

M.Sc. S.Y. (Physics) CBCS Pattern Semester-III  
**PSCPHYT09-Core Paper-IX - Quantum Mechanics-II**

P. Pages : 2

Time : Three Hours



**GUG/W/23/11295**

Max. Marks : 80

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**Either:**

1. a) Explain first order Stark effect in the ground state and first excited state the H-atom. 8
- b) State and explain normal and anomalous Zeeman effects with the help of heat energy diagrams. 8

**OR**

- e) Explain application of time independent perturbation theory. 8
- f) Give first order perturbation theory of non-degenerate system and find the expression of energy and wave function. 8

**Either:**

2. a) What is Einstein's atomic radiation? What are Einstein's A and B coefficients. Derive equation for them. 8
- b) Discuss time dependent perturbation theory and derive the expression of Fermi-Golden rule of probability transition. 8

**OR**

- e) What do you mean by barrier penetration? Explain use of WKB method in barrier penetration. 8
- f) Explain Variational principle and its application to simple cases like ground state of He-atom. 8

**Either:**

3. a) Explain the outlines of Heitler-London theory of the hydrogen molecules. 8
- b) Describe the method of scattering by an attractive square well potential and a perfectly rigid sphere. 8

**OR**

- e) Derive the expression of wave function and energy of the ortho and parastates of the Helium atom and their perturbation by coulomb repulsion. 8
- f) Explain scattering cross-section in laboratory and centre of mass system and scattering by a central potential. 8

**Either:**

4. a) Derive Klein-Gordon relativistic equation for a free particle. **8**  
b) Explain spin-orbit interaction for Dirac's particles. **8**

**OR**

- e) Write down the Dirac equation for a free particle construct matrices for  $\alpha_x$ ,  $\alpha_y$ ,  $\alpha_z$  and  $\beta$ . **8**  
f) Discuss the solution for hydrogen atom in Dirac's theory. **8**
5. Attempt all of the following.
- a) Explain second order stark effect in harmonic oscillator. **4**  
b) What is Yukawa potential in deuteron? **4**  
c) Write a note on identical particles. **4**  
d) Explain physical significance of negative energy states. **4**

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