Roll No. ....

22022

M. Sc. Physics 2nd Semester
Examination – May, 2019

QUANTUM MECHANICS-II

Paper : PHY(H)-202

Time : Three hours]   [Maximum Marks : 80

Before answering the questions, candidates should ensure that they have been supplied the correct and complete question paper. No complaint in this regard, will be entertained after examination.

Note : Attempt *five* questions in all, selecting *one* question from each Unit. Question No. **1** is *compulsory*. All questions carry equal marks.

1. (a) Estimate the ground state energy of Hydrogen atom using variational method. You may take $\psi(r,\theta,\varphi) = e^{-\frac{r}{a}}$ as the trial wave function.   4

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(b) Write the relationship between Einstein coefficients and explain why these are so important in selecting a material for laser fabrication.   4

(c) Define differential scattering cross-section. Write the relation connecting scattering amplitude with differential scattering cross-section.   4

(d) Wave function is either totally symmetric or totally anti-symmetric. Prove this statement for a system of three identical particles.   4

UNIT – I

2. Set-up the Hamiltonian for He-atom and separate it into unperturbed & perturbation part with proper justification for each term. Now using perturbation method estimate the ground state energy of He-atom and compare the result with experimental values.   16

3. What do you understand by a time dependent perturbation ? Develop the first order time dependent perturbation theory and hence obtain the expression of transition rates under constant and harmonic perturbation.   16

(2)

UNIT – II

4. What do you mean by semi-classical theory radiation ? Obtain the probability for absorption stimulated emission when EM radiation interacts matter. Does semi-classical theory of radiation any clue about the spontaneous emission of radiation

5. (a) Discuss electric dipole approximation and der the selection rules for transitions.

   (b) Briefly discuss higher order transitions.

UNIT – III

6. (a) Write and plot an attractive square well potential Discuss the S-wave scattering of a particle of mass m from this potential and obtain an expression for phase shift. **11**

   (b) Show that $\theta_1 = \theta/2$ and

   $$\left(\frac{d\sigma}{d\Omega_1}\right)_{Lab} = 4\cos(\theta/2)\left(\frac{d\sigma}{d\Omega}\right)_{CM}$$

   in case of scattering between two particles of same mass, where θ_1 and θ are the scattering angle in lab and centre of mass frame respectively. **5**

7. (a) What do you mean by elastic and inelastic scattering ? Obtain an expression for total inelastic scattering cross-section. **9**

   (b) State and prove optical theorem. **4**

   (c) In a scattering experiment, the phase shifts are given as $\delta_0 = 60°$ and $\delta_1 = 30°$ and all other phase shifts are zero. Find the differential scattering cross-section for this experiment. **3**

UNIT – IV

8. (a) Discuss how the principle of Indistinguishability of identical particles of a many body system leads to a classification of the physically acceptable wave functions into symmetric and anti-symmetric type. **10**

   (b) What is Slater determinant ? How does it incorporate Pauli's Exclusion Principle ? **6**

9. Write detailed notes on the following : **8 + 8 = 16**

   (a) Helium Spectra

   (b) Collision of identical particles