

**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

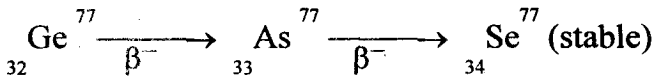
1. Answer any *five* bits ; 2 × 5

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

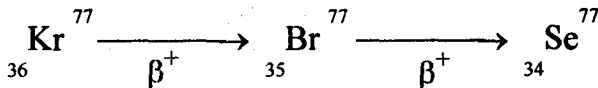
( Turn Over )

( 2 )

- (b) How can you conclude that a heavy ( $A \geq 150$ ) nuclides are energetically unstable against  $\alpha$ -decay?
- (c) What do you mean by recoil free resonance emission of gamma ray?
- (d) Present diagrammatically the mechanism of  $\alpha$ -decay.
- (e) Graphically show the transitions of the following Odd  $A$  ( $77$ ) isobaric nuclei with parabolic presentation :



and



- (f) Nucleus are composed of at least one of the following :
- (i) Electrons only

( 3 )

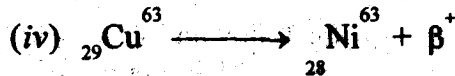
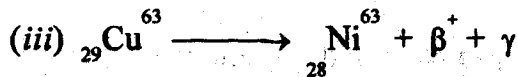
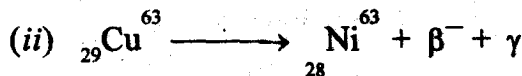
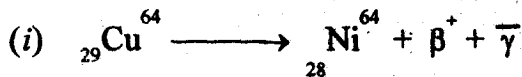
(ii) Protons only

(iii) Neutrons only

(iv) Electrons, protons and neutrons.

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

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



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

( 4 )

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

8 + 2

Or

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

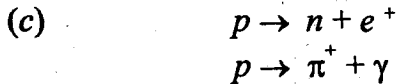
GROUP – B

[ Marks : 20 ]

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

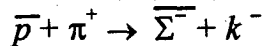
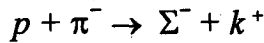
1. Justify any *five* of the following statements with reasoning and derivation wherever possible :
- (a) Define the Lie algebra for the  $SU(2)$  group and represent an arbitrary group element in terms of the generators of the group.

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



Why the above reactions are forbidden ?

(d) The cross-sections of the reactions



are same at a given energy due to \_\_\_\_\_.

The quark content of  $\Delta^{++}$  is \_\_\_\_\_.

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

(f) Define proper Lorentz transformation show that  $\bar{\psi} \gamma_\mu \psi$  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  $\sigma$  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  $\pi^-$  meson is determined experimentally? 1 + 2 + 3

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