Roll No. .....

Question Booklet Number

O. M. R. Serial No.

M. Sc. (Fourth Semester)

(NEP) EXAMINATION, 2025-26

CHEMISTRY

(Nuclear and Radio Chemistry)

Paper Code							
B	0	2	1	0	0	6	T

Questions Booklet Series
B

Time : 1:30 Hours] [*Maximum 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.

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, तो उसे तुरन्त बदल लें।

(Remaining instructions on the last page) **(शेष निर्देश अन्तिम पृष्ठ पर)**

(Only for Rough Work)

1. When hydrogen nuclei trap neutrons, they form :
   (A) Alpha particles
   (B) Deuterium
   (C) Beta rays
   (D) Positron

2. In the nuclear reaction
   $$^{1}_{0}n \rightarrow ^{1}_{1}p + ?$$
   the missing particle is :
   (A) γ-rays
   (B) H^{-}
   (C) $^{0}_{-1}e$
   (D) $^{0}_{+1}e$

3. The number of α and β particles emitted when $^{238}_{92}U$ changes into $^{206}_{82}Pb$:
   (A) 6α and 8β
   (B) 8α and 6β
   (C) 6α and 6β
   (D) 8α and 8β

4. Radioactive isotopes that have an excessive neutron/proton ratio generally exhibit :
   (A) Alpha emission
   (B) Beta emission
   (C) Positron capture
   (D) K-capture

5. Control rods are made of materials having :
   (A) High neutron absorption cross-section
   (B) Low density
   (C) High melting point only
   (D) Zero reactivity

6. Fertile materials in reactors include :
   (A) U-235
   (B) Pu-239
   (C) U-238
   (D) Th-232

7. Moderator in nuclear reactor is used to :
   (A) Absorb neutrons
   (B) Slow down neutrons
   (C) Increase temperature
   (D) Produce protons

8. Gas-filled detectors operate on the principle of :
   (A) Scintillation
   (B) Ionization
   (C) Semiconductor conduction
   (D) Magnetic induction

9. GM counter cannot measure energy of radiation because :
   (A) No amplification
   (B) Pulse height independent of energy
   (C) Low sensitivity
   (D) Small size

