

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

$$\psi(x, t) = \left(\frac{2}{L}\right)^{\frac{1}{2}} e^{ikx} \text{ in the interval } (0, L). \text{ Obtain the expectation value of momentum.}$$

(3+5=8)

- (b) State Heisenberg's uncertainty principle and deduce the relation $\Delta x \cdot \Delta p \geq \hbar$. **(3+4=7)**

- (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? **(3+2=5)**

2. A particle of certain energy E is incident on a one dimensional step potential V_0 . Derive an expression for the reflection and transmission coefficients and hence find a relation between the two, for the case $E > V_0$ **(16+4=20)**

3. (a) Describe Stern-Gerlach's experiment and discuss its significance. **(14)**

- (b) Explain LS and jj coupling schemes. **(3+3=6)**

4. (a) Discuss the elementary theory of the vibrational spectra of a typical diatomic molecule. **(14)**

- (b) Distinguish between Fluorescence and Phosphorescence. **(6)**

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. **(2+6+4=12)**

- (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. **(4+4=8)**

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)**

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