Register Number:

Date: 23-11-2020

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
B.Sc. PHYSICS - V SEMESTER
SEMESTER EXAMINATION: NOVEMBER 2020
PH 5218 – QUANTUM MECHANICS, ATOMIC AND MOLECULAR PHYSICS

Time: 2 ½ hrs Max Marks:70

This paper contains **two** printed pages and **three** parts.

PART - A

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

1 a). Obtain an expression for the phase velocity of a relativistic particle. Explain how it brings out the concept of wave packet?

b). Explain the failure of classical physics to account for the experimental observations on specific heat of solids. [7+3]

2. Describe G.P Thomson experiment with theory, to confirm the existence of matter waves. [10]

3 a). Set up Schrodinger's time dependent wave equation for a moving particle.
b). Write a note on barrier penetration. [7+3]

4 a). Obtain Schrodinger's equation for a free particle trapped in a one dimensional infinite potential well. Solve it to obtain the eigen values of energy.

b). Represent the wave function and the probability density of the particle in the first 3 levels in one dimensional infinite potential well. [7+3]

5 a). Explain different quantum numbers associated with the vector model of the atom and mention their physical significance.

b). What is anomalous Zeeman effect? Why does it occur? [8+2]

6 a). Give the quantum explanation of Raman effect and explain the mechanism behind the existence of Raman lines.

b). Mention the applications of the Raman effect. [7+3]

PART - B

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

7. Calculate the wavelength associated with an electron having energy 1 MeV, considering the non-relativistic case. Also find out momentum of the particle.
   Given, mass of electron $= 9.1 \times 10^{-31}$kg.

8. Evaluate (i) the commutation value of $[x, \frac{\partial}{\partial x}]$ and (ii) If $\Psi(x) = sin2x$, find the eigen value of the operator $\frac{d^2}{dx^2}$.

9. The energy of a linear harmonic oscillator in its 3rd excited state is $1eV$. Calculate frequency of the oscillator. Also find out zero-point energy of the oscillator.

10. A beam of electrons having energy $15\ eV$ is incident on a step potential of height $10\ eV$. Calculate the reflection and transmission co-efficient.

11. Calculate the magnetic field required to observe the normal Zeeman pattern if a spectrometer can resolve spectral lines by 5nm at 500nm. Also find out the precessional frequency of the orbital angular momentum around the magnetic field.

12. If spacing of the rotational lines of HF molecule is 1.1215×10^{12} Hz, calculate the interatomic distance. Atomic mass of H=1amu, F=19amu and $1amu = 1.66 \times 10^{-27}$kg.

PART - C

Answer any **FIVE** questions: [5X2=10]

13 a). Experimentally it is found that, spectral lines are naturally broad. Give reasons.
b). How does de-Broglie wavelength concept lead to Bohr's second postulate?
c). Tunnel diodes are heavily doped. Explain the reasons.
d). What is the degeneracy of the first excited state for an electron trapped in a 3D box? Explain.
e). In Stern-Gerlach experiment, what is the role of inhomogeneous magnetic field on the silver atoms passing through it?
f). Among Bohr and Sommerfeld model, which is the better atomic model? Mention one of its important success over the other.