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End Semester Examination of Semester–III, 2016
Subject : PHYSICS (PG)
Paper : PHSPG–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

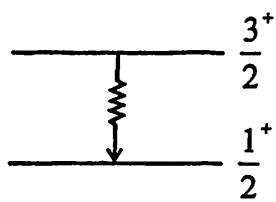
Use separate Answer scripts for Group A and Group B

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) State the multiple characters (E-l and M–l) of γ-radiation emitted in the following transition with given spin-parity values.



ii) Graphically show the transitions of the following odd (77) isobaric nuclei with parabolic presentation:

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

and

$$_{36}Kr^{77} \xrightarrow{\beta+} {}_{35}Br^{77} \xrightarrow{\beta+} {}_{34}Sc^{77} \text{ (Stable)}$$

iii) What is Kurie plot?

iv) How we can conclude that α-decay is possible only when $A \geq 150$ of radioactive model?

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

$$z = \frac{A}{0.15A^{\frac{2}{3}} + 2}$$

vi) Tritium emits β^- particles. Write down the equation for this decay and calculate the end point energy of the β^- particles.
Given: Atomic masses of
Tritium = 3·01695 a.m.u.
Helium = 3·01693 a.m.u.

vii) Show that the nucleus cannot have a permanent electric dipole moment.

viii) Explain non-conservation of parity in beta decay with symbolic (by spin and linear momenta) presentation by products nuclear and particles of the following β-decay

$$_{27}Co^{60}_{33} \rightarrow {}_{28}Ni^{60}_{32} + \beta^- + \bar{\upsilon}_e$$

2. Give a brief account of Gamow's tunneling mechanism for alpha emission and hence obtain an expression for the decay constant λ in terms of the kinetic energy of alpha particles. 2+8

3. What do you mean by internal conversion? Graphically discuss nuclear resonance absorption and fluorescence. What is recoil free gamma ray spectroscopy? 2+6+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) Show that change conjugation operator is hermitian.

   ii) Explain solar neutrino problem.

   iii) Find the dimension of the universal gravitational constant G in natural unit system.

   iv) Classify the following reactions as strong, weak, em on totally forbidden:

   a) $n + p \rightarrow \Sigma^+ + \wedge^0$

   b) $\pi^- + p \rightarrow K^+ + K^- + n$

   v) Can a tetraquark bound state exist in nature?–Explain.

   vi) What is CPT theorem?

vii) IS SU(3), prove that $3 \otimes 3 = 6 \oplus \bar{3}$.

viii) Π^0 cannot decay into three photons – explain.

2. a) In a two body scattering event A + B $\rightarrow$ C + D. Mandelstam variables are defined as

$$s \equiv (P_A + P_B)^2;\ t = (P_A - P_C)^2;\ u = (P_A - P_D)^2;$$

i) Show that

$s + t + u = m_A^2 + m_B^2 + m_C^2 + m_D^2$.

ii) Show that the CM energy of A is

$$E_A^{CM} = \frac{\left(s + m_A^2 - m_B^2\right)}{2\sqrt{s}}.$$ 3+3

b) Determine the intrinsic parity of π using $\pi d \rightarrow nn$ following information are given:

i) spin of d is 1 and orbital angular momentum of d is 0

ii) π is captured by the d in an s-wave state.

iii) d is an isosinglet.

3. a) Mixed symmetric flavor wave functions of proton are:

$$\psi_s = \frac{1}{\sqrt{6}}(2uud - udu - duu) \text{ and}$$

$$\psi_A = \frac{1}{\sqrt{2}}(udu - duu)$$

for spin wave functions of proton, write ϕ_s and ϕ_A by replacing u by $\uparrow$ and d by $\downarrow$.

i) Write down the spin-flavor wave function as a linear combination of ψ_A, ψ_S, φ_A and φ_S. Comment on the symmetry of the obtained wave function.
[Total spin of proton is $\uparrow$.] 3

ii) Calculate the magnetic moment of proton. (μ_u and μ_d an magnetic moments of u-quark and d-quark). 5

b) Write down the gauge group of Glashow-Weinberg-Salam model explaining the terms. What are the gauge bosons in this model? 2