2013

M.Sc. Part–II Examination

PHYSICS

PAPER—IX

Full Marks : 75

Time : 3 Hours

The figures in the margin indicate full marks.

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

Illustrate the answers wherever necessary.

Use separate Answer scripts for Gr. A & Gr. B.

Group—A

[Marks—40]

1. Answer any *six* questions : 6×2

(a) Using the semi-empirical mass formula show that the most stable isobar for odd A nucleus is given by

$$Z = \frac{A}{0.015A^{2/3} + 2}$$ 2

(b) State Geiger-Nuttal law. 2

(c) Mention the general features of β-ray spectrum. 2

(d) State the Pauli's Hypothesis of β-decay. 2

(e) State the principles of double focussing mass spectrograph. 2

(f) What is electric quadrupole moment ? Write down the expression for electric quadrupole moment possesses by a nucleus. 2

(g) Find the spin and parity of $_{13}Al^{27}$ nuclei using shell model. 2

(h) What is the basic principles of velocity selector neutron monochromator. 2

(i) What are the main evidences to show the existence of shell structure within the nuclei. 2

2. Answer any *two* questions : 2×4

(a) Explain how magic numbers are obtained using shell model. 4

(b) Show that the condition of stability against spontaneous fission is given by $\frac{z^2}{A} \leq 50$. 4

(c) What do you mean by multipole radiation ? What are the expected types of gamma-ray transitions between the states of odd-A nuclei : $g_{9/2} \rightarrow p_{1/2}$ 2+2

(d) What is Mossbauer effect ? Write down the applications of Mossbauer effect. 2+2

3. Answer any *two* questions : 2×10

(a) Deduce momentum distribution formula of β-decay according to Fermi's theory. What is Kurie plot ? 8+2

(b) Deduce Briet Wigner formula for spinless ($l = 0$) nuclei. Write also the formula for non zero l value. 8+2

(c) Discuss the basic principle of Rabi's method for determination of magnetic moment of a nuclei. Describe also the experimental arrangement. 5+5

(d) Discuss how fission can be explained by liquid drop method. Deduce Bohr-wheeler's theory of nuclear fission. 3+7

Group—B

[Marks—35]

Answer *Q No 1* and any *two* from the rest.

1. Answer any *five* questions : 3×5

(a) Calculate the coupling constant for l.m. interaction in natural unit.

(b) What are proper and improper symmetries.

(c) Prove that time reversal operator is anti-unitary.

(d) Show that in SU(2)

$$2 \otimes 2 = 3 \oplus 1$$

(e) The tau theta puzzle has been resolved by proposing that parity symmetry is violated in weak decay — Explain.

(f) Draw appropriate Feynman diagram to describe the second order S-matrix element for Compton scattering.

(g) How the principle of detailed balance can be used to determine the spin of $\prod^+$ in the reaction

$$\prod^+ + d \rightleftharpoons p + p'$$

(h) How the strangeness scheme proposed by Gell-Mann, Nishijima and Nakono explains the behaviour of strange particles ?

2. (a) For Baryons prove that $3 \otimes 3 \otimes 3 = 10 \oplus 8 \oplus \bar{8} \times 1$

(b) Prove that Isospin symmetry predicts $m_p = m_n$.

(c) Explain spontaneous symmetry breaking in particle Physics. 5+3+2

3. (a) Prove that $s + t + u = \sum_i m_i^2$

where s, t, u are Mandelstam variables.

(b) Calculate the threshold K.E. of proton in the lab. frame to create an anti-proton in a p–p collision. 5+5

4. (a) State Noether's theorem. Show that the invariance of the Lagrangian under space-time translation leads to the conserved energy–momentum tensor :

$$T_{\mu\nu} = \frac{\partial L}{\partial(\partial_\mu \phi)} \partial_\nu \phi - g_{\mu\nu} L$$

where each symbol has its usual meanings.

(b) Outline the basic concepts of the Glashow-Salam-Weinberg model based on the Gauge group $SU(2)_L \times U(1)$ involving leptons, quarks, gauge bosons and scalars. Indicate how the photon and neutral gauge boson fields arise in the model. Illustrate your answer by drawing Feynman diagram mediated by the photon and the weak neutral gauge boson. 5+5

5. (a) For a Scalar field $\phi(x) = \int \frac{d^3k}{\sqrt{(2\pi)^3 2w_k}}$

$$\left[a(k)e^{-i.k.x} + a^+(k)e^{i.k.x}\right]$$

Prove that

Hamiltonian $\hat{H} = \int d^3k \; w_k \left[a^+(k)\, a(k) + \frac{1}{2}\right]$.

(b) What is Dyson Normal ordering, Why it was introduced ? Find $:\hat{H}:$

Explain Wick's theorem with examples. 5+3+2
