Reg. No ..... Name **18P417**

M Sc DEGREE END SEMESTER EXAMINATION - MARCH 2018

SEMESTER 4 : PHYSICS

COURSE : **16P4PHYT14 ; NUCLEAR AND PARTICLE PHYSICS**

(For Regular - 2016 admission)

Time : Three Hours Max. Marks: 75

Section A

Answer all the following (1 marks each)

1. 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 symmetrics
   d. The Hamiltonian does not conserve the total angular momentum.

2. If the nuclear radius of ^{27}Al is 3.6 fm, the approximate nuclear radius of ^{64}Cu in Fermi is

   a. 4.8 b. 3.6 c. 2.4 d. 1.2

3. The reaction a + X → Y + b may be expressed as

   a. X(a,b)Y b. (X,a) (Y, c. (X,Y,a,b) d. both (a) and (c)

4. Which of the following case, Z-component of the magnetic moment of nulceon 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. $_2He^4$ b. $_1H^2$ c. $_2He^3$ d. Photon

(1 x 5 = 5)

Section B

Answer any 7 (2 marks each)

6. Define the term “mirror nuclei”. Illustrate with suitable examples.
7. Reason out the general nature of the nucleon-nucleon potential.
8. Write a short note on the non-central nature of nuclear force.
9. What are compound nucleus reactions?
10. Define ‘isospin’ of nucleons.
11. What is a nuclear molecule? Explain.
12. What is activation energy in nuclear fission?
13. Describe the various processes involved in the energy production in stars.
14. What is hypercharge?

15. Distinguish between particles and antiparticles.

(2 x 7 = 14)

Section C
Answer any 4 (5 marks each)

16. What is electric quadrupole moment? Show that nucleus with J = ½ has zero quadrupole moment.
17. Show that the neutron – proton S-wave scattering takes place both in the triplet and singlet spin states and find their statistical weights in scattering.
18. What is Q value? The nucleus ^{12}N decays to ^{12}C with value 16.38 MeV. Calculate the maximum recoil energy of the daughter nucleus?
19. For each of the following nuclei, use semi-empirical mass formula to compute the total binding energy and the Coulomb energy: a) ^{21}Ne b) ^{57}Fe.
20. Give the expected shell-model spin and parity assignments for the ground states of the following: a) ^{7}Li, b) ^{11}B, c) ^{17}F and d) ^{5}B.
21. Outline a sketch showing the classification of elementary particles.

(5 x 4 = 20)

Section D
Answer any 3 (12 marks each)

22. Give the quantum mechanical theory of the deuteron assuming a square well potential. Show that the deuteron is a loosely bound system.
23. Discuss the meson theory of nuclear forces. Mention the limitations of the theory.
24. What are direct and compound nuclear reactions. Discuss the salient features and explain with examples.
25. Discuss in detail the Fermi theory of beta decay. Explain the neutrino hypothesis
26. Discuss the liquid drop model. Obtain the semi empirical mass formula. Explain its importance.
27. Discuss the symmetries and conservation laws associated with fundamental particles?

(12 x 3 = 36)