

<b>CSM – 59/18</b>
<b>Physics</b>
<b>Paper – II</b>

*Time : 3 hours*

*Full Marks : 300*

*The figures in the right-hand margin indicate marks.*

*Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and three of the remaining questions, selecting at least one from each Section.*

**SECTION – A**

1. Answer any **three** of the following :
  - (a) Explain wave particle duality ? Give the experimental evidences. 20
  - (b) Find the solution of Schrödinger equation considering a particle of mass 'm', moving in the finite square well potential with energy  $0 < E < V_0$  : 20

$$\text{Where } V_x = \begin{cases} V_0 & x < -a/2 \\ 0 & -a/2 \leq x \leq a/2 \\ V_0 & x > a/2 \end{cases}$$

(c) (i) Considering matter waves for microscopic system, find the de-Broglie wavelength for a proton of kinetic energy 70 MeV, where  $\hbar c = 197 \text{ MeV}$  and rest mass of the proton  $m_p c^2 = 938.3 \text{ MeV}$ . 'C' is the speed of light. 10

(ii) Estimate the uncertainty in the position of neutron moving at  $5 \times 10^6 \text{ ms}^{-1}$  with mass of the neutron is  $1.65 \times 10^{-27} \text{ kg}$ .  $\hbar = 1.05 \times 10^{-34} \text{ Js}$ . 10

(d) Obtain the solution of the one dimensional Schrödinger equation of free particle of mass 'm'. 20

2. (a) Find the reflection coefficient of a particle facing potential step with energy  $E > V_0$ . 20

$$V(x) = \begin{cases} 0 & x < 0 \\ V_0 & x \geq 0 \end{cases}$$

- (b) Obtain the expression for operator  $L^2$  in terms of spherical coordinate system. 20
- (c) Separate the Schrödinger equation of hydrogen atom to centre of mass and relative Co-ordinate system. 20
3. (a) (i) What is the aim of Stern-Gerlach experiment ? Explain it. Why inhomogeneous Magnetic field is required ? 8
- (ii) Explain the fine structure constant of hydrogen atom. 12
- (b) Distinguish between Normal Zeeman Effect and Anomalous Zeeman Effect. Explain Normal Zeeman Effect with experimental setup. 20
- (c) Derive the expression for rotational energy of a diatomic molecule. 20
4. (a) Explain the mechanism of fluorescence and phosphorescence with neat diagram. 20

- (b) (i) What is Raman Effect ? Explain 'stokes' and 'anti-stokes' lines. 10
- (ii) The exciting lines in an experiment is  $5460\overset{\circ}{\text{A}}$  and the stokes line is at  $5520\overset{\circ}{\text{A}}$ . Find the wavelength of the anti-stokes line. 10
- (c) What is NMR ? Discuss its application. 20

### SECTION – B

5. Answer any three questions of the following :

- (a) (i) What is advantage of shell model over extreme single particle model ? 5
- (ii) Using shell model, find the ground state spin of  ${}_{8}^{17}\text{O}$ ,  ${}_{9}^{17}\text{F}$ ,  ${}_{8}^{16}\text{S}$ ,  ${}_{17}^{33}\text{S}$ . 15
- (b) (i) Briefly outline the properties of nuclear force and its nature. Give examples of common potentials used for nuclear calculation. 12
- (ii) Discuss nuclear fission and fusion on the basis of binding energy curve. 8

(c) (i) Explain Q-value in nuclear reaction ?

12

(ii) Calculate the minimum kinetic energy of alpha particle to cause reaction

$^{14}\text{N}(\alpha, p)^{17}\text{O}$ . Given  $m(^{14}\text{N}) = 14.00307\text{u}$ ,  $m(\alpha) = 4.00260\text{u}$ ,  $m(p) = 1.00783\text{u}$  and  $m(^{17}\text{O}) = 16.999130\text{u}$ . 8

(d) Explain  $\gamma$ -decay with neat diagram. What is its mechanism ? 20

6. (a) Applying conservation laws show whether the following decays and particle reactions are possible or not. State the type of interaction involved in each process : 20

$$\Sigma^0 \rightarrow \Lambda^0 + \gamma$$

$$p + \nu_e \rightarrow e^+ + K^0 + \Lambda^0$$

$$p + \pi \rightarrow \Lambda^0 + \bar{\Sigma}^0$$

$$p + \bar{p} \rightarrow \pi^0 + \pi^+ + \pi^- + \pi^+ + \pi^-$$

$$p + \bar{\nu}_\mu \rightarrow \mu^+ + n$$

- (b) What are weak interactions ? Estimate their strength and range giving examples. Mention their kinds. 20
- (c) Write notes on the following : 20
- (i) Intermediate vector boson
  - (ii) Quark structure of hadrons
7. (a) (i) What is Meissner effect ? Show that superconductor behaves as a diamagnetic body. 12
- (ii) Distinguish between type – I and type – II superconductors ? 8
- (b) Discuss the variation of specific heat for superconducting state and normal state. 20
- (c) (i) Give the distinction between BCC and FCC crystals. 10
- (ii) Distinguish between semiconductor and insulator on the basis of band theory with diagram. 10

8. (a) Explain working principle of PNP and NPN transistor with circuit diagram. 20
- (b) What is JFET ? Discuss its output characteristic curves with neat circuit diagram. 20
- (c) What are logic gates ? Discuss those. 20



