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O.M.R. Serial No.

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Question Booklet Number

M.Sc. (SEM.-IV) (NEP) (SUPPLE.) EXAMINATION, 2024-25

PHYSICS

(Nuclear Physics-II)

Paper Code

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**Question Booklet
Series**

A

Time : 1 : 30 Hours

Max. Marks : 75

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.
2. The booklet contains 100 questions. Examinee is required to answer 75 questions in the OMR Answer-Sheet provided and not in the question booklet. All questions carry equal marks.
3. Examine the Booklet and the OMR Answer-Sheet very carefully before you proceed. Faulty question booklet due to missing or duplicate pages/questions or having any other discrepancy should be got immediately replaced.
4. Four alternative answers are mentioned for each question as - A, B, C & D in the booklet. The candidate has to choose the correct / answer and mark the same in the OMR Answer-Sheet as per the direction :

(Remaining instructions on last page)

परीक्षार्थियों के लिए निर्देश :

1. प्रश्न-पुस्तिका को तब तक न खोलें जब तक आपसे कहा न जाए।
2. प्रश्न-पुस्तिका में 100 प्रश्न हैं। परीक्षार्थी को 75 प्रश्नों को केवल दी गई OMR आन्सर-शीट पर ही हल करना है, प्रश्न-पुस्तिका पर नहीं। सभी प्रश्नों के अंक समान हैं।
3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR आन्सर-शीट को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका जिसमें कुछ भाग छपने से छूट गए हों या प्रश्न एक से अधिक बार छप गए हों या उसमें किसी अन्य प्रकार की कमी हो, उसे तुरन्त बदल लें।
4. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार सम्भावित उत्तर- A, B, C एवं D हैं। परीक्षार्थी को उन चारों विकल्पों में से सही उत्तर छानना है। उत्तर को OMR उत्तर-पत्रक में सम्बन्धित प्रश्न संख्या में निम्न प्रकार भरना है :

(शेष निर्देश अन्तिम पृष्ठ पर)

1. Which of the statement is not correct with reference to Liquid drop model?
 - (A) It consider a nucleus to be identical to a liquid drop
 - (B) The short range nuclear force play like the surface tension in liquid drop and keep the nucleus in spherical shape
 - (C) The model explains the nuclear fission same way as liquid drop break into multiple droplets
 - (D) It also explain the spin and magnetic moments of nuclei
2. Which one is not a magic number?
 - (A) 126
 - (B) 82
 - (C) 50
 - (D) 58
3. The contribution of coulomb energy in the semi-empirical mass formula of a anucleus of mass number (A) and atomic number (Z) is of the form :
 - (A) $\frac{Z(Z-1)}{A^{1/3}}$
 - (B) $\frac{Z(Z+1)}{A^{1/3}}$
 - (C) $\frac{Z}{A^{2/3}}$
 - (D) $\frac{ZA^{2/3}}$
4. According to Yukawa theory, the nuclear forces between the nucleus act through the exchange of :
 - (A) μ -meson
 - (B) positron
 - (C) π -meson
 - (D) α -particle
5. The volume of a nucleus in an atom is proportional to the :
 - (A) Mass number
 - (B) Proton number
 - (C) Neutron number
 - (D) Electron number
6. A particle having no charge and almost no mass is :
 - (A) Electron
 - (B) Neutron
 - (C) Positron
 - (D) Neutrino
7. The size of the atom is estimated to be of the order of :
 - (A) Femtometer ($10^{-15} m$)
 - (B) Nanometer ($10^{-9} m$)
 - (C) Micrometer ($10^{-6} m$)
 - (D) Angstorm ($10^{-10} m$)

