10/12/19 M

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 8093 **J**

Unique Paper Code : 32227504

Name of the Paper : Nuclear and Particle Physics

Name of the Course : **B.Sc. (Hons.) Physics : DSE-2**

Semester : V

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all. Question No. **1** is compulsory.
3. **All** questions carry equal marks.
4. Use of Scientific Calculator is allowed.

1. Answer any **five** : (3×5=15)

(a) Show that density of nuclear matter is independent of its mass number.

P.T.O.

(b) What is Pair production phenomenon?

(c) Differentiate between Proportional counter and Geiger Muller chamber.

(d) The atomic ratio between the uranium isotopes ^{238}U and ^{234}U in a mineral sample is found to be 1.8×10^4. The half life of ^{234}U is 2.5×10^5 years. Find half life of ^{238}U.

(e) What is pairing effect? Why are even–even nuclei more stable as compared to even-odd and odd-odd nuclei?

(f) By how much the atomic mass of a parent nucleus exceed the atomic mass of a daughter when (i) an electron is emitted (ii) a positron is emitted and (iii) an electron is captured?

(g) Give any three characteristics of a nuclear force.

(h) Determine the minimum energy of an antineutrino to produce the reaction $\bar{\nu}+p\rightarrow n+e^+$.

2. (a) What are direct reactions? Explain deuteron pick up and stripping reaction. (8)

(b) Show that kinetic energy of an α-particle released in the decay of a nucleus with mass number A is given by

$$KE_\alpha = \frac{(A-4)Q}{A}$$

where Q is the Q -value of the reaction. (7)

3. (a) Starting from the density of states obtained from free Fermi gas confined within a volume; obtain the kinetic energy of the highest occupied orbit. (5)

(b) Compare the minimum energies required to remove a neutron from $^{41}_{20}Ca$, $^{42}_{20}Ca$ and $^{43}_{20}Ca$. (5)

(c) For the mirror nuclei $^{23}_{11}Na$ and $^{23}_{11}Mg$, calculate the coulomb coefficient a_c. Given M[^{23}Mg] = 22.994124 amu and M[^{23}Na] = 22.989768 amu. (5)

4. (a) What conservation laws were apparently being violated in the observed continuous β spectrum? How did it help Pauli in predicting the nature of the new particle? (3+2=5)

P.T.O.

(b) State the assumptions of Gamow's Theory of Alpha Decay and derive an expression for decay constant of a radioactive nuclei using Gamow's Theory of Alpha Decay. (3+7=10)

5. (a) How does a heavy charged particle interact with matter? Differentiate between energy loss due to heavy ions and electrons in matter. (3+3=6)

(b) What is the working principle of a Betatron? (3)

(c) Linear absorption coefficient of Lead for 1 MeV γ rays is 0.75 per cm. Calculate thickness of lead required to reduce the intensity of γ rays to $\frac{1}{100}$. (6)

6. (a) Explain the procedure by which high potential of the order of MV is generated in a Tandem accelerator. Explain the purpose of using SF_6 gas in Tandem accelerator tank. (3+2=5)

(b) Define quenching in GM counters. An organic-quenched GM tube operates at 1000V and has a wire diameter of 0.2 mm. The radius of the cathode

is 2 cm and the tube has a guaranteed lifetime of 10^9 counts. What is the maximum radial field and how long will the counter last, if it is used on the average for 66 hours per week at 2000 counts per minute? (2+3=5)

(c) A cyclotron in which the flux density of 2 T is employed to accelerate protons. The radius of the cyclotron is 0.32 m. Calculate the frequency of the alternating field applied to Dees. Mass of proton $m_p = 1.6 \times 10^{-27}$ kg and charge $= 1.6 \times 10^{-19}$ C. (5)

7. (a) State the conversation principles preserved or violated in the following particle interactions :

(i) $\pi^- + p \rightarrow \Lambda^o + \pi^o$

(ii) $\pi^+ + p \rightarrow K^o + \Lambda^o$

(iii) $\Sigma^o \rightarrow \Lambda^o + \gamma$ (3×3=9)

(b) Distinguish between Baryons and Mesons. (3)

(c) What happens when electron and positron annihilate? (3)

P.T.O.

PHYSICAL CONSTANTS

$m_p = 1.007825$ u, $m_n = 1.008665$ u

$m_e = 0.00055$ u, $m_{He} = 2.0141$ u

1 amu $= 1.66 \times 10^{-27}$ kg, $R_0 = 1.2$ fm

$\epsilon_0 = 8.85 \times 10^{-12}$ F/m, $h = 6.6 \times 10^{-34}$ Js

$c = 3 \times 10^8$ m/s, 1 eV $= 1.6 \times 10^{-19}$ J