Roll. No. ....

O.M.R. Serial No.

Question Booklet Number

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

PHYSICS

(Atomic and Molecular Physics)

Paper Code

B	0	1	1	0	0	1	T

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

(शेष निर्देश अन्तिम पृष्ठ पर)

1. Which electronic transition gives Hα line?

(A) n=5 → n=4

(B) n=4 → n=3

(C) n=3 → n=2

(D) n=2 → n=1

2. How many spectral lines come in Fine structure of H_α line under Hansen's Experiment?

(A) 2 (B) 3

(C) 5 (D) 7

3. How many spectral lines of Hα Fine structure can be explained under Sommerfeld relativistic model?

(A) 2 (B) 3

(C) 4 (D) 5

4. In hydrogen-like atoms, the magnitude of spin–orbit coupling energy increases with :

(A) Decreasing atomic number Z and increasing principal quantum number n

(B) Increasing atomic number Z and decreasing principal quantum number n

(C) Decreasing orbital angular momentum quantum number *l*

(D) Only with electron spin value

5. If L and S are orbital and spin angular momentum then spin-orbit interaction energy is proportional to :

(A) $\vec{L} \bullet \vec{S}$

(B) $\vec{L} \times \vec{S}$

(C) $\vec{L} + \vec{S}$

(D) $L^2 + S^2$

6. If Z, n and k are atomic number, principal quantum number and azimuthal quantum number, then shift of energy with Bohr energy level in terms of wave number is equal to :

(A) $5.84\frac{Z^4}{n^3}\left(\frac{1}{k}-\frac{3}{4n}\right)$

(B) $5.84\frac{n^3}{Z^4}\left(\frac{1}{k}-\frac{3}{4n}\right)$

(C) $5.84\frac{n^3}{Z^4}\left(\frac{3}{4n}-\frac{1}{k}\right)$

(D) $5.84\frac{Z^4}{n^3}\left(\frac{3}{4n}-\frac{1}{k}\right)$

7. What will be the vale of n, l and s for spectral term $2\,{}^3P_1$?

(A) n=2, l=3, s=1

(B) n=3, l=2, s=0

(C) n=3, l=1, S=0

(D) n=2, l=1, s=1

8. What will be spectroscopic terms for d^9 ?

(A) $^1D_{1/2,\ 3/2}$

(B) $^1D_{5/2,\ 7/2}$

(C) $^2D_{1/2,\ 5/2}$

(D) $^2D_{3/2,\ 5/2}$

9. Which series of spectral lines are found in alkali spectra?

(A) Principal, Sharp, Diffuse and Fundamental

(B) Lymen, Balmer, Paschen, Bracket and Pfund

(C) Principal, Sharp, Lymen and Balmer

(D) Principal, Sharp, Diffuse and Pfund

10. Which transition results Principal series of spectral lines for sodium?

(A) $n\,s \rightarrow 3p$; n=4,5,6, ………...

(B) $n\,p \rightarrow 3s$; n=3,4,5, ………..

(C) $n\,d \rightarrow 3s$; n=3,4,5, ……….

(D) $n\,f \rightarrow 3p$; n=3,4,5, ………..

11. The transition responsible for 5896 Å wavelength of spectral line of sodium?

(A) $3\ ^2P_{1/2} \rightarrow 3\ ^2S_{1/2}$

(B) $3\ ^2P_{3/2} \rightarrow 3\ ^2S_{1/2}$

(C) $3\ ^2P_{1/2} \rightarrow 2\ ^2S_{1/2}$

(D) $3\ ^2P_{3/2} \rightarrow 2\ ^2S_{1/2}$

12. The wave number difference of principal and sharp series limit values is equal to wave number corresponding to :

(A) First line of Principal series.

(B) First line of Sharp series.

(C) First line of diffuse series.

(D) First line of Fundamental series

13. The wave number difference of Diffuse and Fundamental series limit values is equal to wave number corresponding to :

(A) First line of Principal series.

