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D 71335 (Pages : 2) Name.....

Reg. No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2014

(CUCSS)

PHY 3C 09—QUANTUM MECHANICS

(2012 Admission onwards)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries **1** *weightage.*

1. Give the magnitude of the first order perturbation energy.
2. What is the effect of the application of an electric field in the linear stark effect ?
3. What are turning points ? Give its significance.
4. What is meant by degeneracy ?
5. Distinguish between stimulated and spontaneous emission.
6. Why does spontaneous emission far exceeds stimulated emission in the visible region ?
7. What are the arguments used in deriving the Klein-Gordon equation ?
8. What do you mean by negative energy states ?
9. Explain what is meant by Pauli Spin matrices.
10. What are indistinguishable particles ? Give example.
11. What is Lamb shift ?
12. Explain Bohr Sommerfield quantum theory.

(12 × 1 = 12 weightage)

Part B

Answer any **two** *questions.*
Each question carries **6** *weightage.*

1. Use the variational method to estimate the energies of a one dimensional harmonic oscillator in the ground state and first excited state.
2. Prove that the WKB approximation gives correct energy Eigen values of all the states of a harmonic oscillator.
3. Outline the Heitler-London theory of the hydrogen molecule and discuss the result.
4. Derive the plane wave solutions of Dirac equation. Write the equation for a Central field.

(2 × 6 = 12 weightage)

Turn over

Part C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

1. A simple harmonic oscillator is perturbed by a harmonic potential so that the result Hamiltonian is given by $H = \frac{p^2}{2m} + \frac{1}{2} m w^2 x^2 + \lambda x^2$. Calculate the first order perturbation energy.
2. Derive the Bohr-Somerfield quantum condition using WKB method.
3. Calculate the Einstein's Coefficients for an electron moving in a central potential.
4. State and explain the postulates of Pauli's theory of Spin. Define Pauli matrices.
5. IF $\bar{\alpha} \times \bar{\beta}$ are Dirac matrices prove that :

   (a) $\alpha_x = \frac{1}{2}[\alpha_x \alpha_y, \alpha_y]$.

   (b) $\alpha_x \alpha_y, \alpha_z = \frac{1}{2}[\alpha_x \alpha_y, \alpha_z \beta, \beta]$.
6. Obtain the spin wave functions for *two* electrons.

(4 × 3 = 12 weightage