

TBHP-601

B.Sc. (Hons.) Physics
(Sixth Semester)
EXAMINATION-2019-20
QUANTUM MECHANICS
Total Time: 3:00 Hours
(Including upload time)
Maximum Marks: 60

Note: Questions paper has three sections. Read carefully instructions for each section.

SECTION-A

(Very short answer type questions)

1. Attempt all questions

1 each

- Write down operator for linear and angular momentum?
- Show that $[\mathbf{x}, \mathbf{p}] = i\hbar$ in the momentum space representation.
- Calculate the commutator $[\mathbf{p}_x, \mathbf{x}^2]$?
- What do you mean by a stationary state system?
- Write wave function for one dimensional linear harmonic oscillator?
- Explain classical and quantum aspect of tunneling through potential barrier?
- Find value of commutator $[\sigma^2, \sigma_x]$?
- Why atoms and not ions are used in Stern-Gerlach experiment? Why is there the need of an inhomogeneous magnetic field in this experiment?
- Explain space quantization?
- Explain Bohr's magnetron? What is the value of Bohr's magnetron?
- Calculate the angle between the total and the orbital angular momentum vectors for the $4D_{3/2}$ state.
- Express $\mathbf{L} \cdot \mathbf{S}$ in terms of $\mathbf{J}, \mathbf{L}, \mathbf{S}$ where $\mathbf{L} = 1, \mathbf{S} = 1/2$.

SECTION-B

(Short answer type question)

2. Attempt any six questions.

4 each

- Explain any two applications of barrier tunneling in detail?
- The angular momentum vector (operator) is defined as $\mathbf{L} = \mathbf{r} \times \mathbf{p}$. Calculate: $[\mathbf{L}_x, \mathbf{L}_y]$ and $[\mathbf{L}_z, \mathbf{L}^2]$.

- c. Draw potential well for finite and infinite values of potential energy. Write Schrödinger equations in both cases. Draw first two Eigen functions for both and discuss the differences in two cases.
- d. Normalize function $\exp(-ax^2)$ and $x\exp(-3x)$?
- e. Calculate the value of (i) l , s , and j (ii) \mathbf{L} , \mathbf{S} , and \mathbf{J} for a **d electron** in a one electron atomic system.
- f. Explain vector model of atom?
- g. What are quantum number specifying the states of an electron in an atom? Explain Paschen Back Effect?
- h. What are Pauli spin matrices?

SECTION-C

(Long answer type question)

3. Attempt any three questions.

8 each

- a. Consider a one dimensional particle which is confined within the region $0 \leq x \leq a$ and whose wave function is $\psi(x, t) = \sin(\pi x/a) \exp(-i\omega t)$.
Find the potential $V(x)$ and also find the probability of finding the particle in the interval $a/4 \leq x \leq 3a/4$.
- b. Explain particle in a rigid three dimensional box and calculate its energy states?
- c. Calculate the eigen value and eigen function for 3-D isotropic and anisotropic harmonic oscillator.
- d. Give a schematic description Stern-Gerlach experiment and indicate its main conclusions. Why was the experiment done with silver atoms?
- e. What is Zeeman effect? Distinguish between normal and anomalous Zeeman effect. Discuss the experimental arrangement for observing normal Zeeman effect.