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N – 6236

Reg. No. :

Name :

Fourth Semester M.Sc. Degree Examination, June 2022

Physics

PH 242 : NUCLEAR AND PARTICLE PHYSICS

(2020 Admission)

Time : 3 Hours

Max. Marks : 75

PART – A

(Answer any **five** questions. Each question carries **3** marks)

- I. (a) Give the salient features of the collective model of nuclear structure.
- (b) Explain what is meant by a compound nucleus.
- (c) Explain magnetic confinement.
- (d) Explain the term critical energy in liquid drop model.
- (e) There are no known mesons of charge two. Give a simple explanation for this.
- (f) Why a proton does not decay into a positron and a photon? Give reasons.
- (g) Give the basic working principle of a proportional counter.
- (h) Explain the concept of scattering length.

(5 × 3 = 15 Marks)

PART – B

(Answer **all** the questions. Each question carries **15** marks)

- II. (A) (a) Discuss in detail the shell model of the nucleus.
- (b) Give the specialities of magic numbers of nuclei.

OR

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- (B) (a) Derive and explain Breit-Wigner resonance formula for nuclear reactions.
 (b) What are stripping reactions?
- III. (A) (a) State the general features and classification of nuclear fission reactors.
 (b) Explain neutron cycle and the four factor formula.

OR

- (B) (a) Discuss the thermonuclear reactions in the laboratory conditions.
 (b) Explain the term ignition temperature and Lawson criterion.
- IV. (A) (a) Draw the schematic representation of a Geiger-Muller counter and explain the same.
 (b) Explain its principle and working operation.

OR

- (B) (a) Explain in detail the eight fold way and SU (3) model for strong interaction.
 (b) Draw the weighted diagram for baryon decuplets and explain the same.
(3 × 15 = 45 Marks)

PART – C

(Answer any **three** questions. Each question carries **5** marks)

- V. (a) Which reaction produces more energy
 (i) the fusion of ${}^3\text{H}_1$ and ${}^3\text{He}_2$ or
 (ii) ${}^2\text{H}_1$ and ${}^4\text{He}_2$. Identify the reaction by the estimation of the Q-values?
- (b) Use the harmonic oscillator shell model to obtain the expected configuration of the ground state of the nucleus ${}^1\text{H}$ and its total L, S, J and T quantum number and parity.



- (c) Evaluate the Q value of the reaction $^{152}\text{Eu} + n \rightarrow ^{152}\text{Sm} + p$. Given the atomic masses in units of u ($1u=932\text{MeV}/c^2$) $^{152}\text{Eu}_{63}=151.92749$, $^{152}\text{Sm}_{62}=151.919756$, $^1\text{H}=1.007825$, neutron= 1.008665 .
- (d) In a nuclear reaction, the fission of U^{235} atom yields 200MeV . If energy of 3.6 kg of uranium is consumed in a day, find the power output of the reactor. Assume that the reactor is 25% efficient.
- (e) A GM counter consists of a 10mm diameter grounded tube with a wire of $50\mu\text{m}$ at $+2 \times 10^3\text{V}$ in the centre. Estimate the appropriate electric field at the wire.
- (f) The Gell-Mann-Nishijima relation which gives the charge of mesons and baryons in terms of certain quantum numbers is $q=e(I_3+B/2+S/2)$. Identify the different terms.

(3 × 5 = 15 Marks)

