CHM-102: ATOMS, MOLECULES AND SYMMETRY

Even Semester 2019-2020   Maximum Marks: 20
Mid-semester Examination-1   Duration: 1 hour

Part-A (4×3 = 12)

1. Employing the state, $\Psi(x,t) = \psi_1 e^{-iE_1 t/\hbar} + \psi_2 e^{-iE_2 t/\hbar}$ (with ψ_1, ψ_2 being real), derive the condition under which $\Psi(x,t)$ behaves like a stationary state.

2. Consider an electron in a 1D-box of length 258 pm. Calculate (a) its zero-point energy (b) its speed corresponding to the zero-point energy.

3. Determine if the following functions are acceptable as wavefunctions:
(a) $\exp(-x)$ $\{0,\infty\}$ (b) $\exp(-x)$ $\{-\infty,\infty\}$ (c) $\sin^{-1} x$ $\{-1,1\}$
(Justify your answers)

4. Employing an arbitrary function f(x) defined over the limits $\{-\infty,\infty\}$, verify, if the operator $\hat{A} = \dfrac{d}{dx}$ is Hermitian?

Part-B (2×4 = 8)

5. If $\Psi(x) = \dfrac{i}{2}\sqrt{\dfrac{2}{a}}\sin\dfrac{\pi x}{a} + \sqrt{\dfrac{1}{a}}\sin\dfrac{3\pi x}{a} - \dfrac{1}{2}\sqrt{\dfrac{2}{a}}\sin\dfrac{4\pi x}{a}$ represents the state of a particle trapped in a 1D-box (of length 'a'), Calculate (a) its mean energy (b) the most probable energy along with the probabilities for other energies.

6. Is $\Psi(x) = Ax\left(1-\dfrac{x}{a}\right)$ an acceptable solution for a particle in a 1D-box (of length 'a'),? If so, determine (a) the constant 'A' (b) find $\langle x \rangle$, $\langle x^2 \rangle$.

Note: $h = 6.62 \times 10^{-34}$ Js, $m_e = 9.1 \times 10^{-31}$ kg, $c = 3 \times 10^5$ km/s

Good Luck!!!!!!!!!

PHY102 : Electromagnetism
First Mid-Semester Examination 2020
Duration : 1 hour

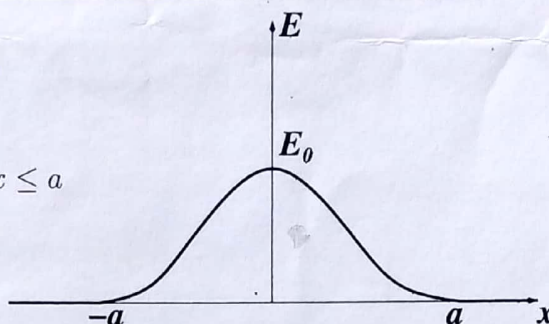**Instructor: A. Chaudhuri**   **Max. Marks 20**

- All questions are compulsory.

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1. Consider the variation of an electric field with x as follows :

$$\mathbf{E}(x,y,z) = \begin{cases} E_0 \cos(\pi x/2a)\hat{\mathbf{x}} & \text{for } -a \leq x \leq a \\ 0 & \text{otherwise} \end{cases}$$

Answer the following :

(a) Write down Gauss's law in differential form. Hence find the charge density in the entire region. [1+2].

(b) Calculate the potential $\phi(x)$. Assume that $\phi = 0$ at $x = 0$. [2]

(c) Plot ρ and ϕ as a function of x. [1+1]

2. Consider a total charge Q distributed in a spherically symmetric manner in a sphere of radius R with a density that varies radially as

$$\rho(r,\theta,\phi) = A(R-r), \quad 0 < r < R.$$

(a) Determine the constant A in terms of Q and R. [2]

(b) Use Gauss's law to find the electric field inside and outside the sphere. [Useful integral : $\int x^n dx = x^{n+1}/(n+1)$ for $n \neq -1$)] [2+2]

3. (a) Two infinite plane sheets of uniform surface charge, with densities $3\sigma_0$ and $-2\sigma_0$, are located a distance apart, parallel to one another. Find the electric field in each of the three regions (i) to the left of both, (ii) between them, (iii) to the right of both. [1+1+1]

(b) Now suppose the two planes, instead of being parallel, intersect at right angles. Show what the field is like in each of the four regions into which space is thereby divided. [2]

4. Prove the identity
$$\nabla \cdot (\phi \mathbf{E}) = (\nabla \phi) \cdot \mathbf{E} + \phi \nabla \cdot \mathbf{E}$$

by explicitly calculating the various derivatives in Cartesian coordinates. [2]

Bio 102- 1st Mid Sem Exam (25 Marks Total)

Name: Yogendra Kumar

Roll No: MS19LL3

All questions from 1-14 carry score of 0.5 and a duduction of 0.25 for wrong marking

1. Binary fission occurs in
   - a. Bacteria
   - b. Virus
   - c. Plant cell
   - d. Animal cell

2. Mitosis is a feature of
   - a. Gonads
   - b. Neurons
   - c. Epithelial cells
   - d. Hair

3. Prophase-I has the following important feature
   - a. DNA synthesis
   - b. Nucleolus appearance
   - c. Crossing over
   - d. RNA synthesis

4. Non-Sister chromosomes are originally from
   - a. Mother
   - b. Father
   - c. Both a and b
   - d. None of the above

5. DNA sysnthesis occurs in
   - a. G1 phase
   - b. G2 phase
   - c. S phase
   - d. M phase

6. Chromatin stage of chromosomes are seen in
   - a. G1 phase
   - b. G2 phase
   - c. S phase
   - d. M phase

7. Karyo type is arrangement of chomosomes based on
   - a. Centromere position
   - b. Length
   - c. Number of genes
   - d. Thickness

8. Centromere is meant for
   - a. Attachment of DNA
   - b. Attachment of proteins
   - c. Attachment of spindle fibres
   - d. All of the above

9. Centrioles are absent in
   - a. Neurons
   - b. Glia
   - c. Liver cells
   - d. Kidney cells

10. Mitosis has significance in
    - a. Sexual reproduction
    - b. Binary fission
    - c. Growth and repair of tissues
    - d. All the above

11. Nucleolus is area where
    - a. Genes are rich
    - b. ribosomal RNA express
    - c. Chromatin condense
    - d. None of the above

12. Cytokinesis is important in
    - a. DNA replication
    - b. Mitosis
    - c. Nuclear division
    - d. Cell compartmentalisation

13. Spindle fibers originate in plants from
    - a. Centrosome
    - b. Centrioles
    - c. Cytoskeleton
    - d. Cell wall

14. Bacterial chromosomes are
    - a. Linear
    - b. Circular
    - c. with a centromere
    - d. with histone

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