10. The dead time of a GM counter is due to :

(A) Detector heating

(B) Ion recombination and recovery time

(C) Loss of voltage

(D) Magnetic effects

11. Linear energy transfer (LET) is highest for :

(A) Gamma rays

(B) Beta particles

(C) Alpha particles

(D) X-rays

12. In radioactive tracer techniques, the most important requirement for the tracer is that it should :

(A) have high atomic number

(B) behave chemically identical to the element being studied

(C) have very high half-life

(D) emit only gamma radiation

13. The technique used to measure very small concentrations of hormones in blood is :

(A) Neutron activation analysis

(B) Radioimmunoassay

(C) Radiometric titration

(D) Flame photometry

14. Radioimmunoassay is based on :

(A) Nuclear fission reactions

(B) Antigen-antibody binding with radioactive tracer

(C) Gamma absorption by metals

(D) Radioactive decay counting only

15. Sterilization of medical products such as syringes and surgical gloves is commonly done using :

(A) Alpha radiation

(B) Beta radiation

(C) Gamma radiation from Co-60

(D) X-ray fluorescence

16. The main objective of food irradiation is to :

(A) Increase food mass

(B) Improve color only

(C) Destroy microorganisms and increase shelf life

(D) Increase vitamins

17. Gamma radiography is widely used for :

(A) Studying molecular structure

(B) Detecting internal defects in metals and welds

(C) Determining pH

(D) Measuring conductivity

18. Carbon-14 dating is mainly used for determining the age of :

(A) Rocks

(B) Organic materials

(C) Metals

(D) Minerals

19. The half-life of Carbon-14 is approximately :

(A) 1000 years

(B) 5730 years

(C) 10,000 years

(D) 1 million years

20. Which radionuclide is commonly used for cardiovascular imaging ?

(A) Tl-201

(B) Co-60

(C) Sr-90

(D) Na-22

21. The radiopharmaceutical used in central nervous system (brain imaging) is generally :

(A) Tc-99 m HMPAO

(B) Co-60 chloride

(C) I-131 iodide

(D) Na-24 chloride

22. The natural radionuclide K-40 contributes to :

(A) Artificial radiation only

(B) Environmental background radiation

(C) Nuclear weapons testing

(D) Medical therapy

23. The radionuclides U-238 and Th-232 are important sources of :

(A) Artificial radioactivity

(B) Natural environmental radio-activity

(C) Medical radiopharmaceuticals

(D) Food irradiation

24. Fallout from nuclear weapons testing mainly contains radionuclides such as :

(A) Sr-90 and Cs-137

(B) Na-24 and K-42

(C) Cu-64 and Fe-59

(D) Ne-20 and Ar-40

25. Strontium-90 is dangerous because it behaves chemically similar to :

(A) Sodium

(B) Calcium

(C) Potassium

(D) Magnesium

26. The isotope commonly used in gamma radiography for industrial testing is :

(A) Co-60

(B) H-3

(C) C-14

(D) Na-24

27. In diagnostic nuclear medicine, gamma rays are preferred because they :

(A) have high penetration power suitable for imaging

(B) produce chemical reactions

(C) are easily absorbed in tissue

(D) are unstable

28. The major purpose of radio-pharmaceuticals is :

(A) Chemical synthesis

(B) Diagnosis and treatment of diseases

(C) Polymer production

(D) Metal purification

29. The main advantage of radioactive tracer techniques is :

(A) low sensitivity

(B) ability to detect extremely small quantities

(C) high cost

(D) limited applications

30. In a radiometric titration, the equivalence point is determined by :

(A) change in colour

(B) change in pH

(C) change in radioactivity

(D) change in conductivity

31. Radiometric titration is particularly useful when :

(A) coloured solutions are used

(B) solutions are very dilute or turbid

(C) strong acids are used

(D) indicators are available

32. In radiometric titration, the activity measured is generally due to :

(A) tracer isotope added to analyte or reagent

(B) only solvent molecules

(C) catalyst

(D) impurity ions

33. In PGNAA, the emitted radiation is measured :

(A) after radioactive decay

(B) during neutron capture immediately

(C) after beta decay

(D) during alpha emission

34. The basic nuclear reaction involved in PGNAA is :

(A) (n, γ) reaction

(B) (p, n) reaction

(C) (α, n) reaction

(D) (γ, n) reaction

35. One major advantage of PGNAA over conventional NAA is :

(A) no need for irradiation

(B) non-destructive real-time analysis

(C) low sensitivity

(D) requirement of chemical separation

36. In CPAA, the activation of elements occurs due to bombardment with :

(A) neutrons

(B) electrons

(C) charged particles such as protons or deuterons

(D) gamma rays

37. A typical nuclear reaction used in CPAA is :

(A) (n, γ)

(B) (p, n)

(C) (γ, n)

(D) (β, γ)

38. CPAA generally requires :

(A) neutron reactor

(B) particle accelerator

(C) mass spectrometer

(D) X-ray tube

39. PIXE analysis is based on :

(A) neutron capture

(B) emission of characteristic X-rays after inner shell ionization by charged particles

(C) gamma emission from radioactive decay

(D) beta decay

40. The incident particles commonly used in PIXE are :

(A) neutrons

(B) protons

(C) gamma photons

(D) electrons

41. PIXE is especially useful for :

(A) trace element analysis

(B) organic synthesis

(C) polymerization reactions

(D) electrochemical analysis

42. A major advantage of PIXE technique is :

(A) destructive analysis

(B) high sensitivity for trace elements

(C) very low precision

(D) limited elemental range

43. Given that a radioactive species decays according to exponential law :

$$N = N_0 e^{-\lambda t}$$

What is the half-life of the species ?

