K23P 1424

Reg. No. : .....

Name : .....

III Semester M.Sc. Degree (CBSS – Reg./Supple./Imp.)
Examination, October 2023
(2020 Admission Onwards)
PHYSICS
PHY 3C12 – Nuclear and Particle Physics

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** questions (either **a** or **b**).

1. a) What is nuclear binding energy and how does the semi-empirical mass formula explain it ? Also, how can we find the Z value for the most stable nucleus using this formula ?

   OR

   b) Derive the expression for the ground state deuteron wave function in a two-body problem, considering the deuteron as a nucleus composed of a proton and a neutron.

2. a) What is the shell model in nuclear physics and how does it account for nuclear magic numbers and the filling of nuclear energy levels ?

   OR

   b) What is the of beta decay and how does the Fermi theory explain it ?

(2×12=24)

SECTION – B

(**1** mark for Part (**a**), **3** marks for Part (**b**), **5** marks for Part (**c**)). Answer **any four**.

3. a) Explain nuclear radius.

   b) Define angular momentum and parity. How are they used to describe nuclear states ?

   c) A nucleus with A = 235, splits into two nuclei whose mass numbers are in the ratio 2 : 1. Find the radii of the new nuclei.

P.T.O.

4. a) What are the characteristic features of the nuclear force ?
   b) Explain the concept of compound nucleus reactions.
   c) A thin sheet of Co^{59}, 0.04 cm thick is irradiated with a neutron beam of flux density 10^{12} neutrons/cm^2/sec for a period of 3 hours. If the cross-section for neutron capture by Co^{59} is 30 barns, calculate the number of nuclei of isotope of Co^{60} produced at the end of the radiation period per cm^2 and the initial beta activity of the sample. Given half life of Co^{60} is 5.2 years and density of Co^{59} is 8.9 g/cm^3.

5. a) Write down different types of Quarks.
   b) Describe the quark model.
   c) Say which of the following reactions are possible ?
      i) $\pi^+ + n^0 \rightarrow \lambda^0 + k^+$
      ii) $\pi^+ + n^0 \rightarrow k^0 + k^+$
      iii) $\bar{\nu}_e + p^+ \rightarrow n^0 + \mu^+$
      iv) $\bar{\nu}_e + p^+ \rightarrow n^0 + e^+$
      v) $\pi^+ + n^0 \rightarrow \pi^- + p^+$

6. a) Why nuclear fission happens ?
   b) Explain characteristics of nuclear fission reaction.
   c) The half lives of two radioactive substance A and B are respectively 1 hour and 2 hours. If initially the number of nuclei of both substances are the same, compare their rate of disintegration after two hours.

7. a) What is magnetic dipole moment of nuclei ?
   b) Explain Spin-Orbit Potential regarding shell model.
   c) Predict the parity, quadrupole moment of the ground state of O_8^{17}, S_{16}^{33}.

8. a) What is Isospin and Strangeness quantum number ?
   b) Discuss the conservation laws that govern nuclear reactions.
   c) Determine the quark content of λ^0, k^+, k^0, $\bar{k^0}$, k^-. **(4×9=36)**