**( NO. OF PAGES: 2 )**

**(FOR THE CANDIDATES ADMITTED DURING THE ACADEMIC YEAR 2023-24 ONLY)**

**SUBJECT CODE 23 PPS 412**

**REG.NO.**

**N.G.M.COLLEGE (AUTONOMOUS) : POLLACHI**

**END-OF-SEMESTER EXAMINATIONS : MAY– 2025**

**M.Sc. – PHYSICS** **MAXIMUM MARKS: 75**

**IV SEMESTER** **TIME : 3 HOURS**

# NUCLEAR AND PARTICLE PHYSICS

**SECTION – A (10 X 1 = 10 MARKS)**

**ANSWER THE FOLLOWING QUESTIONS. (K1)**

1. What is the spin of a deuteron in its ground state?

   (a) 0 (b) 1 (c) 2 (d) 1/2

2. Which nuclear model successfully explains the concept of "magic numbers"?

   (a) Liquid drop model (b) Shell model
   (c) Collective model (d) Superconductivity model

3. Paw Villard theory explains the mechanism of which type of radioactive decay?

   (a) Alpha decay (b) Beta decay (c) Gamma decay (d) Neutron decay

4. What is the main principle behind Bohr-Wheeler's theory of fission?

   (a) Quantum tunneling (b) Liquid drop model
   (c) Shell model (d) Nuclear chain reaction

5. The first discovered antiparticle was the ……

   (a) Antiproton (b) Antineutron (c) Positron (d) Tau lepton

**ANSWER THE FOLLOWING IN ONE (OR) TWO SENTENCES (K2)**

6. What is the binding energy of the deuteron?
7. What does the superconductivity model explain?
8. State the law of radioactive decay.
9. Name one common nuclear fuel used in fission reactors.
10. What is the spin of a meson?

**SECTION – B (5 X 5 = 25 MARKS)**

**ANSWER EITHER (a) OR (b) IN EACH OF THE FOLLOWING QUESTIONS. (K3)**

11. a) Explain the properties of deuteron.

    (OR)

    b) Explain the concept of exchange forces in nuclear physics.

12. a) Explain the liquid drop model and its key assumptions.

    (OR)

    b) Discuss the concept of nuclear vibrational states and their role in nuclear excitation.

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13. a) Discuss Fermi's theory of beta decay. What is the role of the neutrino in beta decay?

(OR)

b) Describe the internal conversion process.

14. a) Derive the four-factor formula and explain its significance.

(OR)

b) Describe a natural fission reactor and explain its significance.

15. a) Discuss the CPT invariance theorem and its implications.

(OR)

b) Discuss the significance of the Higgs boson and its discovery.

**SECTION – C (5 X 8 = 40 MARKS)**

**ANSWER EITHER (a) OR (b) IN EACH OF THE FOLLOWING QUESTIONS.**

**(K4 (Or) K5)**

16. a) Explain neutron-proton (n-p) scattering at low energies. Discuss the concept of scattering length and effective range.

(OR)

b) Explain Yukawa's theory of nuclear forces. Derive the Yukawa potential and discuss its significance in nuclear interactions.

17. a) Derive the Weizsäcker semi-empirical mass formula and explain the physical significance of each term

(OR)

b) Compare the shell model and collective model. Discuss their similarities and differences in explaining nuclear properties.

18. a) Explain Gamow's theory of alpha decay. Derive the expression for alpha particle emission probability.

(OR)

b) Explain the theory of angular correlation in successive radiation.

19. a) Explain the concept of nuclear fission in detail with an emphasis on the Bohr-Wheeler theory.

(OR)

b) Explain how a fusion reactor works and discuss the challenges in sustaining fusion reactions.

20. a) Discuss the general classification of elementary particles and explain their properties.

(OR)

b) Discuss Grand Unification Theories (GUTs) and their role in unifying strong, weak, and electromagnetic forces.

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