D5BPH2102 (PAGES 2) **Reg. No.....**

Name: .....

FIFTH SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2023

(Regular/Improvement/Supplementary)

PHYSICS

GPHY5B07T: QUANTUM MECHANICS

Time: 2 Hours **Maximum Marks: 60**

SECTION A: Answer the following questions. Each carries *two* marks.

(Ceiling 20 Marks)

1. Write the operators associated with energy and momentum.
2. What is discrete spectra?
3. What is photon? Give two of its properties.
4. Why is Thomson's atomic model also known as watermelon model?
5. The Compton-scattering formula suggests that objects viewed from different angles should show scattered light of different wavelengths. Why don't we observe a change in color of objects as we change the viewing angle?
6. State Bohr's correspondence principle.
7. Which one of $\psi_1 = Ae^{x^2}$ and $\psi_2 = Ae^{-x^2}$ is well-behaved quantum mechanical function in the range $-\infty < x < +\infty$?
8. What is meant by work function in photoelectric effect?
9. Distinguish between normal and anomolus Zeeman effect.
10. What is zero point energy?
11. Write down the Schrodinger equation for one dimensional hydrogen atom and explain the symbols.
12. What is a free particle?

SECTION B: Answer the following questions. Each carries *five* marks.

(Ceiling 30 Marks)

13. In a Stern-Gerlach type of experiment, the magnetic field varies with distance in the *z* direction according to *dBz/dz*= 1.4T/mm. The silver atoms travel a distance *x* = 3.5 cm through the magnet. The most probable speed of the atoms emerging from the oven is *v* = 750 m/s. Find the separation of the two beams as they leave the magnet. The mass of a silver atom is 1.8 × 10−25 kg, and its magnetic moment is about 1 Bohr magneton.
14. Show that energy levels of Harmonic oscillator are discrete.

(PTO)

15. Calculate for hydrogen atom
    (i) The velocity of the electron in the ground state
    (ii) The radius of the orbit in the ground state
    (iii) Time taken by the electron to traverse the first Bohr field.

16. Normalize the wave function of a two-dimensional infinite potential well of width L. Given, $\psi_{n_x,n_y}(x,y) = A' \sin\left(\frac{n_x\pi}{L}x\right)\sin\left(\frac{n_y\pi}{L}y\right);\ n_y = 1,2,3 \ldots\ldots; n_y = 1,2,3 \ldots\ldots$
17. The number of particles scattered at 60^0 is 100 per minute in an alpha particle scattering experiment, using gold foil. Calculate the number of particles per minute scattered at 90^0 angles.
18. Calculate the probability of transmission of a particle through a rectangular barrier indicated below:
    Height of the barrier $= 4\ eV$; The width of the barrier = $2\ A^0$;
    Energy of the particle = $1\ eV$; Mass of the particle = $1.6\ X\ 10^{-27}\ kg$.
19. Find the phase and group velocities of the de Broglie waves of an electron whose kinetic energy is 500 keV.

SECTION C: Answer any *one* question. Each carries *ten* marks.

20. (i) Derive time independent Schrodinger equation.
    (ii) Explain the physical significance of wave function.
21. Discuss in detail the non-classical behaviour of a particle trapped in a one-dimensional rigid box.

(1 x 10 = 10 Marks)