(B) First line of Sharp series.

(C) First line of diffuse series.

(D) First line of Fundamental series

14. If v_{ij} is the frequency of a spectral line corresponding to transition between levels i and j then the correct equation under Ritz combination principle :

(A) $v_{ij} = v_{ik} + v_{jk}$

(B) $v_{ij} = v_{ik} - v_{jk}$

(C) $v_{ij} = v_{ik} \pm v_{jk}$

(D) $v_{ij} = v_{ik} \bullet v_{jk}$

15. The intensity ratio for D_1 and D_2 spectral 2lines of sodium is :

(A) 1 : 2 (B) 2 : 1

(C) 3 : 2 (D) 2 : 3

16. The value of multiplicity for optical electron system is :

(A) 0 (B) 1

(C) 2 (D) 3

17. Which of the following terms arises from the groundstate configuration ns^2 of alkaline earth atoms ?

(A) $^1S_0$ (B) $^3P_0$

(C) $^1P_1$ (D) $^3S_1$

18. Which of the following describes the multiplet structure in alkaline earth spectra ?

(A) Doublets

(B) Triplets and singlets

(C) Quartets

(D) Sextets

19. In alkaline earth spectra, the first excited configuration ns-np gives rise to which set of terms ?

(A) ^1P, ^3P (B) ^1D, ^3D

(C) ^1S, ^3S (D) ^1F, ^3F

20. Alkaline earth elements show spectral lines mainly due to transitions of:

(A) $ns^2 \rightarrow ns\,.\,np\,.$

(B) $ns^2 \rightarrow np^2$

(C) $ns^2 \rightarrow nd^2$

(D) $ns^2 \rightarrow ns\,.\,nd$

21. Which pair of states in hydrogen atom are degenerate in Dirac theory but separated by Lamb shift experimentally?

(A) $^2S_{1/2}$ and $^2p_{3/2}$

(B) $^2S_{1/2}$ and $^2P_{1/2}$

(C) $^2P_{1/2}$ and $^2P_{3/2}$

(D) $^1S_{1/2}$ and $^2S_{1/2}$

22. The fine structure of hydrogen spectral lines arises due to:

(A) Zeeman effect

(B) Spin–orbit interaction

(C) Hyperfine interaction

(D) Doppler broadening

23. If L and S are orbital and spin angular momentum associated woth electron motion then under vector atom model the total angular momentum is :