(A) $\frac{N_0}{2}$

(B) $\frac{\ln 2}{\lambda}$

(C) $N_0 \lambda$

(D) $\ln(2\lambda)$

44. In the nuclear equation :

$$^{130}_{52}Te + ^{1}_{1}H \rightarrow ^{131}_{53}I + ?$$

the missing term is :

(A) Positron

(B) Proton

(C) Neutron

(D) Electron

45. Iodine-131 is mainly used in :

(A) Liver imaging

(B) Thyroid therapy and diagnosis

(C) Bone density measurement

(D) Kidney filtration

46. Which radiation source is commonly used for sterilization of medical equipment ?

(A) Alpha radiation

(B) Beta radiation

(C) Gamma radiation from Co-60

(D) Neutron radiation

47. Thallium-201 is mainly used for :

(A) Kidney imaging

(B) Heart imaging

(C) Liver imaging

(D) Bone imaging

48. The unit of radioactivity in SI system is :

(A) Curie

(B) Becquerel

(C) Gray

(D) Roentgen

49. Which radiation has the highest penetrating power ?

(A) Alpha rays

(B) Beta rays

(C) Gamma rays

(D) Neutrons

50. Which scientist proposed the law of radioactive decay ?

(A) Rutherford and Soddy

(B) Dalton

(C) Avogadro

(D) Bohr

51. The artificial transmutation of elements was first achieved by :

(A) Becquerel

(B) Rutherford

(C) Chadwick

(D) Fermi

52. The concept of nuclear charge was established by :

(A) Thomson

(B) Rutherford

(C) Moseley

(D) Bohr

53. Isotopes differ in :

(A) Number of protons

(B) Number of neutrons

(C) Atomic number

(D) Chemical properties

54. Nuclear isomeric transition involves emission of :

(A) Alpha particle

(B) Beta particle

(C) Gamma ray

(D) Neutron

55. Q-value is positive for :

(A) Endothermic reactions

(B) Exothermic reactions

(C) Neutral reactions

(D) Impossible reactions

56. Coulomb barrier prevents :

(A) Neutron penetration

(B) Proton penetration

(C) Electron emission

(D) Gamma emission

57. Reaction cross-section depends on :

(A) Projectile energy

(B) Target nucleus

(C) Type of reaction

(D) All of the above

58. Artificial radioactivity is produced by :

(A) Heating

(B) Bombardment with particles

(C) Cooling

(D) Pressure

59. Square well potential assumes nuclear potential is :

(A) Infinite everywhere

(B) Constant inside nucleus and zero outside

(C) Zero inside nucleus

(D) Linear with distance

60. Harmonic oscillator potential is proportional to :

(A) r

(B) r^2

(C) $1/r$

(D) e^{-r}

61. Yukawa potential has the form :

(A) $1/r$

(B) e^{-r}

(C) $\left(e^{-\mu r}\right)/r$

(D) r^2

62. Yukawa potential indicates nuclear force is :

(A) Infinite range

(B) Finite range

(C) Zero range

(D) Constant

63. Gaussian potential is useful because it :

(A) is discontinuous

(B) Smoothly decreases with distance

(C) is infinite at origin

(D) is constant

64. Exponential potential decreases with distance as :

(A) r^2

(B) $1/r$

(C) e^{-r}

(D) $\log r$

65. $^{11}_{23}Na$ is the more stable isotope of Na. Find out the process by which $^{21}_{11}Na$ can undergo radioactive decay :

