K17P 1219

Reg. No. : .....

Name : .....

Third Semester M.Sc. Degree (Supplementary) Examination, Nov. 2017
(2013 and Earlier Admissions)
PHYSICS
PH 301 : Quantum Mechanics – II

Time : 3 Hours Max. Marks : 50

SECTION – A

Answer **any two** questions. **Each** question carries **10** marks.

1. Explain briefly the method of partial wave analysis. Obtain the formula for expanding a plane wave in terms of partial wave.
2. Obtain the expression for energy of a charged particle obeying Klein-Gordon equation in a Coulomb potential. Explain the significance of the different terms.
3. Derive the spin orbit interaction energy using the Dirac equation.
4. Discuss the necessity of quantum states described using density matrices. **(2×10=20)**

SECTION – B

Answer **any five** questions. **Each** question carries **3** marks.

1. Account for the fine structures of hydrogen atom.
2. What is Born-Oppenheimer approximation ?
3. It is easier to obtain laser action at the infrared wavelengths as compared to visible region. Why ?
4. Define scattering length. How is it related to zero energy cross section ?
5. Explain the phenomenon of scattering of identical particles.
6. What is EPR Paradox ?
7. What is second quantization ? Write down the boson creation operator.
8. What are Fermion creation and annihilation operators ? Express mathematically.

(5×3=15)

P.T.O.

SECTION – C

Answer **any three** questions. **Each** question carries **5** marks.

1. A simple harmonic oscillator is perturbed by a harmonic potential so that the result Hamiltonian is given by $\hat{H} = \frac{P^2}{2m} + \frac{1}{2}mw^2x^2 + \lambda x^2$. Calculate the first order perturbation energy if the ground state of oscillator is given by

$$\psi_0(x) = \left(\frac{mw}{\pi\hbar}\right)^{1/4} - \frac{mw}{2h}x^2.$$

2. What are Einstein's A and B coefficients ? Obtain the relation two.

3. What is scattering amplitude ? How is it related to scattering cross section ?

4. If $\bar{\alpha}$ and $\bar{\beta}$ are Dirac matrices, prove that

   a) $\alpha_x = \frac{1}{2}\left[\alpha_x\alpha_y, \alpha_y\right]$

   b) $\alpha_x\alpha_y\alpha_z = \frac{1}{2}\left[\alpha_x\alpha_y\alpha_z\beta, \beta\right]$

5. Discuss the epistemological and ontological problems raised in quantum mechanics. **(3×5=15)**