(A) $\vec{L} \times \vec{S}$ (B) $\vec{L} + \vec{S}$

(C) $\vec{L} - \vec{S}$ (D) $\vec{L} \pm \vec{S}$

24. The sepectroscopic term under LS coupling for electron system s^1p^1 :

(A) $^1P_1$, $^3P_{0,1,2}$

(B) $^1S_1$, $^3P_{0,1,2}$

(C) $^1S_0$, $^3S_0$

(D) $^1S_1$, $^3P_{1,2,3}$

25. Which one is not equivalent electron system ?

(A) $p^1 d^1$

(B) S^2

(C) p^2

(D) p^3

26. For a term with L=1, S=1, the possible values of J are :

(A) 0, 1, 2

(B) 1, 2

(C) 0, 2

(D) 1 only

27. Value of Rydberg constant for hydrogen is :

(A) 1.09×10^7 cm^{-1}

(B) 1.09×10^{-7} cm^{-1}

(C) 1.09×10^7 m^{-1}

(D) 1.09×10^{-7} m^{-1}

28. Which electron configuration is characteristic of alkali metals and gives rise to their hydrogen-like spectra ?

(A) Completely filled p-orbitals

(B) One s-electron outside a closed shell

(C) Half-filled d-orbitals

(D) Two s-electrons in the outer shell

29. Rydberg-Schuster law and Runge's Law is particularly applicable to :

(A) Singlet-triplet separation in alkaline earth spectra

(B) Fine-structure doublets in alkali atoms

(C) Vibrational spectra of molecules

(D) Rotational spectra of diatomic gases

30. In LS coupling, which of the following is conserved during spin-orbit interaction ?

(A) L and S separately

(B) Only S

(C) Only L

(D) Total angular momentum J

31. The number of lines in Paschen Back effect is equal to spectral lines in :

(A) Normal Zeeman Effect

(B) Anomalous Zeeman Eeffct

(C) Stark effect

(D) All of the above

32. Which statement is true for the Normal Zeeman effect ?

(A) Occurs due to transition in singlet states at low magnetic fields.

(B) It causes splitting in 2 circularly polarized spectral lines along view to magnetic fields.

(C) It causes splitting in 3 plane polarized spectral line at perpendicular view to magnetic fields

(D) All of the above

33. If n=3, s=1, l=2 and j=3 then spectroscopic term is :

(A) $3\,{}^3D_3$ (B) $3\,{}^2P_3$

(C) $3\,{}^2D_3$ (D) $3\,{}^3P_2$

34. Bohr magnetron is equal to :

(A) $\frac{eh}{4\pi m}$ (B) $\frac{eB}{4\pi m}$

(C) $\frac{eB}{2m}$ (D) $\frac{eh}{2m}$

35. Why do the alkali metals spectral lines deviate slightly from those of hydrogen ?

(A) Due to presence of isotopes

(B) Due to Nuclear reactions

(C) Due to Screening effect from core electrons

(D) Due to different numbers of protons

36. Natural broadening of a spectral line arises due to :

(A) thermal motion of atoms.

(B) collisions between atoms.

(C) external electric fields.

(D) finite lifetime of excited states.

37. Space quantization is reason behind the :

(A) Normal Zeeman Effect.

(B) Anomalous Zeeman Effect.

(C) Paschen Back Effect.

(D) All of the above.

38. What causes spin-orbit interaction in atoms ?

(A) External magnetic field.

(B) Magnetic interaction between the nucleus and the electron.

(C) Magnetic interaction between an electron's spin and its orbital motion.

(D) Coulomb attraction between nucleus and electron.

