Physics
Paper-II

Time Allowed: Three Hours **Maximum Marks: 300**

*Note: Candidate should answer questions No. **1** and **5** which are compulsory and any **three** of the remaining questions, selecting at least **one** from each section.*

SECTION – A

1. (a) Write Schrodinger equation for free particle in 1-D. Solve it to find the energy Eigen values and Eigen functions. 04+08+08=20

   (b) Determine the expression for density of states for bulk material. 20

   (c) Derive the expression for vibrational energy for harmonic oscillator model of a diatomic molecule. Show that energy levels are equally spaced.

   15+05=20

2. (a) The potential function for a certain particle moving along positive x-axis is represented as $V(x) = \begin{cases} 0 \ for \ x < 0 \\ V_0 \ for \ x \geq 0 \end{cases}$. Calculate the transmittance (T) and reflectance (R) at the potential discontinuity and show that $T+R = 1$.

   12+12+06=30

   (c) Write Schrodinger equation for an electron inside a box of infinite walls. Solve it to find the energy Eigen values and Eigen functions.

   05+10+15=30

3. (a) Determine the $<r>$, $<r^2>$ and the most probable value of r for an electron of the hydrogen atom in its ground state. Given that $\psi_{100} = Ce^{-\frac{r}{a_0}}$ where C and a_0 are the normalization constant and Bohr's radius respectively.

   10+10+10=30

(b) The quantum numbers for the two optical electrons in a two-valence electron atom are: $n_1 = 6, l_1 = 3, s_1 = \frac{1}{2}$ $n_2 = 6, l_2 = 1, s_2 = \frac{1}{2}$.

(a) Assuming L-S coupling, find the possible values of L and hence J.

(b) Assuming j-j coupling, find the possible values of J. 15+15=30

4. (a) What is Raman effect? Explain Classical theory of Raman effect.

The Raman lines are observed at wavelengths 267*nm* and 343*nm* in the vibrational Raman spectrum of *HF*. Find the fundamental vibrational frequency of the *HF* molecule. 05+15+10=30

(b) Write a short note on (i) Fluorescence (ii) Phosphorescence and (iii) NMR

10×3=30

SECTION – B

5. (a) What are magic numbers? Write the experimental evidences for magic numbers. Find the spin and parity of $^{11}B_5$, $^{23}Na_{11}$, and $^{33}S_{17}$.

02+06+12=20

(b) Explain the types of interactions occurring in particle physics with examples. 20

(c) What are logic gates? Draw circuit diagram, symbol and write Boolean expression for *AND* gate, *OR* gate and *NOT* gate. 02+18=20

6. (a) Out of three possible states of two nucleon system i.e. nn, np, and pp, which is stable and what are the experimentally measured physical properties of that system. Also describe the stable two nucleon system in its ground system. 10+20=30

(b) Prove that nuclear density is independent of mass number.

Write short note on (i) β-decay (ii) Q-value of nuclear reaction.

Calculate the energy of γ-rays emitted in β-decay of ^{28}Al, where end point energy is 2.86 MeV, atomic masses of ^{28}Ai and ^{28}Si are 27.981908 and 27.976929 a.m.u. respectively. 10+12+08=30

7. (a) What are classical and quantum origin conservation laws obeyed in particle physics? Explain with examples. 30

(b) Discuss the formation of allowed and forbidden energy bands on the basis of Kronig-Penney model. Discuss the extreme conditions when energy levels are either discreet or continuous. 20+10=30

8. (a) Draw and explain input and output characteristics of a transistor in *CE*-configuration.

The current gain of a transistor in common emitter circuit is 49. Calculate the common base current gain and base current when emitter current is 3mA. 20+10=30

(b) Write a brief note on *JFET* and *JEFT* different parameters.

15+15=30