8. Which of the following are not Mirror nuclei?
- (A) ${}_1H^3, {}_2He^3$
- (B) ${}_5B^{11}, {}_6C^{11}$
- (C) ${}_3Li^7, {}_4Be^7$
- (D) ${}_6C^{13}, {}_7N^{14}$
9. According to the meson theory of nuclear forces :
- (A) A neutron emits a (π^-) meson and converted into a proton
- (B) A neutron emits a (π^0) meson and converted into a proton
- (C) A neutron emits a (π^+) meson and converted into a proton
- (D) A neutron cannot be converted into a proton.
10. According to Collective model, which one of the following nuclei have spherical shape and zero electric quadrupole moment :
- (A) ${}_{20}Ca^{40}$
- (B) ${}_7N^{14}$
- (C) ${}_6C^{11}$
- (D) ${}_3Li^7$
11. Which of these statement is not correct with reference to nuclear forces. Nuclear forces are :
- (A) Short range
- (B) Charge independent
- (C) Spin independent
- (D) Non-central
12. The liquid drop model successfully explain :
- (A) Nucleus has spherical shape and uniform density
- (B) Excited state of nuclei
- (C) Spin
- (D) Magnetic moment of nuclei
13. Which of the following quantity is constant for all the nuclei?
- (A) Size
- (B) Volume
- (C) Density
- (D) All of these
14. The semi-empirical formula for binding energy of nucleus contains a surface correction term. This term depends upon the mass number A of nucleus as :
- (A) $A^{2/3}$
- (B) $A^{-2/3}$
- (C) $A^{1/3}$
- (D) $A^{-1/3}$
15. The light energy emitted by a star is due to :
- (A) Reflection of solar light
- (B) Breaking of nuclei
- (C) Joining of nuclei
- (D) Burning of nuclei

16. The stability of the nucleus can be predicted by which of the following?
- (A) Electron to neutron ratio
(B) Neutron to proton ratio
(C) Neutron to electron ratio
(D) Proton to electron ratio
17. The liquid drop model was proposed by :
- (A) Rutherford
(B) Thomson
(C) Chadwick
(D) Bohr
18. Which nuclear model is similar to atomic model?
- (A) Collective model
(B) Liquid drop model
(C) Both (A) and (B)
(D) Shell model
19. The "magic numbers" for atoms are :
- (A) number of electrons that confer atomic stability
(B) number of protons and/or neutrons that confer nuclear stability
(C) n/p ratio that confer nuclear stability
(D) atomic masses that indicate fissile isotopes
20. The deviation of the charge distribution of a nucleus from spherical symmetry can be estimated by measuring its :
- (A) Electric charge
(B) Electric dipole moment
(C) Electric quadrupole moment
(D) Magnetic dipole moment
21. Who postulated that "every particle has an antiparticle?"
- (A) Dirac
(B) Rutherford
(C) Pauli
(D) Thomson
22. Which of the following statement is not correct for SU (3) group?
- (A) It is a group
(B) Its elements are Hermitian matrices
(C) Its elements have determinant +1
(D) All are not correct
23. A particle having almost zero charge and zero mass :
- (A) Electron
(B) Neutron
(C) Photon
(D) Neutrino
24. Which physical quantity is not conserved in the Nuclear reaction?
- (A) Energy
(B) Momentum
(C) Mass
(D) Both (A) and (C)

25. The field particle in electromagnetic force is :
- (A) Muon
(B) Pion
(C) Photon
(D) Hyperon
26. Nuclear reactor is based on :
- (A) Nuclear Fusion
(B) Nuclear Fission
(C) Chemical reaction
(D) None of these
27. Baryon consists of _____ quarks.
- (A) One
(B) Two
(C) Three
(D) Zero
28. What is the approximate magnetic dipole moment of a proton?
- (A) 1 Bohr magneton
(B) 2.79 Bohr magneton
(C) -1.91 Bohr magneton
(D) 0 Bohr magneton
29. Nucleons are :
- (A) Bosons
(B) Fermions
(C) Both bosons and fermions
(D) Neither bosons nor fermions
30. If an elementary particle Σ^+ made up of quarks composition $u+u+s$. What is the charge of Σ^+ ?
- (A) 0
(B) $1e$
(C) $2e$
(D) $3e$
31. Graviton have spin :
- (A) 0
(B) 1
(C) 2
(D) 3
32. In elementary particle physics, the mirror symmetry is called as :
- (A) Strangeness
(B) Isomerism
(C) Parity
(D) Charge independence
33. The relative magnitudes of gravitational, weak, electromagnetic and strong interactions are in the ratio :
- (A) $10^{-39} : 10^{-13} : 10^{-3} : 1$
(B) $1 : 10^{-3} : 10^{-13} : 10^{-39}$
(C) $1000 : 100 : 10 : 1$
(D) $1 : 10 : 100 : 1000$