39. Lande g factor for ${}^2S_{1/2}$ is-

(A) 2 (B) 3

(C) 3/2 (D) 2/3

40. Which two series of lines in alkali spectrum have same limiting values?

(A) Principal and sharp

(B) Sharp and diffuse

(C) Diffuse and Findamental

(D) Principal and diffuse

41. What is the outer electron configuration of alkaline earth elements that influences their spectra?

(A) ns^2 (B) np^6

(C) nd^{10} (D) nf^{14}

42. In first order Stark effect, the energy shift is proportional to :

(A) E^{-1} (B) E

(C) E^2 (D) E^{-2}

43. The shift of energy in anomalous Zeeman effect is "

(A) $g_l m_l \mu_B B$

(B) $g_s m_s \mu_B B$

(C) $g_j m_j \mu_B B$

(D) $(g_l m_l + g_s m_s) \mu_B B$

44. The Lande g factor and magnetic moment in terms of Bohr magnetron (μ_B) for the state $^3P_1$ are respectively:

(A) $\frac{1}{2}$ and $\frac{3}{\sqrt{2}} \mu_B$

(B) $\frac{3}{2}$ and $\frac{3}{\sqrt{2}} \mu_B$

(C) $\frac{3}{\sqrt{2}}$ and $\frac{3}{\sqrt{2}} \mu_B$

(D) $\frac{1}{\sqrt{2}}$ and $\frac{2}{\sqrt{3}} \mu_B$

45. If R is Rydberg constant, then wavelength of H_α line is :

(A) 5R/36 (B) 36/5R

(C) R/4 (D) 4/R

46. Under vector atom model the value of inner quantum number can have values:

(A) *l-s and l+s*

(B) *l-s to l+s* in increment of 1

(C) *l-s to l+s* in increment of 2

(D) all of the above

47. Under JJ coupling scheme, the correct one is :

(A) $J = L \pm S$

(B) $\vec{J} = \vec{L} + \vec{S}$

(C) $\vec{J} = \sum_i \vec{J}_i \,;\, \vec{J}_i = \vec{L}_i + \vec{S}_i$

(D) All of the above

48. The value of n, l, s, j and multiplicity for 2^3D_1 is :

(A) 2, 3, 1, 1 and 3

(B) 2, 1, 1, 1 and 3

(C) 2, 2, 3, 2 and 1

(D) 2, 2, 1,1 and 3

49. Limiting wave number corresponding to Principal and diffuse series in Na spectra are :

(A) $\frac{R}{(3+p)^2}; \frac{R}{(3+d)^2}$

(B) $\frac{R}{(3+s)^2}; \frac{R}{(3+p)^2}$

(C) $\frac{R}{(3+s)^2}; \frac{R}{(3+d)^2}$

(D) $\frac{R}{(3+p)^2}; \frac{R}{(3+s)^2}$

50. Expression of angular Larmour frequency is :

(A) $\frac{eB}{4\pi m}$

(B) $\frac{eB}{2\pi m}$

(C) $\frac{eB}{2m}$

(D) $\frac{eh}{4\pi m}$

51. Which effect shall occur in presence of low magnetic field corresponding to transition ${}^1P_1 \rightarrow {}^1S_0$?

(A) Normal Zeeman Effect

(B) Anomalous Zeeman effect

(C) Paschen back effect

(D) All of the above

52. If n is principal quantum number and n_1 & n_2 are parabolic quantum numbers then the electric quantum number is equal to :

(A) $n-n_1-n_2-1$

(B) $n+n_1+n_2+1$

(C) $n-n_1-n_2+1$

(D) None of the above

53. Magnitude of orbital magnetic moment is :

(A) $\frac{e}{2m}L$

(B) $\frac{g_1 e}{2m}L$

(C) $g_1 \sqrt{1(1+1\mu_B)}$

(D) All of the above

54. Splitting of spectral line in electric field is called as :

(A) Normal Zeeman Effect

(B) Anomalous Zeeman Eeffct

(C) Paschen Back effect

(D) Stark Effect

55. Which of the following is not a cause of spectral line broadening?

(A) Natural broadening

(B) Doppler broadening

(C) Pressure broadening

(D) Diffraction broadening

56. If B is external magnetic field then frequency shift of sigma lines in normal Zeeman effect is :

(A) $\frac{eB}{4\pi m}$

(B) $\frac{4\pi m}{eB}$

(C) $\frac{eB}{2m}$

(D) $\frac{2m}{eB}$

57. The value of g_l and g_s are :

(A) 1, 2

(B) 2, 1

(C) 1, 3

(D) 3, 1

58. The doublet spectral lines of alkali metals is due to :

(A) External electric field

(B) Zeeman effect

(C) Hyperfine structure

(D) Spin-orbit interaction

59. The doublet splitting due to LS coupling always happens in :

(A) optical electron system

(B) non-equivalent electron system

(C) equivalent electron system

(D) All of the above

60. The presence of two valence electrons in alkaline earth atoms leads to:

(A) Simple hydrogen-like spectra

(B) Only singlet states

(C) Only triplet states

(D) Complex spectra with both signlet and triple states

61. If I_a, I_b and I_c are principal axis moment of inertia then which condition satisfies for the prolate type symmetric top molecule?

(A) $I_a = I_b = I_C$

(B) $I_a < I_b = I_C$

(C) $I_a = I_b < I_C$

(D) $I_a = I_b > I_C$

62. Which statement is not true for the rotational spectrum of a molecule considered as rigid rotator ?

(A) It is obtained for hetro-nuclear molecule havingpermanent dipole moment.

