

**M.Sc. 4th Semester Examination, 2010**

**PHYSICS**

**PAPER—PH-2202 (A & B)**

*Full Marks : 40*

*Time : 2 hours*

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

**Paper — PH-2202 A**

*Marks : 20*

*Time : 1 hour*

**1. Answer any five from the following : 2 × 5**

- (a) Discuss the different types of two-body nucleon-nucleon interactions in tabular form.

( Turn Over )

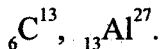
- (b) Using experimental evidences, show that the Deuteron ground state wave function ( $\psi_0$ ) can be expressed as

$$\psi_0 = a_0 \psi_{1s} + a_2 \psi_{1d}$$

- (c) With the help of compound nuclear model explain nuclear reactions.

- (d) Present graphically how Bohr - wheeler used the liquid-drop model to explain the process of nuclear fission.

- (e) Write the shell configuration and predict the spin and parity of the following ground state nuclei on the basis of single particle shell model:



- (f) How does the collective model incorporate essential features of liquid-drop model of nuclei?

(g) State and discuss the 'thermal neutron'.

(h) Illustrate using  $B^{10} (\alpha, p) C^{13}$  nuclear the conservation of parity in nuclear reaction (S-wave) [ $B^{10}$ ,  $\alpha$  and  ${}_1H^1$  is even while  $C^{13}$  is odd].

2. Answer any *one* bit :

10 × 1

(a) What are the resonance levels and resonances in the formation of the compound nucleus? Give a simple derivation of the Breit-Wigner one level formula for the radiative capture cross-section of neutron reaction in nuclei to describe resonances.

3 + 7

(b) Describe the various experimental techniques involved in neutron spectroscopy, giving special emphasis on time of flight method to select neutron beams of definite energies.

2 + 8

Paper—PH-2202 B

(Quantum Field Theory)

Marks : 20

Time : 1 hour

Answer Q. No. 1 and any one from the rest

1. Answer any five bits :

2 × 5

(a) Write down the Lagrangian for Fermion fields and gauge fields.

(b) Write down time-ordered product for fermionic fields.

(c) For real scalar field show that  $a^+|n_k\rangle$  and  $a|n_k\rangle$  are eigenstates of the number operator  $N_k$ .

(d) Show that the eigenvalues of the number operator of a Dirac field is either zero or unity.

(e) Draw a Feynman diagram for  $e^- + \mu^- \rightarrow e^- + \mu^-$  scattering and write down its amplitude.

(f) Evaluate :

$$\text{Tr} (\not{\epsilon}_2 r^\mu \not{\epsilon}_1 r^{\mu'})$$

(g) Evaluate :

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

where  $\hat{C}$  and  $\hat{P}$  are charge conjugation and parity operators.

(h) Discuss Higg's mechanism.

2. (a) Write down the Lagrangian density for complex scalar field. If this Lagrangian is invariant under global gauge transformation, using Noether's theorem find the corresponding conserved current  $j^\mu$ . Verify  $\partial_\mu j^\mu = 0$ .

(b) Also show that total charge

$$Q = Q_{\text{fermion}} - Q_{\text{anti-fermion}}$$

2 + 3 + 2 + 3

3. (a) Deduce an expression for Fermion propagator.
- (b) Define parity, time reversal and charge conjugation operations. Obtain any two of the operators for the Dirac field.
- (c) Give an idea about neutral current and symmetry breaking.

10

