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December 2021

B.Sc. (Chem.) - V SEMESTER

Physical Chemistry-V (BCH-502)

Time : 90 Minutes] [Max. Marks : 25

Instructions :

1. *It is compulsory to answer all the questions (1 mark each) of Part-A in short.*
2. *Answer any three questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART - A

1. (a) Light of wavelength λ shine on a metal surface with intensity x and the metal emit y electron per sec of average energy Z. What will happen if x is doubled? (PO1, PO5, CO1) (1)

(b) A photon of wavelength 4000 Å strikes to a metal surface. If work function of the metal is 1.13 eV then what will be kinetic energy of emitted photo electron? (PO1, PO5, CO1) (1)

(c) Find the [L^2, Lx] = ? (L angular momentum). (PO1, PO5, CO1) (1)

(d) If five particles are distributed as 2-2-1 in three successive energy levels with an increase in energy where the first and second exited states are doubly degenerate. Calculate maximum probability distribution? (PO1, PO5, CO1) (1)

(e) Assume that a particle of mass m is confined to a cubic box and its energy is $(101\ h^2)/(8\ ma^2)$. What is the degeneracy of this level? (PO1, PO5, CO1) (1)

(f) How many vibrational modes exist in HCN and CO_2? (PO5, PO6, CO4) (1)

(g) **(A)** A molecule to give pure rotational Raman spectrum, the polarizability of the molecule must be anisotropic.

(R) Polarizability depends on orientation of the molecule w.r.t. direction of electric field. Which one below is correct ?

1. A & R both correct.
2. only A is correct.
3. A & R both correct but R is not correct explanation of A. (PO1, PO5, CO4) (1)

(h) Calculate the force constant of HCL bond if fundamental vibrational frequency is 8.667×10^{13} sec^{-1}. (PO1, PO5, CO4) (1)

(i) The emission spectra of H-atom analyzed in between 100 nm and 200 nm. How many spectral lines are seen in this region? (PO1, PO5, CO1) (1)

(j) Calculate the Zero-point energy for a particle in an infinite potential well for an electron confined to a 1 nm atom. (PO1, PO5, CO1) (1)

PART - B

2. (a) Write a short note on Raman Spectroscopy. (2)

(b) Define Hot Bands and find the relation of E. (PO1, PO5, CO4) (3)

3. (a) Show that the functions

$\psi = (1/2\pi)^{1/2}$

$\psi = (1/\pi)^{1/2} \cos nx$

in the interval 0 to 2π are orthogonal; n is an integer. (3)

(b) If $\hat{I}$ and $\hat{E}$ are two operators such that $[\hat{I}, \hat{E}] = 5$, then find out value for $[\hat{I}, \hat{E}^2] = ?$ (PO1, PO5, CO1) (2)

4. A particle in an infinite square well, $V(x) = 0$ for $0 < x < L$, $V(x) = 1$ otherwise. Verify that = A sin kx and = A exp (ikx) are eigenfunction of the Hamiltonian operator for the particle. What is the eigenvalue and energy at zero temperature? (PO1, PO5, CO1) (5)

5. (a) Explain Plank's radiation Law. How does it explain classical concept of distribution of black body radiation? (4)

(b) What is the significance of 'TMS' in NMR spectroscopy. Explain. (PO1, PO5, CO4) (1)

6. (a) Describe various vibrational modes of molecules with suitable examples. (4)

(b) Sketch 'Jablonski' diagram. (PO1, PO6, CO4) (1)
