any three** from following questions : $5 \times 3 = 15$

- (a) Derive the expression of work done in an isothermal reversible expansion of an ideal gas. 88g CO_2 gas is expanded isothermally and reversibly from 100 L to 120 L at 27°C . Calculate the amount of work done by the system. $3 + 2 = 5$
- (b) Derive Gibbs-Duhem equation for a two-component system.
- (c) For a cyclic process show that $\oint dS = 0$.
- (d) Predict the spontaneity of the following reactions : $1 \times 5 = 5$
 - (i) $2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$
 - (ii) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3$
 - (iii) $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3$
 - (iv) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$
 - (v) $2\text{HI}(\text{g}) \rightarrow \text{H}_2(\text{g}) + \text{I}_2(\text{g})$

(e) What is extensive property? For 1 mole of an ideal gas show that $\bar{C}_P - \bar{C}_V = R$.

$1 + 4 = 5$

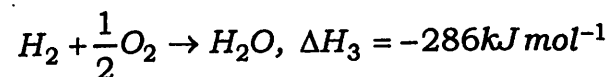
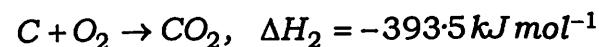
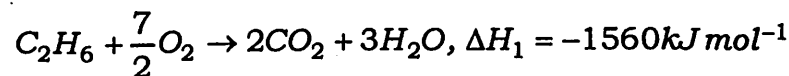
4. Answer **any three** questions from the following : $10 \times 3 = 30$

- (a) What is Joule-Thomson effect? Show that Joule-Thomson experiment is an isoenthalpic process. Define Joule-Thomson co-efficient. How can you determine Joule-Thomson co-efficient experimentally? Show that

$$\left(\frac{\partial H}{\partial P}\right)_T = -\mu_{JT} C_P. \quad 1 + 4 + 2 + 1 + 2 = 10$$

- (b) Derive the expression of efficiency of Carnot engine. Give the characteristics of η . Give the signs of w , ΔS and q in each step of the Carnot cycle. $5 + 2 + 3 = 10$

- (c) (i) Derive Kirchhoff's equation.
- (ii) Calculate the standard enthalpy change formation of C_2H_6 from the following data of heat of combustion : $6 + 4 = 10$



(d) Show that —

(i) $PV^{\gamma} = \text{constant}$ for an adiabatic process;

(ii) $\Delta S = C_V \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1}$ for an ideal gas;

(iii) $\Delta S_{\text{mixing}} = -nR \sum x_i \ln x_i$

3+2+5=10

(e) (i) For an irreversible process show that $\Delta S_{\text{univ}} \geq 0$ 5

(ii) What is residual entropy? Explain with an example. 1+4=5

(f) (i) Show that

$$K_p = K_x (P)^{\Delta n_g} = K_c (RT)^{\Delta n_g}$$

(ii) What are colligative properties? Explain two practical applications of colligative properties.