

**M. Sc. DEGREE END SEMESTER EXAMINATION - APRIL 2021****SEMESTER 4 : PHYSICS****COURSE : 16P4PHYT14 : NUCLEAR AND PARTICLE PHYSICS***(For Regular - 2019 Admission and Supplementary - 2018/2017/2016 Admissions)*

Time : Three Hours

Max. Marks: 75

**PART A****Answer All (1 mark each)**

1. Nuclear forces are
  - a. Spin dependent and have no non-central part
  - b. Spin dependent and have a non-central part
  - c. Spin independent and have no non-central part
  - d. Spin independent and have a non-central part
2. The ground state wave function of deuteron is in a superposition of s and d states. Which of the following is NOT true as a consequence?
  - a. It has a non-zero quadrupole moment
  - b. The neutron-proton potential is non central
  - c. The orbital wave function is not spherically symmetric
  - d. The Hamiltonian does not conserve the total angular momentum.
3. In the  $\beta$ -decay of neutron  $\rightarrow p^+ + e^- + \bar{\nu}_e$ , the antineutrino  $\bar{\nu}_e$  escapes detection. Its existence is inferred from the measurement of
  - a. Energy distribution of electrons
  - b. Angular distribution of electrons
  - c. Helicity distribution of electrons
  - d. Forward-backward asymmetry of electrons
4. Which of the following case, Z-component of the magnetic moment of nucleon is independent of total angular momentum (j), according to shell model?
  - a. proton ( $j = l+1/2$ )
  - b. neutron ( $j = l+1/2$ )
  - c. proton ( $j = l-1/2$ )
  - d. neutron ( $j = l-1/2$ )
5. Which one of the following is not a Boson?
  - a.  ${}^2_2\text{He}^4$
  - b.  ${}^1_1\text{H}^2$
  - c.  ${}^2_2\text{He}^3$
  - d. Photon

**(1 x 5 = 5)****PART B****Answer any 7 (2 marks each)**

6. Show that  $1\text{amu} = 931\text{ MeV}$ .
7. Write a short note on the non-central nature of nuclear force.
8. Stable light nuclei have equal number of protons and neutrons whereas the heavy nuclei have excess of neutrons. comment.
9. What are compound nucleus reactions?

10. What are direct reactions? Give example.
11. What is the role of neutrino in  $\beta$  – decay?
12. What factors make fusion reaction difficult to achieve?
13. What do you understand by nuclear fusion reactors? Mention the ways of achieving self sustained fusion reactions?
14. What are quarks? Name the different flavours of quarks.
15. What are leptons ? Give two examples.

**(2 x 7 = 14)**

### PART C

**Answer any 4 (5 marks each)**

16. What is electric quadrupole moment? Show that nucleus with  $J = \frac{1}{2}$  has zero quadrupole moment.
17. What is electrical quadrupole moment of a nucleus? What is its role in nuclear physics?
18. Describe beta ray spectrum. Illustrate how the continuous beta spectrum is explained.
19. Calculate the atomic number of the most stable nucleus for a given mass number A.
20. Describe the variation of deformation parameter vs energy in nuclear fission and explain the barrier height.
21. Describe an experimental evidence for color hypothesis.

**(5 x 4 = 20)**

### PART D

**Answer any 3 (12 marks each)**

- 22.1. Calculate the distance of closest approach of  $\alpha$ -particle of a given kinetic energy to an atomic nucleus. Explain why there is an upper limit for the energy of the incident particle beyond which the particle cannot be reflected back by the nucleus. What is the significance of this observation?

**OR**

2. Discuss the different nuclear properties of deuteron.

- 23.1. Give an account of Fermi's theory of beta decay. Compare the theoretical predictions with experimental findings.

**OR**

2. Discuss the salient features of  $\beta$ -ray spectrum and explain how Pauli's hypothesis of neutrino - $\beta$  emission. Solved the anomalies in the B-ray spectrum. Mention the properties of the neutrino.

- 24.1. Discuss the liquid drop model. Obtain the semi empirical mass formula. Explain its importance.

**OR**

2. Describe the following: i) Quark model ii) classification of elementary particles iii) different types of interactions and gauge particles.

**(12 x 3 = 36)**