(A) β^- emission

(B) α-emission

(C) β^+ emission

(D) K-electron capture

66. The elements $^{30}_{14}Si$, $^{31}_{15}P$ and $^{32}_{16}S$ are called :

(A) Isotopes

(B) Isobars

(C) Isotones

(D) Radioactive element

67. The half-life period of ^{90}Th is 67.3×10^{10} years. 1.0×10^{-3} kg of this will be reduced to 5.0×10^{-4} kg in :

(A) 1.3×10^{10} years

(B) 0.65×10^{10} years

(C) 2.6×10^{10} years

(D) 0.65×10^{5} years

68. In neutron activation analysis, the atom is identified by :

(A) Decay characteristic of the daughter element

(B) The velocity of the neutron

(C) Nuclear recoil

(D) Threshold energy of the reaction

69. The plot of mean binding energy per nucleon versus atomic number Z :

(A) Increases as Z increases

(B) Decreases as Z decreases

(C) Increases, reaches a maximum and decreases

(D) Reaches a limiting value as Z increases

70. The particle having a major role in binding the nucleus is :

(A) Neutron

(B) Electron

(C) Meson

(D) Proton

71. What is the energy released in the nuclear reaction ?

$$^{238}_{92}\text{U} \rightarrow {}^{117}_{46}\text{A} + {}^{117}_{46}\text{B} + 2{}^{1}_{0}n$$

(Binding energy per nucleon of A and B = 8.5 MeV; Binding energy of ^{235}U = 7.6 MeV)

(A) 20 MeV

(B) 180 MeV

(C) 200 MeV

(D) 300 MeV

72. During the disintegration of sodium as :

$$^{24}_{11}\text{Na} \rightarrow {}^{24}_{12}\text{Mg} + {}^{0}_{-1}e$$

The ratio of number of neutrons to number of protons :

(A) Increases

(B) Decreases

(C) Remains constant

(D) Increase and decrease both

73. In the following incomplete nuclear equation :

$$^{64}_{29}\text{Cu} \rightarrow ? + {}^{64}_{28}\text{Ni}$$

the missing term is :

