CITY COLLEGE

Internal Assessment 2021

Physics (Hons.) CBCS Semester 4

Paper: CC10

Time: 1 Hour; Full Marks: 20

Answer any *ten* questions from the following: **10×2 = 20**

1. Write the boundary conditions required to solve 1-D finite square well potential problem.
2. Show that the energy level of a hydrogen atom for a given 'n' is n^2 fold degenerate, where n is the principal quantum number.
3. The radial wave function for 1-s state of a hydrogen atom is given by $Ce^{\frac{-r}{a_0}}$, where C and a_0 are constants. Find average value of $\frac{1}{r}$.
4. For a wave function $Ce^{\frac{-r}{a_0}}$, where C and r_0 are constants, show that the probability density is maximum at $r = a_0$.
5. A positron and an electron from a short-lived atom called positronium before the two annihilates to form γ rays. Calculate in eV, the ground state energy of positronium.
6. Let Ψ_0 and Ψ_2 denote, respectively, the ground state and second excited state energy eigenfunctions of a particle moving in a 1-D harmonic oscillator potential with frequency ω. At t = 0 the particle has the wave function $\Psi(x) = \frac{1}{\sqrt{3}}\Psi_0(x) + \frac{2}{\sqrt{3}}\Psi_2(x)$. Determine the expectation value of energy as a function of time.
7. Show that the classical probability of finding L.H.O. in dx at x is given by $P(x)dx = \frac{dx}{\pi\sqrt{a^2-x^2}}$, where a is the amplitude of oscillation.
8. What do you mean by a wave packet?
9. What are Normal and Anomalous Zeeman effects?
10. Show that the raising and lowering operators J_+ and J_- are Hermitian conjugates.
11. Prove that spin matrices S_x and S_y have $\pm(h/4\pi)$ eigenvalues.
12. What is the difference between LS coupling and JJ coupling?
13. Is it possible for a Lande-g-factor to have a value smaller than 1?
14. Discuss similarities and differences between a matter wave and an electromagnetic wave.
15. Exactly why do we conclude that the spin quantum numbers are half-integral?

Answer scripts must be emailed to **sem4hcityphysics@gmail.com** within 15 minutes of the end of the examination.