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SHRI S. H. KELKAR COLLEGE OF ARTS, COMMERCE & SCIENCE, DEVGAD
SEMESTER IV EXAMINATION, 2022-23

Class: S. Y. B.Sc **USPH402** **Quantum Physics**
Duration: 3 hrs **Marks: 100**

Q.1) A. Select the correct alternative **(12)**

1. Waves associated with moving particles are called
   a. Matter waves
   b. Probability waves
   c. De Broglie waves
   d. All of the above
2. All radiations consists of invisible tiny bundles of energy. For light waves these bundles are called
   a. Phonons
   b. Plasmons
   c. Photons
   d. Phynons
3. Phenomenon of emission of electrons from metal surface on incidence of suitable radiations is called
   a. Photoelectric effect
   b. Mangeto-striction effect
   c. Photovoltaic effect
   d. Dynamic effect
4. Classically, particle with energy less than barrier height must get
   a. Transmitted
   b. Reflected
   c. Annihilated
   d. Propagated
5. Energy of particles gets restricted to certain allowed values is known
   a. Optimization
   b. Generalization
   c. Annihilation
   d. Quantization
6. Expectation value position <x> of a particle in a box is
   a. 0
   b. ½
   c. Infinite
   d. -½

B) Answer in short **(08)**

1. What is a wave function?
2. Write the time-energy uncertainty relation.
3. Write one dimensional time dependant Schrodinger equation.
4. What is a free particle?

Q.2) A) Attempt any one of the following **(08)**

1. Derive classical wave equation considering one dimensional SHM.
2. Derive schrodinger's time dependent equation. What do you mean by wave function?

B) Attempt any one of the following **(08)**

1. Write the concept of well behaved wave function and state the procedure to normalize a wave function.
2. Derive schrodinger's time independent equation.

C) Attempt any one of the following **(04)**

1. Show that wave function add but not the probability.
2. Find expectation value of momentum for a wave function $\varphi = \sqrt{\frac{2}{l}} \sin\frac{\pi x}{l}$ for the region $0 < x < l$

Q.3) A) Attempt any one of the following **(08)**

1. Set up Schrodinger equation for a free particle. Solve the equation to obtain eigen function.
2. Set up Schrödinger equation for the particle approaching towards a step potential with energy greater than height of the state. Solve the equation & obtain expression for reflection co-efficient.

B) Attempt any one of the following **(08)**

1. A classical particle is moving in x direction incident on rectangular barrier of height V_0. Discuss the motion of particle.
2. Particle is incident on step of height V_0. The energy E of particles is less than V_0. Set up the STIE.

C) Attempt any one of the following **(04)**

1. Write a note on tunnel effect.
2. α particle of energy 10 MeV approaches a potential barrier of height 50 MeV and width 10^{-15} m. Determine the transmission co-efficient. (Mass of α particle = 6.68×10^{-27} kg, ħ = 1.054×10^{-34} J/s)

Q.4) A) Attempt any one of the following **(08)**

1. Using normalized wave function for particle in one dimensional well find expectation value of position and momentum of the particle.
2. Set up Schrödinger equation for a particle in one dimensional box solve it to obtain energy Eigen function and normalization

B) Attempt any one of the following **(08)**

1. Set up Schrödinger equation for particle a confined to a cubical rigid box and obtain normalize Eigen function the particle.
2. Find energies of five lowest energy levels of a particle in a cubic box. Which of these levels are degenerate? Find their degeneracy.

C) Attempt any one of the following **(04)**

1. Find probability of a particle trapped in one dimensional box length L can be found between 0.45 L and 0.55 L in the ground state.
2. Show that energy state $E = \frac{66\,\hbar^2}{8\,mL^2}$ of a particle in cubical box is 12 fold degenerate.

Q.5) Attempt any four **(20)**

1. Find the expectation value of position <x> of a particle in one dimensional box.
2. Draw energy level diagram, and diagram showing wave function and probability density on a particle on one dimensional box.
3. Write difference between free states and bound states of particle.
4. Write any three postulates of quantum mechanics.
5. Write operators for
   i. Momentum ii. Total energy iii. Kinetic energy iv. Hamilton operator
6. Derive expression for angular momentum operator, L.