34. The proton, neutron, electron and photon are called the :
- (A) Secondary particles
(B) Fundamental particles
(C) Basic particles
(D) Initial particles
35. Which of these is not made from quarks?
- (A) Proton
(B) Neutron
(C) Lepton
(D) Meson
36. As per the standard model, how many elementary particles are seen?
- (A) 91
(B) 71
(C) 61
(D) 81
37. Which one of the following statement regarding neutrino is wrong?
- (A) Neutrino has spin ($\frac{1}{2}$)
(B) Neutrino has zero rest mass
(C) Neutrino does not interact with matter
(D) Neutrino has charge equal to electron
38. In the Gell-Mann-Nishijima formula, what does 'B' represent?
- (A) Binding energy
(B) Baryon number
(C) Beta decay
(D) Bottomness
39. The Gell-Mann-Nishijima formula helped to introduce the concept of :
- (A) Isospin
(B) Strangeness
(C) Electric charge
(D) Baryon number
40. The baryon number of proton, the lepton number of proton, lepton number of electron and the baryon number of electron are respectively :
- (A) 0, 0, 1, 0
(B) 1, 0, 1, 0
(C) 1, 1, 0, 0
(D) 0, 1, 1, 0
41. The Gell-Mann-Nishijima formula primarily relates which quantum numbers of hadrons :
- (A) Mass, spin and parity
(B) Electric charge, baryon number, isospin and strangeness
(C) Lifetime, decay modes, and magnetic moment
(D) Color charge, flavor and gluon content

42. What parameters are used to characterize the low energy n-p scattering and extract information about the nuclear force?
- (A) The range of the nuclear force and the particle's mass
 - (B) The binding energy of the deuteron and the scattering angle
 - (C) The scattering length (a) and the effective range (r_0)
 - (D) The phase shift for higher partial waves
43. How do the singlet and triplet spin states affect the low energy n-p scattering?
- (A) The scattering length is the same for both singlet and triplet states
 - (B) The nuclear force is stronger for triplet state (parallel spins) compared to the singlet state (antiparallel spins)
 - (C) The nuclear force is stronger for singlet state compared to the triplet state
 - (D) The spin states have no impact on the scattering cross-section
44. Which particles mediate the strong interaction between quarks?
- (A) Photons
 - (B) Gluons
 - (C) W and Z bosons
 - (D) Higgs bosons
45. Spin of electron is :
- (A) $1/2$
 - (B) $1/3$
 - (C) $1/4$
 - (D) $1/8$
46. What is the fundamental force responsible for binding quarks together?
- (A) Electromagnetic force
 - (B) Gravitational force
 - (C) Weak nuclear force
 - (D) Strong nuclear force
47. Which of the following phenomena is explained by the collective model?
- (A) Nuclear fission and heavy ion reactions
 - (B) Alpha and beta decay modes
 - (C) Nuclear stability and structure
 - (D) All of the above
48. The atoms ${}_{92}\text{U}^{238}$ and ${}_{92}\text{U}^{234}$ are :
- (A) Isotopes
 - (B) Isobars
 - (C) Isotones
 - (D) Isomers
49. When an electron and positron annihilate :
- (A) One photon created
 - (B) Two photons are created
 - (C) Two neutrons are created
 - (D) Nothing is created

