

City College

3rd Semester Internal Examination 2021-22

Physics (Hons)

Paper: CC7 (Modern Physics)

Time- 1 hour

Full Marks-20

Answer any ten questions.

10×2=20

1. Show that if an electron and a proton have the same non-relativistic kinetic energy, the proton has a shorter de Broglie wavelength.
2. An electron moves in the X direction with a speed $4 \times 10^6 \text{ ms}^{-1}$. If its speed is measured to a precision of 1%, with what precision can its position simultaneously be measured?
3. An electron of mass $9.1 \times 10^{-31} \text{ kg}$ is moving with a velocity $0.995c$ where c is the speed of light. What is its phase velocity?
4. A particle constrained to move along x-axis in the region $0 \leq x \leq a$ has a wave function $\psi(x) = N \sin \frac{n\pi x}{a}$, where n is an integer. Normalize the wave function.
5. Prove that the operator $-i\hbar \frac{d}{dx}$ is Hermitian.
6. Prove that operators having common set of eigenfunctions commute.
7. Calculate the expectation value of position x corresponding to the wave function $\Psi_n(x) = \sqrt{\frac{2}{a}} \sin \frac{n\pi x}{a}$, $0 \leq x \leq a$, $n=1,2,3,\dots$
8. A nucleus with $A=235$ splits into two nuclei whose mass numbers are in ratio 2:1. Find the radii of both the nuclei. Given $R_0=1.4 \text{ fm}$.
9. The atomic mass of ${}^6\text{C}^{12}$ is 12.000000amu and that of ${}^6\text{C}^{13}$ is 13.003354amu. Find the energy required to remove a neutron from ${}^6\text{C}^{13}$ in MeV. Mass of neutron= 1.008665amu.
10. Using the semi empirical mass formula, find the atomic number of most stable isobar for a nucleus with $A=77$.
11. Prove that β^- decay occurs only if the mass of parent atom is greater than mass of daughter atom.
12. What is the role of moderator in nuclear fission reactors?

13. If the source temperature is 300K, show that in the optical region the emission is predominantly due to spontaneous transition.
14. What are the differences between spontaneous and stimulated emission?
15. What are radiative and non-radiative transitions?