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M. Sc. Chemistry, I Semester
End-term Examination 2023

Paper Name: Physical Chemistry I
Time: 2:30 hours

Paper Code: MCHCC-101
Maximum Marks: 60

Note: This paper has 3 sections A, B, and C. Attempt all the three sections

Section A: Answer *all* the questions; **Section B:** Answer *any 2* out of 4; **Section C:** Answer *all* the questions, each question has an *internal choice*

Abbreviations Used

CLO- Course Learning Outcome, PLO- Program learning Outcome, BTL- Bloom Taxonomy Level: BT level 1-Remember; BT level 2- Understand; BT level 3-Apply; BT level 4-Analyse; BT level 5-Evaluate, BT level 6-Create

Q. No.		BTL	CLO	PLO
SECTION A				
Very Short Type Questions (Attempt <u>all</u> questions)		10x1.5 = 15 Marks		
A 1.	Name factors that affect the chemical potential of any component in a homogenous mixture of many components.	1	2	3
A 2.	For a salt of M_xY_z type, how the mean ion activity is related to the activity of constituent ions?	3	1	3
A 3.	In thermodynamic terminology how a second order phase transition differs from a first order phase transition?	1	2	2
A 4.	How the electrophoretic velocity of an ion in a 1:1 electrolyte shall change if the strength of the applied field is doubled and the concentration is increased four times?	4	5	2
A 5.	What is meant by the concept electro dialysis?	1	5	3
A 6.	Assume that the potential energy is independent of the position, write down the Hamiltonian operator for a particle in one dimensional box?	2	1	1
A 7.	Why a quantum mechanical operator is required to be a Hermitian operator?	1	1	1
A 8.	What will be the value of linear momentum observable along x-axis if the wavefunction $\psi = e^{-i4x}$?	5	1	1
A 9.	How the pressure gradient across the curved surface of a liquid shall change if it is changed from a spherical liquid drop of radius R to cylindrical shape of radius R/2?	5	3	2
A 10.	List the main advantages of Nano-catalysts over the conventional heterogenous catalysts?	1	3	2
SECTION B				
Long Type Questions (Attempt any two out of four)		2x10 = 20 Marks		
B 1.	List the main assumptions of Debye-Huckel theory of activity coefficient of electrolyte solutions? Using these assumptions	1, 6	5	3

- predict how potential varies with distance from the center of an ion in its associated ion cloud.
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|------|--|------|---|---|
| B 2. | Assuming the solvent as a structureless continuum, derive relation that can be used for the estimation of free energy of solvation of an ion? Use this relation to predict what factors that shall affect the solubility of an ion in any solvent? | 3 | 5 | 3 |
| B 3. | Set up the Schrodinger equation for H-atom and show how it is split it into the three separate equations? | 6 | 1 | 1 |
| B 4. | What is surface excess? Derive an expression that connects the surface tension of a solution with the concentration and surface excess of the solute. | 1, 3 | 1 | 3 |

SECTION C

Short Type Questions (Attempt all questions)

5x5 = 25 Marks

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|------|---|------|---|---|
| C 1. | What are excess functions? Comment on the sign and magnitude of the excess enthalpy and excess volume for non-ideal solutions showing positive and negative deviations from ideal behavior? | 1-4 | 2 | 3 |
| | OR | | | |
| | How phase diagrams of three component systems are constructed? With the aid of a suitable diagram define and explain the meaning of tie line and plait point? | 3, 6 | 2 | 3 |
| C 2. | What are the high field and low field approximations of Butler-Volmer equation? | 1 | 5 | 3 |
| | OR | | | |
| | What are fuel cells? How fuel cells differ from Batteries? List the main advantages of batteries over that of fuel cells? | 1, 2 | 5 | 3 |
| C 3. | If linear operators A and B have common complete set of eigenfunction, then evaluate [A,B] . | 5 | 1 | 1 |
| | OR | | | |
| | Using $\psi = \sqrt{2} \sin \pi x$ as expression for the wave function of particle in a one dimensional box of length 1.0, estimate the probability of finding the particle in range $x=0.25$ to 0.75 . Use $\int_a^b \sin^2 \pi x dx = \frac{x}{2} + \frac{1}{4\pi} \sin 2\pi x \Big _a^b$ as standard integral. | 5 | 1 | 1 |
| C 4. | How is probability of ion-pair formation calculated in Bjerrum model? | 4 | 5 | 2 |
| | OR | | | |
| | Write Ilkovic equation? Suggest how polarography can be used for quantitative estimations of analytes using this equation? | 1, 6 | 5 | 3 |
| C 5. | List the main approximations of Langmuir adsorption isotherm? According to this isotherm how variations in partial pressure of an adsorbing gas influence its extent of adsorption over a solid surface? | 1, 4 | 3 | 3 |
| | OR | | | |
| | Explain briefly how the surface area of an adsorbent is estimated via use of BET adsorption isotherm? | 4 | 4 | 3 |