

Exam. Code : 103206

Subject Code : 1437

B.A./B.Sc. 6th Semester

PHYSICS

Paper—A

(Nuclear Physics)

Time Allowed—Three Hours] [Maximum Marks—35

Note :— Section-A is compulsory. Attempt each question from Sections B, C, D and E. Each section carries equal marks.

SECTION—A

1. (a) Find the packing fraction of deuteron. Given $M_d = 2.014102$ u.
- (b) Why do stable heavy nuclei have greater number of neutrons than protons ?
- (c) What is the ground state angular momentum and parity of ^{13}C nucleus ?
- (d) Calculate binding energy per nucleon of alpha-particle. Given $M_p = 1.007825$ u, $M_n = 1.008665$ u and $M_{\alpha} = 4.002603$ u.
- (e) What is the approximate magnetic moment of ^3Li ?

- (f) What do you mean by saturation of nuclear forces ?
- (g) Describe phenomenon of internal pair creation in nuclei.

SECTION—B

2. (a) Discuss the nature of the nuclear forces and the Yukawa theory.
- (b) Estimate the eccentricity of $^{123}\text{Sb}_{51}$, given the quadrupole moment is -1.0 barns. Assume the mean radius to be equal to $1.2 A^{1/3}$ fm, where A is the mass number of nucleus.
3. (a) Describe a method to determine the charge radius of the nucleus.
- (b) Using semi-empirical mass formula, how can one determine the most-stable isobar among odd- A nuclei ?

SECTION—C

4. (a) Describe briefly the elementary theory for β -decay.
- (b) In β -decay, if a $\left(\frac{5}{2}\right)^+$ nuclear state decays by first forbidden Fermi-type transition, what are the possible spin-parity of final state ?

5. (a) A radioactive element has a half-life of 25 hours. After what time will $1/8^{\text{th}}$ of initial number of its atoms disintegrate ? After what time will $1/32$ of the initial number remain unchanged ?
- (b) How do you classify nuclear transitions in beta decay ? What are allowed and forbidden transitions ? Illustrate your answer with examples.

SECTION—D

6. (a) Discuss different types of nuclear reactions with appropriate examples.
- (b) A beam of 7.3 MeV alpha-particle is used to produce the reaction $^{27}\text{Al}(\alpha, p)^{30}\text{Si}$. The protons are emitted at 0° are found to have an energy of 9.34 MeV. What is the Q-value of this reaction ?
7. (a) Discuss the kinematics of the nuclear reaction. Obtain the expression of the Q-value and discuss its significance.
- (b) The Q-values of the reactions $^2\text{H}(\text{d}, \text{t})^1\text{H}$ and $^2\text{H}(\text{d}, ^3\text{He})^1\text{n}$ are 4.032 and 3.269 MeV respectively. The β -disintegration energy of ^3H is known to be 0.019 MeV. Calculate the β -disintegration energy of neutron ?

SECTION—E

8. (a) Explain the origin of nuclear magnetic moment. Using Schmidt single particle model, deduce expressions for magnetic dipole moment. What are Schmidt lines ?
- (b) Write angular momentum and parities of ^{17}O and ^{27}Al .
9. (a) What are the limitations of shell model ?
- (b) Given that the single particle separation between $1d_{5/2}$ and $1d_{3/2}$ in ^{17}O is 5 MeV, calculate the strength of spin-orbit interaction.