(6 pages) **Reg. No. :** .....

Code No. : 7148 **Sub. Code : PPHM 43**

M.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2019.

Fourth Semester

Physics — Core

NUCLEAR AND PARTICLE PHYSICS

(For those who joined in July 2017 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer.

1. The nuclear force is
   (a) charge – dependent
   (b) charge – independent
   (c) spin – independent
   (d) weakly in triplet state

2. The ground state of deuteron is
   (a) a pure s-state
   (b) a pure d-state
   (c) a pure p-state
   (d) a mixture of s and d states

3. The wave mechanical theory of α-particle was given by
   (a) Fermi (b) Geiger and Nuttall
   (c) Gamow (d) Rutherford

4. The selection rule for Fermi transition is
   (a) $\Delta I = 0$ (b) $\Delta I = 1$
   (c) $\Delta I = -1$ (d) $\Delta I = \pm 1$

5. Which of the following is not a magic number?
   (a) 2 (b) 8
   (c) 28 (d) 50

6. The nuclear energy levels were introduced by
   (a) Liquid drop model
   (b) Shell model
   (c) Collective model
   (d) Radioactive model

7. The unit of level width is

(a) barn (b) cm

(c) cm^{-1} (d) electron-volt

8. The statistics followed by nucleons in nuclear reaction is

(a) Bose-Einstein

(b) Maxwell-Boltzmann

(c) Fermi Dirac

(d) All the above

9. The carrier particle of strong interaction is

(a) photon (b) quark

(c) graviton (d) gluon

10. Strange particles are

(a) Baryons and leptons

(b) Photons

(c) Leptons and mesons

(d) Neutrons and baryons

PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 250 words.

11. (a) Give a brief account of the Meson-theory of nuclear forces.

Or

(b) Derive an expression for magnetic dipole moment of a nucleus.

12. (a) Plot the energy spectrum of β-decay and explain why it is continuous spectrum.

Or

(b) Discuss internal conversion and internal pair creation and their significance.

13. (a) What is the magic about magic numbers? Explain how the Shell model of a nucleus accounts for the existence of magic numbers.

Or

(b) Discuss the main features of collective model for atomic nucleus. What are the vibrational and rotational states of the nucleus?

14. (a) State and explain reciprocity theorem.

Or

(b) Give a brief account on nuclear chain reaction.

15. (a) Explain the fundamental interactions among elementary particles.

Or

(b) Classify the elementary particles. What do you know about leptons and mesons?

PART C — (5 × 8 = 40 marks)

Answer ALL questions choosing either (a) or (b).

Each answer should not exceed 600 words.

16. (a) Discuss the effective range theory of low energy n-p scattering and hence explain the physical significance of scattering length.

Or

(b) Set up and solve Schrödinger equation for the deuteron in s-state assuming a square well potential and show that no excited state it possible for deuteron.

17. (a) Give a brief account of Fermi's theory of β-decay. How far this theory has been verified experimentally?

Or

(b) Explain Gamow's theory of α-decay. How is Geiger-Nuttal law obtained from it?

18. (a) Give an account of Bohr-Wheeler theory of nuclear fission. Discuss the various factors affecting the critical size of a reactor.

Or

(b) Discuss semi-empirical mass formula explaining meaning of each term in it and state its limitations.

19. (a) Give an account of Bohr's compound nucleus formation hypothesis for nuclear reactions.

Or

(b) What is meant by nuclear resonance? Derive Breit Wigner formula for nuclear reactions.

20. (a) Explain the Gell-Mann and Neeman classification of elementary particles.

Or

(b) Give quantum numbers associated with each quark. How are these quarks combine to form baryons and mesons?

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