

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 : 1×7=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.

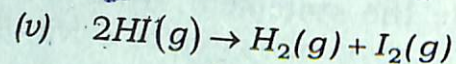
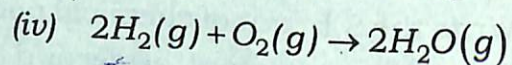
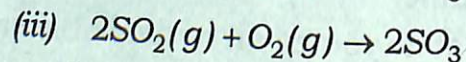
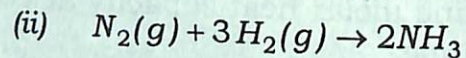
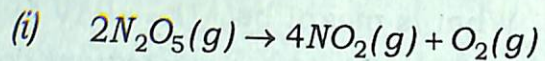
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2. Answer the following questions : $2 \times 4 = 8$

- (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.

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 100L to 120L 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 : $1 \times 5 = 5$



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

$1 + 4 = 5$

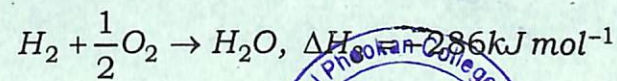
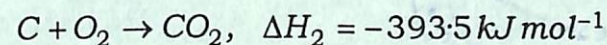
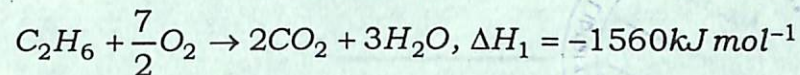
4. Answer **any three** questions from the following : $10 \times 3 = 30$

- (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

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

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

