

QP CODE: 26019118



Reg No :

Name :

M.Sc DEGREE (CSS) EXAMINATION, MARCH 2026

Fourth Semester

Core Courses - PH010401 - NUCLEAR AND PARTICLE PHYSICS

M Sc PHYSICS, M Sc SPACE SCIENCE.

2019 Admission Onwards

99F6CF63

Time: 3 Hours

Weightage: 30

Part A (Short Answer Questions)

*Answer any **eight** questions.*

Weight 1 each.

1. Estimate the radius of the nucleus ${}_{20}^{45}\text{Ca}$.
2. What is the density profile of the nucleus? What are the major conclusions obtained?
3. Explain why there is no deuteron with anti-parallel nucleon spins.
4. Compare the collective features of nuclei with properties of a droplet of liquid.
5. Explain the comparative half-life of different beta transitions.
6. Outline the characteristics of compound nuclear reactions.
7. Briefly explain the resonance reaction.
8. Give the properties of pi mesons.
9. What is CPT theorem?
10. Define LIGO.

(8×1=8 weightage)

Part B (Short Essay/Problems)

*Answer any **six** questions.*

Weight 2 each.

11. How does the ground state spin and parity of an odd-odd nucleus is determined? Illustrate with an example.
12. Briefly explain the nuclear force as an exchange force mediated by mesons.
13. Obtain the collective structure for the nucleus.





14. Explain the energy release mechanism in beta decay.
15. Calculate the minimum kinetic energy for the alpha particle to initiate the reaction
 ${}^4_2\text{He} + {}^{14}_7\text{N} \rightarrow {}^{17}_8\text{O} + {}^1_1\text{H}$
 $m({}^4_2\text{He}) = 4.0039 \text{ u}; m({}^1_1\text{H}) = 1.0081 \text{ u}; m({}^{14}_7\text{N}) = 14.0075 \text{ u}; m({}^{17}_8\text{O}) = 17.0045 \text{ u}$
16. Determine the type of interaction (strong, weak, or electromagnetic) through which the following processes take place. Give reasons.
 (a) $n + p \rightarrow \Lambda^0 + K^0$ (b) $\Sigma^+ \rightarrow n + e^+ + \nu_e$ (c) $\pi^0 \rightarrow 2\gamma$
17. Analyse the following according to their quark content.
 (a) $K^- + p \rightarrow \Omega^- + K^+ + K^0$ (b) $p + p \rightarrow \pi^+ + \Lambda^0 + K^0$ (c) $\pi^- + n \rightarrow \Delta^- + \pi^0$ (d) $\Omega^- \rightarrow \Lambda^0 + K^-$
18. Give the theory of Rutherford backward scattering and its applications.

(6×2=12 weightage)

Part C (Essay Type Questions)

Answer any **two** questions.

Weight 5 each.

19. Analyse quantum mechanically the nucleon-nucleon scattering by assuming a square well potential and show that the scattering cross section is constant for low energy scattering. Explain the discrepancy between experimental and theoretical values of cross sections.
20. Discuss how the shell model gives a reasonable agreement with observed magnetic dipole moments and electric quadrupole moments of the nucleus.
21. Explain Coulomb scattering and obtain the Rutherford formula.
22. Discuss the validity of Grand Unified theories for particle interactions.

(2×5=10 weightage)

