PG/IIIS/PHS-303/13

M.Sc. 3rd Semester Examination, 2013

PHYSICS

PAPER – PHS- 303(Gr. A + B)

Full Marks : 40

Time : 2 hours

The figures in the right hand margin indicate 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]

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

1. Answer any *five* bits : 2 × 5

(*a*) State the various applications of mass spectrometer in modern science.

(*b*) How can you conclude that a heavy ($A \geq 150$) nuclides are energitically unstable against α-decay ?

(*c*) What do you mean by recoil free resonance emission of gamma ray ?

(*d*) Present diagrammatically the mechanism of α-decay.

(*e*) Graphically show the transitions of the following Odd A (77) isobaric nuclei with parabolic presentation :

$$_{32}Ge^{77} \xrightarrow{\beta^-} {}_{33}As^{77} \xrightarrow{\beta^-} {}_{34}Se^{77} \text{ (stable)}$$

and

$$_{36}Kr^{77} \xrightarrow{\beta^+} {}_{35}Br^{77} \xrightarrow{\beta^+} {}_{34}Se^{77}$$

(*f*) Nucleus are composed of at least one of the following :

(*i*) Electrons only

(*ii*) Protons only

(*iii*) Neutrons only

(*iv*) Electrons, protons and neutrons.

(*g*) Show with figure the continuous nature of energy spectrum of the β- particles in the nuclear beta-decay, electron capture and indicate the end point energy.

(*h*) Which one of the following nuclear decay is possible ?

(*i*) $_{29}Cu^{64} \longrightarrow {}_{28}Ni^{64} + \beta^{+} + \overline{\gamma}$

(*ii*) $_{29}Cu^{63} \longrightarrow {}_{28}Ni^{63} + \beta^{-} + \gamma$

(*iii*) $_{29}Cu^{63} \longrightarrow {}_{28}Ni^{63} + \beta^{+} + \gamma$

(*iv*) $_{29}Cu^{63} \longrightarrow {}_{28}Ni^{63} + \beta^{+}$

2. **Discuss the basic principle of the Rabi's method for determination of magnetic moment of nuclei. Describe the experimental arrangement.** 5 + 5

3. Following Fermi's theory of beta-decay find out the probability per unit time for the emission of β^- particles (an electrons) in the momentum range η_e and $\eta_e + d\eta_e$. Show the Fermi-Kurie plot. 8 + 2

Or

Write basic β-transitions and electron capture. Show dual beta-decay (β^+, β^-) electron -capture and γ transitions characteristics with the familiar example of $_{29}Cu^{64}$ by schematic diagram with maintaining relative abundance of the competing transitions is shown on the nuclear mass energy diagram.

GROUP – B

[*Marks* : 20]

Answer **Q.No.1** and any **one** from the rest 2 × 5

1. Justify any *five* of the following statements with reasoning and derivation wherever possible :

   (*a*) Define the Lie algebra for the $SU(2)$ group and represent an arbitrary group element in terms of the generators of the group.

(*b*) Show that a mass less Dirac particle has definite helicity.

(*c*) $$p \rightarrow n + e^{+}$$
$$p \rightarrow \pi^{+} + \gamma$$
Why the above reactions are forbidden ?

(*d*) The cross-sections of the reactions
$$p + \pi^{-} \rightarrow \Sigma^{-} + k^{+}$$
$$\overline{p} + \pi^{+} \rightarrow \overline{\Sigma^{-}} + k^{-}$$
are same at a given energy due to _____.
The quark content of Δ^{++} is _____.

(*e*) Explain $\tau - \theta$ puzzle and how it was resolved ?

(*f*) Define proper Lorentz transformation show that $\overline{\psi}\ \gamma_{\mu}\ \psi$ transforms as a four vector under proper Lorentz transformation.

(*g*) Give examples of spontaneous symmetry breaking.

2. (*a*) Show that the sum of three Mandelstam variables s, t, and u for the reaction $a + b \rightarrow c + d$ is given in natural units by

$$s + t + u = m_a^2 + m_b^2 + m_c^2 + m_d^2$$

where m_a denotes the mass of the particle '*a*'. 4

(*b*) Assuming isospin symmetry for pi-meson-nucleon scattering show that, near $\Delta(1232)$ resonance.

$$\sigma(\pi^+ p \rightarrow \pi^+ p) : \sigma(\pi^- p \rightarrow \pi^- p) : \sigma(\pi^- p \rightarrow \pi^0 n) = 9 : 1 : 2$$

where σ denotes the total cross-section for the process in the parenthesis. 6

3. (*a*) What is *G*-parity ? Find an expression of it. How intrinsic parity of π^- meson is determined experimentally ? 1 + 2 + 3

(*b*) State and prove CPT theorem. 1 + 3
