

D 130252

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Name.....

Reg. No.....

**FIFTH SEMESTER (CBCSS—U.G.) DEGREE EXAMINATION  
NOVEMBER 2025**

Physics/Applied Physics

PHY 5B 07/APH 5B 07—QUANTUM MECHANICS

(2019 Syllabus)

Time : Two Hours

Maximum : 60 Marks

**Section A (Short Answer Type)***Answer all questions ; each question carries 2 marks.**Ceiling : 20 marks.*

1. What is Compton wavelength ? Write its value for the electron.
2. Why can a single free electron not absorb a single photon ?
3. Explain the classical theory of the photoelectric effect.
4. Write Bohr's postulate on quantization of angular momentum.
5. Define the Rydberg constant and give its relation with fundamental constants.
6. What is the correspondence principle ?
7. Mention two deficiencies of Bohr's model.
8. What did the Frank-Hertz experiment establish ?
9. State the physical meaning of the wavefunction modulus squared.
10. Write the time-dependent Schrödinger equation for a one-dimensional particle.
11. What is a stationary state ?
12. Write down the general properties of wave functions.

**Turn over**

**Section B (Paragraph/Problem Type)**

Answer **all** questions ; 5 marks each.

Ceiling : 30 marks.

13. X-rays of wavelength 0.2400 nm. are Compton-scattered at  $60^\circ$ . (a) Find the scattered wavelength. (b) Find the kinetic energy of the recoil electron.
14. Using Bohr's model, calculate the wavelengths of the Balmer transitions  $n = 3 \rightarrow 2$  and  $n = 4 \rightarrow 2$  in hydrogen. Take the Rydberg constant  $R_H = 1.097 \times 10^7 \text{ m}^{-1}$ .
15. Calculate the de Broglie wavelength of : (i) a 10 g bullet at  $500 \text{ ms}^{-1}$  ; (ii) An electron with kinetic energy 1 eV.
16. The uncertainty in the position of an electron in a certain state is  $\Delta x = 1.0 \times 10^{-10} \text{ m}$ . Using Heisenberg's principle, estimate the minimum uncertainty in its momentum and the corresponding uncertainty in velocity. (Electron mass  $m_e = 9.11 \times 10^{-31} \text{ kg}$ ).
17. A neutron is confined in a nucleus of radius  $1.0 \times 10^{-14} \text{ m}$ . Model it as a particle in a one-dimensional box of width equal to the nuclear radius. Estimate its ground-state energy.
18. For a one-dimensional infinite well of width L, obtain normalized eigenfunctions and show that the probability of the ground state in  $[0, L/2]$  equals  $\frac{1}{2}$ .
19. In a weak magnetic field, obtain the normal Zeeman splitting pattern for the hydrogen  $n = 2$  level and sketch the components.

**Section C (Essay Type)**

Answer any **one** question; 10 marks each.

20. Obtain the eigenvalues and eigenfunctions of the simple harmonic oscillator. Plot the energy level diagram.
21. Write down the Schrodinger equation in spherical polar coordinates and, using separation of variables, obtain the functional forms of the radial part  $R(r)$ , the polar part  $\Theta(\theta)$ , and the azimuthal part  $\Phi(\phi)$ .

(1 × 10 = 10 marks)