(A) An electron

(B) A positron

(C) A neutron

(D) A proton

74. The Liquid Drop Model explains nuclear fission through analogy with :

(A) Vibrating string

(B) Charged liquid drop

(C) Crystal lattice

(D) Gas cloud

75. Which term in the semi-empirical mass formula accounts for Coulomb repulsion ?

(A) Volume term

(B) Surface term

(C) Coulomb term

(D) Pairing term

76. The Fermi Gas Model assumes nucleons behave as :

(A) Classical particles

(B) Non-interacting fermions

(C) Bosons

(D) Fixed particles

77. Fermi energy in nucleus depends mainly on :

(A) Nuclear temperature

(B) Density of nucleons

(C) Charge of nucleus

(D) Shape of nucleus

78. Spin-orbit coupling in shell model leads to :

(A) Decrease in binding energy

(B) Appearance of magic numbers

(C) Nuclear fission

(D) Radioactivity

79. Shell model best explains :

(A) Nuclear deformation

(B) Nuclear fission

(C) Ground-state spin and parity

(D) Fusion reactions

80. Collective model explains :

(A) Only single-particle motion

(B) Only shell structure

(C) Rotational and vibrational spectra of nuclei

(D) Only neutron motion

81. Optical model treats nucleus as :

(A) Transparent medium

(B) Reflecting mirror

(C) Complex potential well absorbing particles

(D) Solid sphere

82. Radius of the nucleus is related to mass number A by :

(A) $R = R_0 A^{\frac{1}{2}}$

(B) $R = R_0 A$

(C) $R = R_0 A^2$

(D) $R = R_0 A^{\frac{1}{3}}$

83. The proper rays for radiocarbon dating are :

(A) UV rays

(B) IR rays

(C) Cosmic rays

(D) X-rays

84. Which of the following is NOT a magic number ?

(A) 2

(B) 8

(C) 20

(D) 21

85. Nordheim rules are applied to determine :

(A) Nuclear radius

(B) Spin and parity of odd-odd nuclei

(C) Binding energy

(D) Decay constant

86. Scintillation detectors detect radiation via :

(A) Heat production

(B) Light emission

(C) Sound waves

(D) Pressure

87. Semiconductor detectors operate based on :

(A) Gas ionization

(B) Electron-hole pair formation

(C) Chemical reaction

(D) Magnetic induction

88. Nuclear spectroscopy is used to measure :

(A) Chemical composition

(B) Energy of nuclear radiations

(C) Temperature

(D) Density

89. The decay constant (λ) is related to half-life ($t_{1/2}$) by :

(A) $\lambda = 0.693 \times t_{1/2}$

(B) $\lambda = \frac{t_{1/2}}{0.693}$

(C) $\lambda = \frac{0.693}{t_{1/2}}$

(D) $\lambda = t_{1/2}^2$

90. Magic numbers in nuclear stability arise due to :

(A) Liquid drop model

(B) Shell model

(C) Bohr model

(D) Fermi gas model

91. Successive radioactive decay follows :

(A) First-order kinetics

(B) Second-order kinetics

(C) Zero-order kinetics

(D) Mixed order

92. In positron emission, atomic number :

(A) Increases by 1

(B) Decreases by 1

(C) Remains same

(D) Decreases by 2

93. Electron capture competes with :

(A) Alpha decay

(B) Beta minus decay

(C) Beta plus decay

(D) Gamma decay

94. The product obtained by successive emission of α-particle and β-particle from $^{238}_{92}U$ is :

(A) Radium

(B) Thorium

(C) Lead

(D) Protactinium

95. Packing fraction is most closely related with :

(A) Dipole moment

(B) Electron spin

(C) Increase in relativistic mass

(D) Mass defect

96. U-235 may be separated from natural uranium by a process called :

(A) Ionisation

(B) Electrolysis

(C) Precipitation

(D) Gaseous diffusion

97. Nuclear particles which are presently thought to hold the nucleus together are :

(A) Mesons

(B) Neutrons

(C) Electrons

(D) Protons

98. $^{238}_{92}U$ disintegrates by a series of α and β emissions to form $^{230}_{90}Th$. The number of α and β particles emitted are :

(A) 4 α particles

(B) 3 α and 1 β

(C) 2 α and 2 β

(D) 1 α and 3 β

99. Of the following isotopes, the one that is not radioactive is :

(A) ^{60}Co

(B) ^{131}I

(C) ^{40}Ca

(D) ^{90}Sr

100. Which one of the following is a device to detect radioactive particles that incorporates a superheated liquid ?

(A) Bubble chamber

(B) Cloud chamber

(C) Spintharoscope

(D) Scintillation counter

(Only for Rough Work)

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 :

Example :

Question :

Q. 1 (A) ● (C) (D)
Q. 2 (A) (B) ● (D)
Q. 3 (A) ● (C) (D)

Illegible answers with cutting and over-writing or half filled circle will be cancelled.

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 and 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.

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 छाँटना है। उत्तर को OMR आन्सर-शीट में सम्बन्धित प्रश्न संख्या में निम्न प्रकार भरना है :

उदाहरण :

प्रश्न :

प्रश्न 1 (A) ● (C) (D)
प्रश्न 2 (A) (B) ● (D)
प्रश्न 3 (A) ● (C) (D)

अपठनीय उत्तर या ऐसे उत्तर जिन्हें काटा या बदला गया है, या गोले में आधा भरकर दिया गया, उन्हें निरस्त कर दिया जाएगा।

5. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।

6. सभी उत्तर केवल ओ. एम. आर. 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. ओ. एम. आर. 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 के अन्त में, रफ-कार्य के लिए दिए खाली पेज पर ही किया जाना चाहिए।

11. परीक्षा-कक्ष में लॉग-बुक, कैलकुलेटर, 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 प्रश्न-पुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्षनिरीक्षक को दिखाकर उसी सिरीज की दूसरी प्रश्न-पुस्तिका प्राप्त कर लें।