

FYUGP/3rd Sem/25(NEP)New

2025

Four Year Under Graduate Programme (FYUGP)

3rd Semester Examination (Under NEP)

(New Session 2024-25)

CHEMISTRY (Major)

Paper Code : CEMMJ DC-301(A) & B

(Physical-II & Inorganic-II)

Full Marks : 30

Time : Two Hours

The figures in the margin indicate full marks.

*Candidates are required to give their answers
in their own words as far as practicable.*

[Use separate answers script for

Physical-II & Inorganic-II]

Paper : DC-301(A)

(Physical-II)

1. Answer any two questions :

1×2=2

- (a) Why is chemical potential often described as the "escaping tendency" of a component in a mixture?**
- (b) What is meant by partial molar property in a mixture?**

P.T.O.

$$G_1 = H - TS_1 \quad A_1 = U - TS_1$$

$$\left(2 \right) \frac{\partial}{\partial T} \left(\frac{G_1}{T} \right) = \frac{\partial}{\partial T} \left(\frac{H}{T} - S_1 \right) = \frac{\partial}{\partial T} \left(\frac{U}{T} - TS_1 \right)$$

- (c) Why does the Kelvin-Planck statement of the second law imply the impossibility of a perpetual motion machine of the second kind?

2. Answer any three questions : $2 \times 3 = 6$

- (a) The entropy of an isolated system cannot decrease. Justify or criticize.

(b) Show that $\left[\frac{\partial(G/T)}{\partial T} \right]_P = -\frac{H}{T^2} - \frac{\frac{\partial G}{\partial T}}{T}$

- (c) Show that Gibbs free energy decrease will be largest when equimolar quantities of two ideal gases are mixed.

- (d) Write down the criteria for equilibrium and spontaneity for a thermodynamic process, in terms of both Gibbs and Helmholtz free energy.

- (e) A Carnot refrigerator operates between $T_L = 270$ K and $T_H = 300$ K. If it extracts 100 J of heat from the low-temperature reservoir, calculate the work input required.

3. Answer any one question : $7 \times 1 = 7$

- (a) (i) Properly mentioning the conditions, derive the Gibbs-Duhem equation.

- (ii) Derive an expression for the fugacity of a gas that obeys the van der Waals equation of state.

4+3

$$A = U - TS$$

(3)

- (b) (i) Draw Carnot's cycle in a T-S diagram.

- (ii) Derive the following Maxwell's relation :

$$\left(\frac{\partial T}{\partial V} \right)_S = - \left(\frac{\partial P}{\partial S} \right)_V$$

- (iii) Find the expression for the Joule-Thomson coefficient of a gas obeying the equation of state : $P(V-b) = RT$.

$$P(V-b) = RT \quad 2+2+3$$

Paper : DC-301(B)

(Inorganic-II)

1. Answer any two questions :

1×2=2

- (a) What is formal potential?

- (b) What is the significance of the Madelung constant?

- (c) Predict the shape of I_3^- using VSEPR theory.

2. Answer any three questions :

2×3=6

- (a) How does change in pH influence redox potential?

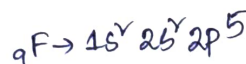
- (b) Explain the structure of PCl_2F_3 .

- (c) $LiCl$ is soluble in organic solvent while $NaCl$ is insoluble in such solvent — Explain.

- (d) MnO_4^{2-} undergoes a disproportionation reaction in an acidic medium but MnO_4^- does not. Give a reason.

- (e) What are the limitations of radius ratio rule?

P.T.O.



(4)

3. Answer any one question :

7×1=7

- (a) (i) Calculate lattice energy of NaCl crystal from the following data using Born-Haber cycle :

Sublimation energy (S) = 108.7 kJ mol⁻¹

Dissociation energy for

Cl₂ (D) = 225.9 kJ mol⁻¹

Ionization energy for

Na(g)(I) = 489.5 kJ mol⁻¹

Electron affinity for

Cl₂(g)(E) = -351.4 kJ mol⁻¹

Heat of formation of

NaCl(ΔH_f) = -414.2 kJ mol⁻¹

- (ii) Explain why Cu²⁺ ion readily liberates iodine from iodide but in presence of ethylenediamine it does not.

$[E_{\text{Cu}^{2+}/\text{Cu}^+}^{\circ} = 0.15\text{V}, E_{\text{I}_2/\text{I}^-}^{\circ} = 0.54\text{V}]$

- (iii) Why CsCl lattice is more stable than NaCl?

- (b) (i) Calculate the % ionic character of a bond with observed dipole moment 1.2D and bond length 1.0Å. [1D = 3.33564×10⁻³⁰ C.m] ✓

- (ii) What are non-stoichiometric defects? Give an example.

(5)

- (iii) Melting point of MgBr₂ is higher than that of AlBr₃ — Explain.

- (iv) What is the dimension of Madelung constant (A) in the Born-Landé equation? 2+2+2+1

$$A_1 = U_1 - TS_1$$

$$A_2 = U_2 - TS_2$$

$$A_2 - A_1 = U_2 - U_1 - TS_2 + TS_1$$

$$\Delta A = \Delta U + T(S_1 - S_2)$$

$$\Delta A = \Delta U + T[(TS_2) - (-TS_1)]$$

$$= \Delta U + T \left[\left(\frac{\partial A_2}{\partial T} \right)_H - \left(\frac{\partial A_1}{\partial T} \right)_H \right]$$