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M.Sc. (CBCS) DEGREE EXAMINATION,
APRIL 2023.

Fourth Semester

Physics – Core

NUCLEAR AND PARTICLE PHYSICS

(For those who joined in July 2021 onwards)

Time : Three hours

Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. Meson theory of nuclear forces was given by

- (a) Heisenberg
- (b) Yukawa
- (c) Wigner
- (d) Bartlett's

2. The scattering cross-section of an impenetrable sphere of radius a , in the limit of zero energy can be expressed as

- (a) $4\pi a^2$
- (b) $4\pi a^3/3$
- (c) $4\pi a^3$
- (d) $4\pi a^{1/3}$

3. The spin of α – particles is

- (a) $\frac{1}{2}$
- (b) 0
- (c) 1
- (d) 2

4. The wave mechanical theory of α -particle can give by

- (a) Fermi
- (b) Geiger and Nuttall
- (c) Gamow
- (d) Rutherford

5. The magic numbers are

- (a) 2, 8, 20, 28, 50, 82, 126
- (b) 2, 4, 8, 18, 52
- (c) 20, 40, 80, 126
- (d) 3, 6, 9, 12, 15

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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 reaction cross-section is
 (a) barn (b) fermi
 (c) rather ford (d) m^{-1}
8. _____ is proto type fast breeder reactor.
 (a) KAIGA (b) HNPF
 (c) MAPS (d) BHAVINI
9. The reaction $\mu^+ \rightarrow e^+ + V_e + \bar{V}_\mu$ proves the conservation of _____ number.
 (a) Lepton (b) Baryon
 (c) Strangeness (d) Isospin
10. The carrier particle of strong interaction is
 (a) Photon (b) quark
 (c) graviton (d) gluon

PART B — (5 × 5 = 25 marks)

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

11. (a) Derive an expression for magnetic dipole moment of a deuteron.
 Or
 (b) Discuss in detail the excited states of the deuteron and prove that no Bound state exists for $l > 0$.
12. (a) Give a short notes on nuclear isomerism.
 Or
 (b) Plot the energy spectrum of β -decay and explain why it is continuous Spectrum.
13. (a) Write a short note on Schmidt line.
 Or
 (b) Discuss the main features of collective model for atomic nucleus. What are the vibrational and rotational states of the nucleus?
14. (a) Give a brief account on nuclear chain reaction.
 Or
 (b) Explain four-factor formula regarding nuclear fission in an assembly.



15. (a) What do you understand by the classification of elementary particles?

Or

- (b) Explain the fundamental interactions among elementary particles.

PART C — ($5 \times 8 = 40$ marks)

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

16. (a) Discuss in detail the $n-p$ scattering at low energies and derive an expression for total scattering cross-section using partial wave analysis.

Or

- (b) Explain in detail about the meson theory of nucleus force.

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

Or

- (b) Give a brief note on internal conversion.

18. (a) Give an account of Bohr-wheeler theory of nuclear fission. Discuss the condition of criticality of a nuclear reactor.

Or

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- (b) What are magic numbers? How magic numbers and energy levels were Predicted by single particle Shell model?

Or

19. (a) Describe the compound nucleus theory of nuclear reactions.

- (b) Discuss in detail the nuclear cross-section and derive the expression for total cross section.

20. (a) Discuss (i) CPT theorems (ii) Meson octet.

Or

- (b) Obtain the Gellmann – Okubo mass formula.

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