

**M.Sc.****2009****4th Semester Examination****PHYSICS****PAPER—PH-2202****Full Marks : 40****Time : 2 Hours**

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

*Candidates are required to give their answers in their own words as far as practicable.*

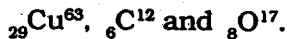
*Illustrate the answers wherever necessary.*

**Group—A****(Marks : 20)**

1. Answer any five from the following : 2×5
- (a) Discuss the exchange forces between the nucleons with examples.
  - (b) Establish the target capture  ${}_{13}\text{Al}^{27}(\text{d},\text{p}){}_{13}\text{Al}^{28}$  nuclear reaction for  $E_d > 50$  MeV.
  - (c) Give few examples of the Independent Particle models.
  - (d) What do you mean by the reaction channels for nuclear reactions? Express with example.

*(Turn Over)*

- (e) What are semi-magic and double magic nuclei ?
- (f) Using single-particle shell model find the spin-parity values of the following (any two) ground state nuclides :



- (g) Present graphically the types of neutrons with energy.
- (h) Give the range of life-time and nucleon traverse-time on the formation and disintegration of the compound nucleus.

2. Answer any one bit :

10×1

- (a) What do you mean neutron optics? Derive the relation between refractive index ( $\mu$ ) and scattering length ( $a$ ) of a material with nuclei per unit volume ( $N$ ) due to neutron for wave length ' $\lambda$ ', 2+8
- (b) What do you understand by the level width ( $\Gamma$ ) and level separation ( $D$ ) between the levels of a continuum in nuclear reactions ?

Discuss the basic ideas of the continuum theory of nuclear reactions. 2+8

**Group—B**

(Marks : 20)

1. Answer any five bits :

2×5

- (a) Prove that the time reversal operator is anti-unitary.
- (b) State the usefulness of normal ordering of operators.
- (c) Define gauge co-variant derivative why it was introduced ?
- (d)  $\hat{H}_{\text{int}}^{\text{e.m.}} = e\bar{\psi}\gamma_{\mu}\psi A_{\mu}$ .
- (e) How does standard model predict neutral current ?

Evaluate  $\hat{C}\hat{H}_{\text{int}}^{\text{e.m.}}\hat{C}^{-1}$ .

$$(f) \quad L = \frac{1}{2}\partial^{\mu}\phi\partial_{\mu}\phi - \frac{1}{2}m^2\phi^2.$$

Prove that  $m^2\phi + \square\phi = 0$ .

- (g) Discuss Higg's mechanism.
- (h) What do you mean by non-abelian symmetry ?

2. Answer any one bit :

- (i) (a) For the process  $e^{-}\mu^{-} \rightarrow e^{-}\mu^{-}$ , write down the scattering amplitude with necessary Feynman diagram.

5

(b) Prove that

$$\begin{aligned} & \text{Tr}[(\not{p}_2 + m) \gamma^\mu (\not{p}_1 + m) \gamma^\lambda] \\ &= 4 \left[ p_2^\mu p_1^\lambda + p_2^\lambda p_1^\mu + m^2 g^{\mu\lambda} - p_1 \cdot p_2 g^{\mu\lambda} \right] \end{aligned} \quad 5$$

(ii) (a) Prove that the invariance of the scalar field Lagrangian under space-time translation leads to the conserved energy-momentum tensor

$$T_\nu^\mu = \frac{\partial L}{\partial(\partial_\mu \phi)} - L \delta_\nu^\mu. \quad 5$$

(b) What is CPT theorem? Write the consequence of CPT theorem. Why parity is not conserved in weak interaction?

1+2+2

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