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End Semester Examination of Semester–III, 2015
Subject : PHYSICS (PG)
Paper : PHS–303 (Theory)
Full Marks : 40
Time : 2 Hrs

The figures in the margin indicate the marks corresponding to the question

Candidates are requested to give their answers in their own word as far as practicable.

Illustrate the answers whenever necessary

Use separate Answer scripts for Group A and Group B

Group A (Marks 20)

Answer Question **No. 1** and **any one** out of Question **No. 2** and Question **No. 3.**

1. Answer **any five** questions : 2x5=10

   i) What is the mass-parabola for isobaric Nuclei?

   ii) Write down the assumptions for Gamow's theory of α-decay?

   iii) Graphically show that continuous nature of β-ray spectrum and indicate the end point energy.

   iv) What are the important uses of Mössbancer effect?

   v) Prove that alpha particle disintegration energy

$E_\alpha = K_\alpha \left(\frac{M_\alpha}{M_R} + 1 \right)$, where K_α = Kinetic energy of the emitted α-particle. M_α and M_R are the masses of the α-particle and residual nucleus.

vi) Determine the Stable nucleus that has a radius = $\frac{1}{3}$ that of Os^{189}.

vii) How is the electric quadrupole moment of a nucleus related to its shape?

viii) Which one of the following nuclear decay is possible?

a) $_{29}Cu^{64} \rightarrow {}_{28}Ni^{64} + \beta^+ + \bar{\gamma}$

b) $_{29}Cu^{63} \rightarrow {}_{28}Ni^{63} + \beta^- + \gamma$

c) $_{29}Cu^{63} \rightarrow {}_{28}Ni^{63} + \beta^+ + \gamma$

b) $_{29}Cu^{63} \rightarrow {}_{28}Ni^{63} + \beta^+$

Discuss.

2. Discuss the basic principle of the Rabi's method of determining the magnetic moment (μ_e) of a nucleus and describe the experimental arrangement. 5+5

3. Following Fermi's theory at β-decay find out the probability per unit time for the emission of an electron in the momentum range of p_e and $p_e + dp_e$. What is Kurie plot? Write down the selection rule of β-decay. 6+2+2

Group – B (Marks 20)

Answer Question **No. 1** and **any one** out of Question **No. 2** and Question **No. 3.**

1. Answer **any five** questions: 2x5=10

   i) Calculate the range of interaction of weak force.

   ii) Show that the eigon value of the charge conjugation operator of a system of fermion-antifermion bound state is $(-1)^{l+s}$ where l is the relative orbital angular momentum and s is the total spin of the system.

   iii) Assuming isospin invariance in strong interaction, show that the proton and the neutron are mass degenerate.

   iv) What is G-parity? Which interactions do respect G-parity?

   v) Classify the following reactions as strong, weak, electromagnetic on totally forbidden:

   a) $K^- + p \rightarrow \Sigma^- + K^0$

   b) $n + p \rightarrow \Sigma^+ + \Lambda^0$

   vi) Prove that particles and antiparticles have opposite values of I_3.

   vii) How many generators are there in SU(2) group? Write down the generators.

   viii) Why do neutrino oscillations imply non Zero neutrino masses?

2. a) Prove that in SU(3) : $3 \otimes 3 \otimes 3 = 10 \oplus 8 \oplus 8 \oplus 1$.

   b) Assuming the principle of charge independence show that for pi-meson nucleon scattering near $\Delta(1232)$ resonance $\sigma(\pi^+ p \to \pi^+ p)$: $\sigma(\pi^- p \to \pi^- p)$: $\sigma(\pi^- p \to \pi^0 x) = 9 : 1 : 2$ where σ denotes the total cross-section for the process in the parenthesis. 4+6

3. a) The Bevatron at Berkeley was built to produce anti protons, by the reaction $p + p \to p + p + p + \bar{p}$. That is a high energy proton strikes a proton at rest, creating a proton-antiproton pair. What is the threshold energy for this reaction?

   b) Explain solar neutrino problem. How was it resolved?

   c) Explain spontaneous symmetry breaking in particle physics. 4+3+3