

<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**

**Techofworld.In**

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

Techofworld.In

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. **Techofworld.In** 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  $5460\text{\AA}$  and the stokes line is at  $5520\text{\AA}$ . Find the wavelength of the anti-stokes line. 10
- (c) What is NMR ? Discuss its application. 20

### SECTION – B

Techofworld.In

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

**Techofworld.In**

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. **Techofworld.in** 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

[Techofworld.In](http://Techofworld.In)