50. Spins of boson is equal to :
- (A) A positive integer
 - (B) Integer
 - (C) Positive integral multiple of $1/2$
 - (D) Any fraction
51. Inverse square law is valid for :
- (A) Electromagnetic and Strong Nuclear force
 - (B) Weak and Strong Nuclear force
 - (C) Gravitational and electromagnetic forces
 - (D) All of the above
52. A deuteron consists of :
- (A) One proton and one neutron
 - (B) Two proton and one neutron
 - (C) Two proton and two neutron
 - (D) One proton and two neutron
53. What does CP violation refer to?
- (A) Violation of the conservation of charge
 - (B) Violation of the conservation of parity
 - (C) Violation of the combined conservation of charge and parity
 - (D) Violation of the conservation of strangeness
54. Mean free path of charge carriers depends on :
- (A) Size of the molecule
 - (B) Temperature
 - (C) Pressure
 - (D) All of the above
55. The law of conservation of isospin is valid only for :
- (A) Strong interaction
 - (B) Electromagnetic interaction
 - (C) Weak interaction
 - (D) Gravitational interaction
56. What is a key consequences of CP violation in the early Universe?
- (A) It explains the existence of dark matter
 - (B) It explains the existence of dark energy
 - (C) It explains the observed asymmetry between matter and antimatter
 - (D) It explains the existence of black holes
57. What is the spin of the deuteron?
- (A) 0
 - (B) 1
 - (C) $1/2$
 - (D) $3/2$

58. Which of the following is non zero for deuteron?
- (A) Magnetic moment
 - (B) Electric dipole moment
 - (C) Spin orbit coupling constant
 - (D) All of these
59. The absence of excited states in deuteron is due to :
- (A) lack of electromagnetic interaction
 - (B) Weak binding energy
 - (C) Nuclear spin orbit coupling
 - (D) None of these
60. Particles that interact by the strong force are called :
- (A) Leptons
 - (B) Hadrons
 - (C) Muons
 - (D) Electrons
61. An alpha particle is same as :
- (A) A helium nucleus
 - (B) A hydrogen nucleus
 - (C) A proton
 - (D) A positron
62. Atoms with $\frac{1}{2}$ nucleon spin cannot have :
- (A) Hyperfine structure
 - (B) Electric quadrupole moment
 - (C) Fine structure
 - (D) None of these
63. Which of the interactions cause the non-conservation of orbital angular momentum of the electron in an atom?
- (A) Spin-orbit interaction
 - (B) Spin-spin interaction
 - (C) Electrostatic interaction between electrons
 - (D) Electrostatic interaction between electrons and nucleus
64. The quark structure of Δ^{++} is :
- (A) uuu
 - (B) udu
 - (C) sss
 - (D) ddd
65. The quark structure of proton and neutron is respectively :
- (A) uss, uus
 - (B) uus, uss
 - (C) udd, uud
 - (D) uud, udd
66. Nuclear forces are :
- (A) Gravitational attractive
 - (B) Electrostatic repulsive
 - (C) Long range and strong attractive
 - (D) Short range and strong attractive

67. Suppose that a neutron at rest in free space decays into a proton and an electron. This process would violate :
- (A) Conservation of charge
(B) Conservation of energy
(C) Conservation of linear momentum
(D) Conservation of angular momentum
68. The theory governing combinations of quarks based on quantum electrodynamics is called :
- (A) Baryon theory
(B) Meson theory
(C) Lepton theory
(D) Quantum chromodynamics
69. The particle which most easily penetrates through the nucleus of an atom is :
- (A) Electron
(B) Alpha particles
(C) Proton
(D) Neutron
70. Gell-Mann–Nishijima formula is :
- (A) $Q = I_3 + \frac{3}{2}(B + S)$
(B) $Q = I_3 + \frac{1}{2}(B + S)$
(C) $Q = (B + S)$
(D) $Q = I_3 + (B + S)$
71. The mean momentum of a nucleon in a nucleus with mass number A varies as :
- (A) A
(B) A^2
(C) $A^{-2/3}$
(D) $A^{-1/3}$
72. The quadrupole moment of the nucleus is a _____ quantity.
- (A) Scaler
(B) Vector
(C) Tensor
(D) None of these
73. The electron rest mass is of the order of :
- (A) $10^{-28} gm$
(B) $10^{-31} gm$
(C) $10^{-35} gm$
(D) $10^{-25} gm$
74. In the semi empirical formula the observed parity of odd Z and odd N nuclei in nature is taken care of by the :
- (A) Surface energy term
(B) Coulomb energy term
(C) δ -term
(D) Asymmetry term
75. In elementary particle physics, the mirror symmetry is called as :
- (A) Strangeness
(B) Isomerism
(C) Parity
(D) Charge independence

