CSM : 15

PHYSICS
PAPER - II

Time Allowed : 3 hours Full Marks : 100

Marks for each question is indicated against it.

Attempt any 5 (five) questions taking not more than 3 (three) questions from each Part.

PART A

1. (a) What is meant by expectation value? A particle is described by the wave function
\[ \psi(x,t) = \left( \frac{2}{L} \right)^{\frac{1}{2}} e^{ikx} \] in the interval (0, L). Obtain the expectation value of momentum.

(b) State Heisenberg’s uncertainty principle and deduce the relation \( \Delta x \Delta p \geq \hbar \).

(c) Develop the Schrödinger equation for a free particle. How does it differ from the same equation for a particle moving under the action of some force?

2. A particle of certain energy E is incident on a one dimensional step potential \( V_o \). Derive an expression for the reflection and transmission coefficients and hence find a relation between the two, for the case \( E > V_o \).

3. (a) Describe Stern-Gerlach’s experiment and discuss its significance.

(b) Explain LS and jj coupling schemes.

4. (a) Discuss the elementary theory of the vibrational spectra of a typical diatomic molecule.

(b) Distinguish between Fluorescence and Phosphorescence.

PART B

5. (a) Describe briefly the liquid drop model of the nucleus and hence establish the semi-empirical mass formula. Explain its application in predicting the most suitable isotope in a mass parabola of an isobar.

(b) Describe the ground state of a deuteron and give an account of the nature of the forces between a proton and a neutron in a deuteron.
6. (a) State and explain with examples the conservation laws which govern the elementary particle reactions and decay. (12)

(b) What are quarks? Outline the basic assumptions and properties of quarks. Give the quark model of (i) mesons (ii) protons and anti-protons. (2+2+4=8)

7. (a) How are magnetic substances classified? Outline the characteristic features of Diamagnetic and Ferromagnetic substances. Give two examples of each. (3+6+2=11)

(b) What are superconductors? State and explain Meissner effect. What are type I and type II superconductors? (2+5+2=9)

8. (a) Outline the characteristic features of Operational Amplifiers. With a neat circuit diagram explain how an operational amplifier can be used as an integrator. (5+7=12)

(b) State and explain De Morgan’s law. (3+5=8)