

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} 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 \tilde{N} ?
- (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 $\Delta H_{\text{mix}} = 0$ and $\Delta V_{\text{mix}} = 0$.
- (e) Calculate the frequency of radiation emitted when a linear harmonic oscillator of frequency $6 \times 10^{13} \text{ s}^{-1}$ 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°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 $E^\circ_{\text{Ag}^+/\text{Ag}} = 0.799 \text{ volts}$. [3.5]
- (ii) Calculate the surface tension of water at 30°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 $0.1 \text{ (N) CH}_3\text{COOH}$. $K_a = 2 \times 10^{-5}$. [2]
- (ii) At 100°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 $x \rightarrow \pm \infty$. 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]