76. The volume of a nucleus in an atom is proportional to the :
- (A) Electron number
 - (B) Proton number
 - (C) Neutron number
 - (D) Mass number
77. According to Shell model of the nucleus which one is incorrect :
- (A) Magic number exist
 - (B) Nucleons interact with their nearest neighbours only
 - (C) Nucleons in a nucleus interact with a general force field
 - (D) Large electronic quadrupole moment exists for certain nuclei
78. Which of the following fundamental forces conserves the strangeness quantum number?
- (A) Strong interaction
 - (B) Weak interaction
 - (C) Electromagnetic interaction
 - (D) Both (A) and (C)
79. Which of these particles is considered a "strange particle"?
- (A) Kaon
 - (B) Neutron
 - (C) Pion
 - (D) Proton
80. The strangeness for Ω^- is :
- (A) 0
 - (B) -1
 - (C) -3
 - (D) -2
81. What is the primary characteristic of the collective model in nuclear physics?
- (A) It treats nucleons as independent particles orbiting a potential well
 - (B) It describes the nucleus as a collective system, emphasizing the correlated motion of nucleons
 - (C) It uses the principle of Classical mechanics to describe nuclear structure
 - (D) It focuses on the individual behavior of each nucleon within the nucleus
82. The Collective model is particularly successful in describing which properties of nuclei?
- (A) Nuclear force and its range
 - (B) Binding energy per nucleon and nuclear stability
 - (C) Nuclear rotation and vibrations
 - (D) Individual spin and parities of nucleon in closed shells

83. What is the fundamental principle behind partial wave analysis in scattering theory?
- Analyze the scattering in terms of a fourier transform of the potential
 - Considering only the forward scattering amplitude
 - Approximate the scattering potential as a series of delta functions
 - Treat the scattered wave as a sum of spherical waves, each corresponding to a specific angular momentum
84. In low energy scattering, which partial wave typically dominates the scattering process?
- Higher angular momentum partial waves ($l \geq 2$)
 - P-wave ($l = 1$)
 - S-wave ($l = 0$)
 - None of these
85. The sum of strangeness quantum number (S) and baryon number (Y) is called :
- Isospin
 - Intrinsic spin
 - Hypercharge
 - None of these
86. Partial wave analysis is particularly useful for studying scattering by what type of potentials?
- Time dependent potentials
 - Spherically symmetric potentials (central potentials)
 - Potentials with strong short-range interactions
 - Potentials that vary linearly with position
87. Why is low energy n-p scattering relatively simpler to analyze compare to p-p scattering?
- Neutrons are easier to produce and detect than protons
 - The strong nuclear force is weaker in n-p interactions
 - There is no coulomb repulsion between a neutron and a proton
 - All of these
88. The correct pair of Particle and antiparticle :
- Neutrino and neutron
 - Electron and positron
 - Mesons and photons
 - All of these are correct
89. For which elementary particles, concept of isospin cannot be applied :
- Mesons
 - Leptons
 - Nucleons
 - Hyperons
90. A baryon is made up of :
- A quark-antiquark pair
 - Three quark
 - Three antiquark
 - An electron positron gamma state
91. Neutron was discovered by :
- Thomson
 - Rutherford
 - Chadwick
 - Anderson

