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THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2025

(CBCSS)

Physics

PHY 3C 10—NUCLEAR AND PARTICLE PHYSICS

(2019 Admission onwards)

Time : Three Hours　　　　　　　　　　　　　　　　　　　Maximum : 30 Weightage

Answer the questions as per the instructions given in each section.

Section A

*Answer **all** questions.*
Each question carries 1 weightage.

1. Define the binding energy of a nucleus. How is it related to the mass defect ?

2. What is internal conversion in gamma decay ?

3. What is meant by magic numbers in the nuclear shell model ?

4. State the physical significance of spin-orbit coupling in nuclei.

5. What is Scintillation ? Give one example of a scintillator material.

6. What is counting statistics ? State the distribution governing radiation counting.

7. What are the four fundamental forces of nature ?

8. Define baryon number and lepton number.

(8 × 1 = 8 weightage)

Section B

*Answer any **two** questions.*
Each question carries 5 weightage.

9. Explain the concept of singlet and triplet potentials. How do they account for the difference in binding of the np, pp, and nn systems ?

10. Describe nuclear lifetimes and discuss the factors determining the lifetime in α, β, and γ decay processes.

Turn over

11. Describe the collective model of nuclei with nuclear vibrations and rotations. Explain the role of deformation in determining nuclear energy spectra.

12. Describe the classification of elementary particles based on internal symmetries, including baryons, mesons, leptons, and gauge bosons. Explain the role of SU(3) symmetry and the eightfold way.

$(2 \times 5 = 10 \text{ weightage})$

Section C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

13. Explain why the deuteron has only the triplet state $(^3S_1)$ bound but not the singlet state $(^1S_0)$.

14. An α-particle of energy 5 MeV is emitted in a radioactive decay. Calculate the Q-value, given that the recoil kinetic energy of the daughter nucleus is 0.12 MeV.

15. Explain the role of valence nucleons in determining nuclear magnetic dipole moments.

16. Using the semi-empirical mass formula, explain how the binding energy varies with mass number and identify the term responsible for pairing effects.

17. Describe the construction and operation of a photomultiplier tube (PMT).

18. Explain Yukawa's theory of the strong interaction and the role of the pion.

19. Discuss the conservation of isospin and its components in strong interactions.

$(4 \times 3 = 12 \text{ weightage})$