U.G. 3rd Semester Examination 2021

CHEMISTRY (Honours)

Paper Code : DC-5

(Physical Chemistry)

(CBCS)

Full Marks: 25 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 five questions: **1×5=5**

a) Which of the following quantities does not depend on the concentration of the electrolyte ?

(i) Conductance
(ii) Equivalent conductance
(iii) Equivalent conductance at infinite dilution
(iv) Specific conductance

b) Which of the following is true for the viscosity of a medium ?

(i) Viscosity of liquid decreases while the same for gas increases with increase of temperature.
(ii) Viscosity of liquid increases while the same for gas decreases with increase of temperature.
(iii) Viscosity of both liquid and gas increases with increase of temperature.
(iv) Viscosity of both liquid and gas decreases with increase of temperature.

c) Which of the following conductometric titrations will show a linear increase of the conductance with volume of the titrant added up to the break point and an almost constant conductance afterwards

(i) A strong acid with a strong base
(ii) A strong acid with a weak base
(iii) A weak acid with a strong base
(iv) A weak acid with a weak base

d) In a particle in 1-D box with increase of mass ($m \rightarrow \infty$) energy separation (ΔE) becomes

(i) Constant
(ii) Infinite
(iii) 0
(iv) None of above

e) Standard chemical potential (μ^0) of an ideal gas

(i) depends on T, P.
(ii) depends on T but not P.
(iii) depends on P but not T.
(iv) depends neither on T or P.

f) The zero point energy of a harmonic oscillator is

(i) $0.5h\nu$

(ii) 0

(iii) $h\nu$

(iv) $3h\nu$

g) The de Broglie wavelength (λ) of an electron moving in a n^{th}nth Bohr orbit is given by

(i) $\lambda = \frac{2\pi r}{n}$

(ii) $\lambda = \frac{n}{2\pi r}$

(iii) $\lambda = 2\pi r\, n$

(iv) $\lambda = \frac{\pi r^2}{n}$

h) Among the following statements, the one that is NOT true for a Hermitian operator is:

(i) The eigen values are real
(ii) The eigen functions are orthogonal
(iii) They represent observables
(iv) The scalar product of two different eigen functions is equal to one

2. Answer any *four* questions **2×4=8**

(a) Why is the mean free path inversely proportional to σ^2 and to Ñ ?

(b) Calculate the change in chemical potential of an ideal gas at 300K when its pressure is changed from 2atm to 5atm.

(c) What is the importance of chemical potential? What is its interpretation?

(d) For mixing of ideal gases at constant T and P show that $\Delta H_{mix} = 0$ and $\Delta V_{mix} = 0$.

(e) Calculate the frequency of radiation emitted when a linear harmonic oscillator of frequency $6 \times 10^{-13}\, s^{-1}$ goes from $n = 2$ to $n = 1$ state.

(f) If $\hat{A}\phi = \lambda\phi$, prove that $e^{\hat{A}}\phi = e^{\lambda}\phi$.

3. Answer any two questions **(2×6=12)**

(a) (i) At $25^0 C$, after the addition of $110\, ml$ of $0.1\, N\, NaCl$ soln to $100\, ml$ of a $0.1\, N\, AgNO_3$ solution, the reduction potential of a silver electrode placed in it is $0.36\, volts$. Assuming activities to be identical with concentrations, calculate the solubility product of silver chloride, Given $\xi^0_{Ag/Ag^+} = 0.799\, volts$ [3.5

(ii) Calculate the surface tension of water at $30^0\, C$ given that at that temperature water climbs to a height of $9.11\, cm$ in a clean glass capillary tube of internal radius $0.320\, mm$. The density of water at $30°C$ is $0.9956\, g\, cm^{-3}$. [2.5

(b) (i) Calculate the pH of the solution obtained by mixing $10\, ml$ of $0.2(N)\, KOH$ with $30\, ml$ of $0.1(N)\, CH_3COOH$. $K_a = 2\times10^{-5}$ [2

(ii) At $100^0 C$ the vapour density of N_2O_4 is 25 at $1\, atm$. Show that $K_P = 9.6$.[3

(iii) After temperature increases, what will be the fate of an exothermic reaction? [1

(c) (i) Find out $\hat{L}_x$, $\hat{L}_y$, $\hat{L}_z$ using the relation $L = r \times p$. [3

(ii) Find eigen function and eigen values of the operator $\frac{d}{dx}$ under the condition that eigen function remains finite at $x \to \pm\infty$. Find the eigenvalues. For additional restriction $\phi(\pi) = \phi(-\pi)$ find the eigenvalue.
[3

(d) (i) State Gibbs Duhem Equation and also point out its significance as well as importance. [3

ii) A mixture is composed of A and B in the molar ratio $1:0.3$. For a change of $-10\, J\, mole^{-1}$ in the chemical potential of A, what would be the corresponding change in chemical potential of B. [3