

**FYUGP/4th Sem/26(NEP)New**

**2026**

**Four Year Under Graduate Programme (FYUGP)**

**4th Semester Examination (Under NEP)**

**(New Session 2024-25)**

**CHEMISTRY (Major)**

**Paper Code : CEMMJ DC-403**

**(Physical-III)**

**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.*

**1. Answer any four questions :**

**1×4=4**

(a) A real gas shows  $Z = 1.08$  at high pressure.  
State whether repulsive or attractive forces  
dominate.

(b) What is the dimension of viscosity coefficient? *(ML<sup>-1</sup>T<sup>-1</sup>)*

(c) A compound of A and B atoms has a cubic unit  
cell. 'A' atoms are at the corners and the body  
centre position. 'B' atoms are at the face-  
centered position. Write the molecular formula  
of the compound.

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- (d) A solution has a cell constant of  $1.2 \text{ cm}^{-1}$  and a measured conductance of  $0.002 \text{ S}$ . Calculate its specific conductance.  $K = \frac{1}{RA}$
- (e) A capillary tube of radius  $0.05 \text{ cm}$  shows a rise of  $3 \text{ cm}$  for water at  $25^\circ\text{C}$ . Calculate the approximate surface tension (assume density of water =  $1 \text{ g cm}^{-3}$ ).  $h = 3$
- (f) Define advancement of a chemical reaction. Plot the variation of free energy with advancement of the reaction indicating the state of equilibrium.

2. Answer any six questions :

 $2 \times 6 = 12$ 

- (a) Find the numerical value of the compressibility factor of a gas that obeys the following equation of state,  $P(V-nb) = nRT$ . The  $P$  and  $T$  are such that  $V/n = 10b$ .

- (b) In the relation  $\Delta G^0 = -RT \ln K$ ; If some one puts  $K = K_C$  and some other puts  $K = K_P$  they may have different  $\Delta G^0$  values for the same reaction. How is it possible?

- (c) Differentiate between Debye, Keesom, and London interactions with examples.

- (d) State Kohlrausch's law of independent migration of ions and explain its application in determining molar conductance at infinite dilution.

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- (e) Explain how conductometric titration can be used to determine the solubility product of  $\text{AgCl}$ .
- (f) Show that in a crystal lattice there cannot be five-fold rotational axis of symmetry.  $\frac{360}{5}$
- (g) Why is it difficult to assign the position of the 'H' atom through X-ray crystallography?
- (h) Establish Nernst Distribution law from thermodynamic standpoint.

3. Answer any two questions :

 $7 \times 2 = 14$ 

- (a) (i) Derive an expression for work necessary to split a spherical oil drop of radius  $R$  to 'n' number of droplets. The surface tension of oil is  $\gamma$  unit.

$$\gamma = \frac{4R}{T}$$

$$V = \frac{4\pi R^3}{3}$$

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- (ii) A liquid flows through a capillary of radius  $0.05 \text{ cm}$  and length  $10 \text{ cm}$  under a pressure difference of  $2 \times 10^4 \text{ dyn cm}^{-2}$ . The observed volume flow rate is  $0.2 \text{ cm}^3 \text{ s}^{-1}$ . Calculate the viscosity coefficient of the liquid.

- (iii) Comment on how viscosity varies with temperature for liquids compared to gases.

 $3+2+2$ 

- (b) (i) Define Boyle temperature ( $T_B$ ) of real gas. Derive an expression of  $T_B$  in case of van der Waals gas.

P.T.O.

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(ii) Two van der Waals gases have the same value of 'b' but different values of 'a'. Which of these would occupy greater volume under identical conditions? If the gases have the same 'a'-value but different 'b'-values, which of the two would be more compressible?

(iii) Draw pressure vs. volume ( $P$  vs.  $V$ ) isotherms for the van der Waals gas below the critical temperature and compare it with the experimental curve at the same temperature.

3+2+2

(c) (i) Derive the Bragg's equation,  $n\lambda = 2d \sin \theta$  for the reflection of X-ray from the faces of a crystal.

(ii) Using X-rays of wavelength  $\lambda = 154.2$  pm, a face-centered cubic lattice produces reflections from the 111 and 200 planes. If the density of copper, which is a face-centered cubic lattice, and is  $8.935$  g/cm<sup>3</sup>, at what angles will the reflection of copper appear for the first order reflection?

(iii) If  $\xi$  is the degree of advancement of chemical reaction, then at equilibrium  $(\partial G / \partial \xi)_{P,T} = 0$ . Justify.

3+2+2

$$\left( \frac{\partial G}{\partial \xi} \right)_{P,T} = 0$$

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(d) (i) State and derive Ostwald's dilution law for weak electrolytes. Explain its application in determining the dissociation constant of acetic acid.

(ii) "During measurement of conductance, alternating current (AC) is used." — Explain.

(iii) A Hittorf cell fitted with silver-silver chloride electrodes, is filled with HCl solution that contains  $0.3856$  mg HCl/g of water. An electric current of  $2$  mA is passed through the solution for exactly  $180$  minutes. At the end of electrolysis, the cathode solution weighs  $51.7436$  g and contains  $0.0267$  g HCl. The anode solution weighing  $52.0461$  g contains  $0.0133$  g HCl. What is the transport number of  $H^+$ ?

3+2+2