92. In CP symmetry, C and P stands for :
- Charge Conjugation and Parity
 - Continuous and Parallel
 - Continuous Particle
 - Charge Conjugation and Particle
93. Which of the following functions describe the nature of interaction potential $V(r)$ between two quarks inside a nucleon? (r is the distance between the quarks and (a) and (b) are positive constants) :
- $V(r) = \frac{a}{r} + br$
 - $V(r) = -\frac{a}{r} - br$
 - $V(r) = -\frac{a}{r} + br$
 - $V(r) = \frac{a}{r} - br$
94. If the system is invariant with respect to the time in space than which quantity is conserved :
- Energy
 - Momentum
 - Angular momentum
 - All of these
95. Hypercharge of the particles is :
- $Y = 2Q - I_3$
 - $Y = 2Q - 2I_3$
 - $Y = Q - I_3$
 - $Y = 2Q$
96. The first evidence for direct CP violation was observed in the NA31 experiment at :
- NASA
 - ISRO
 - CERN
 - FERMI Lab
97. In CPT symmetry, T stands for :
- Transformation
 - Time reversal
 - Torque
 - None of the above
98. Which one of the following statement regarding neutrino is wrong?
- Neutrino has spin ($\frac{1}{2}$)
 - Neutrino has zero rest mass
 - Neutrino does not interact with matter
 - Neutrino has charge equal to electron
99. What is the Isospin and its third component for neutron and proton :
- $\frac{1}{2}$ and $(\frac{1}{2}, -\frac{1}{2})$
 - $-\frac{1}{2}$ and $(\frac{1}{2}, -\frac{1}{2})$
 - $\frac{1}{2}$ and $(-\frac{1}{2}, \frac{1}{2})$
 - None of these
100. Which elementary particle is associated with the weak nuclear force?
- Higgs boson
 - Gluon
 - W boson
 - Quark

Rough Work / रफ कार्य

Example :

Question :

Q.1 (A) ● (C) (D)

Q.2 (A) (B) ● (D)

Q.3 (A) ● (C) (D)

5. Each question carries equal marks. Marks will be awarded according to the number of correct answers you have.
6. All answers are to be given on OMR Answer Sheet only. Answers given anywhere other than the place specified in the answer sheet will not be considered valid.
7. Before writing anything on the OMR Answer Sheet, all the instructions given in it should be read carefully.
8. After the completion of the examination, candidates should leave the examination hall only after providing their OMR Answer Sheet to the invigilator. Candidate can carry their Question Booklet.
9. There will be no negative marking.
10. Rough work, if any, should be done on the blank pages provided for the purpose in the booklet.
11. To bring and use of log-book, calculator, pager & cellular phone in examination hall is prohibited.
12. In case of any difference found in English and Hindi version of the question, the English version of the question will be held authentic.

Impt. On opening the question booklet, first check that all the pages of the question booklet are printed properly. If there is any discrepancy in the question Booklet, then after showing it to the invigilator, get another question Booklet of the same series.

उदाहरण :

प्रश्न :

प्रश्न 1 (A) ● (C) (D)

प्रश्न 2 (A) (B) ● (D)

प्रश्न 3 (A) ● (C) (D)

5. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।
6. सभी उत्तर केवल ओ०एम०आर० उत्तर-पत्रक (OMR Answer Sheet) पर ही दिये जाने हैं। उत्तर-पत्रक में निर्धारित स्थान के अलावा अन्यत्र कहीं पर दिया गया उत्तर मान्य नहीं होगा।
7. ओ०एम०आर० उत्तर-पत्रक (OMR Answer Sheet) पर कुछ भी लिखने से पूर्व उसमें दिये गये सभी अनुदेशों को सावधानीपूर्वक पढ़ लिया जाये।
8. परीक्षा समाप्ति के उपरान्त परीक्षार्थी कक्ष निरीक्षक को अपनी OMR Answer Sheet उपलब्ध कराने के बाद ही परीक्षा कक्ष से प्रस्थान करें। परीक्षार्थी अपने साथ प्रश्न-पुस्तिका ले जा सकते हैं।
9. निगेटिव मार्किंग नहीं है।
10. कोई भी रफ कार्य, प्रश्न-पुस्तिका में, रफ-कार्य के लिए दिए खाली पेज पर ही किया जाना चाहिए।
11. परीक्षा-कक्ष में लॉग-बुक, कैल्कुलेटर, पेजर तथा सेल्युलर फोन ले जाना तथा उसका उपयोग करना वर्जित है।
12. प्रश्न के हिन्दी एवं अंग्रेजी रूपान्तरण में भिन्नता होने की दशा में प्रश्न का अंग्रेजी रूपान्तरण ही मान्य होगा।

महत्वपूर्ण: प्रश्नपुस्तिका खोलने पर प्रथमतः जाँच कर देख लें कि प्रश्नपुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्षनिरीक्षक को दिखाकर उसी सिरिज की दूसरी प्रश्नपुस्तिका प्राप्त कर लें।