K24P 3145

Reg. No. : .....

Name : .....

III Semester M.Sc. Degree (C.B.C.S.S. – O.B.E. – Regular) Examination, October 2024
(2023 Admission)
PHYSICS/PHYSICS WITH COMPUTATIONAL AND NANO SCIENCE SPECIALISATION
MSPHY03C13/MSPHN03C13 : Quantum Mechanics II

Time : 3 Hours

Max. Marks : 60

SECTION – A

Answer **any 5**, **each one** carries **3** marks. **(5×3=15)**

1. Describe the connection formulae for WKB approximation.
2. Give an account of electric dipole approximation.
3. Briefly discuss detailed balancing. Explain why the intensity of stimulated emission between two atomic levels is much less than that of stimulated absorption.
4. What is differential scattering cross section ? How is it related to the number of particles scattered ?
5. What are Weyl equations ? Explain how they describe the helicity of neutrino.
6. Describe the procedure of canonical quantization of the field.

SECTION – B

Answer **any 3**, **each one** carries **6** marks. **(3×6=18)**

7. Apply nondegenerate perturbation theory to find the first order correction due to relativistic energy of hydrogen atom. Comment on lifting the degeneracy of the n^{th} level and also the removal of accidental degeneracy.
8. Find the transmission probability for tunnelling of a particle through a rectangular potential barrier with a bumpy top, using the method of WKB approximation.

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9. Show that free electrons can neither emit nor absorb photons.
10. Consider the elastic scattering of 50 MeV neutrons from a nucleus. The phase shifts measured in the experiment are $\delta_0 = 95°$, $\delta_1 = 70°$, $\delta_2 = 60°$, $\delta_3 = 30°$, $\delta_4 = 20°$, $\delta_5 = 5°$. For $\ell \geq 6$ the phase shifts are negligible. Find the total cross section. Mass of neutron is 1.674928×10^{-27} kg. Also find the radius of the nucleus.
11. Show that Klein-Gordon equation leads to negative probability density.

SECTION – C

Answer **any 3**, **each one** carries **9** marks. **(3×9=27)**

12. Explain the variational principle, to find the upper bound for the ground state energy. Using the variational principle find the ground state energy of He atom.
13. Discuss the transition probability in time dependent perturbation theory. Find the transition rate for constant perturbation and deduce Fermi-Golden rule.
14. Discuss the Born approximation for elastic scattering problem when the potential is spherically symmetric. Illustrate it for Coulomb potential. Discuss the validity criterion for it.
15. Derive the Dirac equation. Find the conserved current.
16. Discuss the second quantization of the Schrödinger wave field for Bosons and Fermions.

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