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2016

M.Sc.

3rd Semester Examination

PHYSICS

PAPER – PHS-301 (Gr. – A + B)

Full Marks : 40

Time : 2 Hours

(Quantum Mechanics III – PHS 301A)

Answer Q1 and any one from Q2 and Q3

1. Answer any five bits: 5X2 = 10

(a) Why ground state of a two-electron atomic system is always a singlet?

(b) Explain the origin of the mass-velocity correction term (H_{MV}) for a hydrogen-like atom.

(c) Show that transitions between $2p_{3/2}$, $2p_{1/2}$, and $1s_{1/2}$ result in 10 different lines for weak-field Zeeman effect.

(d) State when partial wave method and Born approximation are applicable.

(e) Deduce the relation between total cross-section (σ) and imaginary part of the forward scattering amplitude (Im $f_k(\theta)$).

(f) Which of the following transitions are electric dipole allowed: (i) 1s $\rightarrow$ 2s (ii) 3s $\rightarrow$ 5d.

(g) A system in an unperturbed state 'a' is suddenly subjected to a constant perturbation $H'(r)$. Find the probability of transition from state 'a' to state 'b'.

(h) Assuming LS coupling, list the possible spectral terms ^{2s+1}L which result from the following electronic configuration; (i) ns n′p; (ii) np^2.

2. (a) Calculate the First Born amplitude for the potential $U_0 \frac{e^{-\alpha r}}{r}$ and hence calculate differential cross-section. (4)

(b) For very strong field Zeeman Effect, show that energy of the system is

$E = E_n + \mu_B(m_l + 2m_s)B_z$ [symbols have their usual meanings]. (3)

(c) Calculate the first order energy correction (ΔE_{SO}) due to perturbation of H_{SO} where $H_{so} = \frac{1}{2m^2c^2r}\frac{dV(r)}{dr}\vec{L}.\vec{S}$. (3)

3. (a) Write the wave function of the 2^3S (s=1) level of He in the central field approximation. Also express them in the form of Slater Determinants (or a sum of Slater Determinants). (1+2)

(b) Write a pair of Hatree-Fock coupled equations for the spatial orbitals u_{1S} (r) and u_{2S} (r) corresponding to 2^3S (s=1) wave function of He. (2)

(c) For harmonic perturbation, calculate the first order transition probability and show that in the case of absorption the transition probability increases quadratically with time. (5)

(Statistical Mechanics II – PHS 301B)

Answer Q1 and any one from Q2 and Q3

(Turn Over) (Continued)