

2023

4th Semester Examination

CHEMISTRY (Honours)

Paper : C 8-T

(Physical Chemistry - III)

[CBCS]



Full Marks : 40

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.*

Group - A

Answer any *five* questions : $2 \times 5 = 10$

1. When vapour pressure of solution becomes greater than vapour pressure of pure solvent?
2. In case of water molecule, the $O-H$ bond moment is 1.51 D and dipole moment is 1.85 D. Calculate HOH bond angle.
3. Four phases of sulphur can't coexist. — Explain.
4. Antimony electrode can only be used within pH range 2-8. Why?
5. Write the trial wave function for H_2^+ ion.

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(2)

6. What is the physical significance of coefficients in LCAO-MO treatment?

7. State and explain Konowaloff's rule.

8. How liquid junction potential can be reduced?

Group - B

Answer any *four* of the following : $5 \times 4 = 20$

9. (a) What is van't Hoff factor?

(b) Sea water is approximately 0.5 M NaCl solution. What is the minimum pressure that must be applied at 25°C to purify sea water by reverse osmosis? Given the degree of dissociation of NaCl is 0.9.

2+3

10. (a) Derive Duhem-Margules equation.

(b) Calculate the volume of nitrogen dissolved per litre of water in equilibrium with air at 20°C, the partial pressure being 0.80, given Henry's law constant,

$$K = \frac{P_{N_2}}{x_{N_2}} = 8 \times 10^4 \text{ where, } x_{N_2} \text{ is expressed in mole-fraction.}$$

3+2

11. (a) The EMF of a galvanic cell : $X | X^{n+} || Y^{m+} | Y$ changes with temperature according to the equation $E = a + bT + cT^2$ where a, b, c are constants and T temperature in Kelvin. Using proper argument evaluate $\Delta S, \Delta H$ and ΔC_p in terms of a, b and c .

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(3)

(b) Give example of electrode concentration cell. 4+1

12. (a) Show that $[L^2, L_z] = 0$

(b) What is zero point energy of rigid rotator? 3+2

13. (a) Show that the 1s wave function of H-atom given

$$\psi_{1s} = \frac{1}{\sqrt{\pi a_0^3}} \exp\left(-\frac{r}{a_0}\right) \text{ is normalized. } a_0 \text{ is the Bohr radius.}$$

(b) Write Hamiltonian operator of hydrogen molecule ion. 3+2

14. (a) For the following cell with transference, $Ag | AgCl(s), HCl(a_1) || HCl(a_2), AgCl(s) | Ag$. Derive an expression for liquid junction potential. 4

(b) How to make a chemical cell without transference without using a salt bridge? 1

Group - C

Answer any *one* question : $10 \times 1 = 10$

15. (a) Derive thermodynamically Gibbs phase rule.

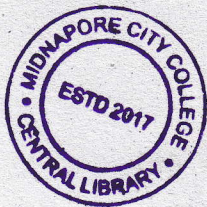
(b) What is Trouton's rule?

(c) Define eutectic temperature.

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(4)

(d) A solution consists of 0.05 molal of $MgSO_4$, 0.01 molal of $AlCl_3$, and 0.02 molal of glucose. Calculate the ionic strength of the solution. 4+2+2+2

16. (a) The radial wave function of $2p$ orbital of a hydrogen atom is given by

$$R_{21} = N \left(\frac{r}{a_0} \right) e^{-\frac{r}{2a_0}},$$

where N is a constant.

- (i) Determine the number and location of node(s) in $2p$ wave function.
- (ii) Write down the expression of radial distribution function of the function of the $2p$ electron and sketch the radial distribution curve. 4
- (b) Draw and explain equal-probability contour diagram with respect to $2s$ orbital? 1
- (c) Show that the operators $3x^2$ and $\frac{d}{dx}$ do not commute with each other. 2
- (d) Considering H_2 as an example, draw and comparison between valence bond and Molecular orbital model. 3