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B.Sc/4th Sem (H)/CHEM/23(CBCS)

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.

P.T.O.

(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 : $X | X^{n+} || Y^{n+} | Y$ 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 .

(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 by $\Psi_{1s} = \frac{1}{\sqrt{\pi a_0^3}} \exp\left(-\frac{r}{a_0}\right)$ is normalized. a_0 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 : 10×1=10

15. (a) Derive thermodynamically Gibbs phase rule.
- (b) What is Trouton's rule?
- (c) Define eutectic temperature.

P.T.O.

- (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 valance bond and Molecular orbital model. 3