

Date:

Registration number:

**ST. JOSEPH’S COLLEGE (AUTONOMOUS), BENGALURU-27**

**B.Sc. PHYSICS - V SEMESTER**

**SEMESTER EXAMINATION: FEBRUARY 2022**

**(Examination conducted in January-March 2022)**

**PH 5218 – Quantum Mechanics, Atomic and Molecular Physics**

Time- 2 ½ hrs Max Marks-70

This question paper contains 2 printed pages and 3 parts

**Part -A**

**Answer any 4 questions:** [4X10=40]

1. a). With neat diagram, describe Davisson and Germer’s experiment.

Discuss the observation made by them in the experiment. [6]

b). With necessary calculations, show that Davisson and Germer’s experiment

support de-Broglie hypothesis on matter waves. [4]

1. a). Obtain de-Broglie wave equation and mention it in different forms. [5]

b). Explain the Schrodinger’s concept of a wave packet? Obtain the relation

between phase velocity and group velocity of a non-relativistic particle. [5]

1. a). Derive Schrodinger’s time dependent wave equation for a moving particle. [7]

b). Write a note on tunnel diode. [3]

1. a). Set up the Schrodinger’s wave equation for a linear harmonic oscillator

and obtain its eigen values of energy. Draw the energy level diagram. [8]

b). Explain the Zero-point energy of a linear harmonic oscillator. [2]

1. a). What is Zeeman effect. Give the quantum theory of Normal Zeeman effect. [8]

b). What is Paschen-Back effect? [2]

1. a). Obtain an expression for the rotational energy of a diatomic molecule. [6]

b). Explain Raman effect. Mention the characteristics of Raman lines. [4]

**Part -B**

$m\_{e}=9.1×10^{-31}$ kg, $m\_{p}=1.67×10^{-27}$ kg, $h=6.625×10^{-34}$ Js,

**Solve any 4 problems:** [4X5=20]

1. An electron moving with a speed of 500ms-1 is measured with an accuracy of 0.004%. Calculate the uncertainty with which position of the electron can be measured.
2. An electron is trapped in 1D-box is given by a wave function $Ѱ\left(x\right)=\sqrt{\frac{2}{L}} sin⁡(\frac{nπx}{L})$

for $0<x<L,$ where $L$ is the width of the box. Find the probability of finding the particle between $L/4 to 3L/4$ in its ground state.

1. The lowest energy of a proton in an infinite potential well is 40eV. Find the width of the box. Also calculate energy of proton in the next two higher energy states.
2. A 1eV electron got trapped inside the metal surface. If the potential barrier is 2eV and the width of the barrier is 2Å, calculate the probability of transmission of the electron.
3. In a Stern-Gerlach experiment, silver atoms traverse a distance of 0.1m through a non-homogeneous magnetic field of gradient 60 Tm-1. If the separation between the two traces at the end of the magnetic field is 0.15mm, calculate the velocity of the silver atoms. Mass of silver atoms = 1.79x10-25 kg and one Bohr magneton = 9.25x10-24 JT-1.
4. For orbital quantum number $l=3, $calculate the possible angles that orbital angular momentum vector makes with z-axis along which magnetic field is applied.

**Part -C**

1. **Answer any 5 questions:** [5x2=10]

a). What is UV catastrophe?

b). If $x and V $are position and potential energy operators, find out whether they will commute

 with each other or not? What does it imply?

c). What are the advantages of using spherical polar co-ordinates to discuss hydrogen atom?

 Explain.

d). An electron is trapped in a 1D-box and another electron in a 3D-box both having same

 dimensions. What would be the energy of the electrons in these cases?

e). Is Sommerfeld atom model better than Bohr atom model? Justify the answer.

f). Colour of the sky is blue. Give reasons.

g). What would be the total number of electrons in a shell corresponding to the principal

 quantum number 5?