(B) It is obtained in far IR and microwave region.

(C) The energy states are equidistant but spectral lines are not equidistant.

(D) The selection rule for transition in rotational energy states is $\Delta J = \pm 1$.

63. The rotational spectrum of molecule is obtained in region :

(A) $10^{-2}\mu \rightarrow 10^{0}\mu$

(B) $10^{0}\mu \rightarrow 10^{2}\mu$

(C) $10^{2}\mu \rightarrow 10^{4}\mu$

(D) $10^{4}\mu \rightarrow 10^{6}\mu$

64. If a linear molecule is considered as rigid rotator having moment of Inertia I, then expression for rotational constant, energy of rotational state and wave number corresponding to transition $J \rightarrow J+1$ are respectively:

(A) $B = h/(8\pi^2 Ic); E(J) = hcBJ\,(J+1); \overline{v} = 2B(J+1)$ ω

(B) $B = \hbar/(8\pi^2 Ic); E(J) = hcBJ\,(J+1); \overline{v} = 2B(J+1)$

(C) $B = \hbar/(8\pi^2 Ic); E(J) = BJ\,(J+1); \overline{v} = 2BJ(J+1)$

(D) $B = h/(8\pi^2 Ic); E(J) = BJ\,(J+1); \overline{v} = 2BJ(J+1)$

65. If B is rotational constant and ω is vibrational constant for linear diatomic molecule then centrifugal distortion constant D is equal to :

(A) $D = 4\omega^2 / B^3$

(B) $D = 4\omega^3 / B^2$

(C) $D = 4B^3 / \omega^2$

(D) $D = 4B^2 / \omega^3$

66. If B is rotational constant and D is centrifugal distortion then term value corresponding to energy of non-rigid rotator is :

(A) $2B\,(J+1) - 2D\,(J+1)^2$

(B) $2BJ\,(J+1) - 2DJ^2\,(J+1)^2$

(C) $BJ\,(J+1) - DJ^2\,(J+1)^2$

(D) $B\,(J+1) - D\,(J+1)^2$

67. The rotational constant for a linear diatomic molecule is B. If the rotational spectral line corresponding to transition J to J+1 at temperature T has maximum intensity then value of J is :

(A) $\sqrt{\frac{kT}{2Bhc}} - \frac{1}{2}$

(B) $\sqrt{\frac{kT}{2Bhc} - \frac{1}{2}}$

(C) $\sqrt{\frac{2Bhc}{kT}} - \frac{1}{2}$

(D) $\sqrt{\frac{2Bhc}{kT} - \frac{1}{2}}$

68. Considering molecule as non-rigid rotator, the wave number corresponding to spectral line for transition J=1 to 2 is-

(A) 2B – 4D

(B) 2B – 24D

(C) 4B – 32D

(D) 4B – 16D

69. If ω is vibrational constant then the possible value energy in terms of wave number of vibrational energy states considering molecule as harmonic oscillator in term of rotational constant is :

(A) $\frac{1}{2}\hbar\omega; \frac{3}{2}\hbar\omega; \frac{5}{2}\hbar\omega;$ ....

(B) $\frac{1}{2}\omega; \frac{3}{2}\omega; \frac{5}{2}\omega;$ ....

(C) $\hbar\omega; 3\hbar\omega; 5\hbar\omega;$ ....

(D) $\omega; 3\omega; 5\omega;$ ....

70. If the molecule is considered as anharmonic oscillator, then wave number corresponding to Ist band and Ist overtone is :

(A) $\omega_e\,; 2\omega_e$

(B) $\omega_e\,; (1-2x_e)\,; 2\omega_e(1-3x_e)$

(C) $\omega_e\,; (1-3x_e)\,; 2\omega_e(1-2x_e)$

(D) $\omega_e\,; (1-3x_e)\,; 2\omega_e(1-4x_e)$

71. If ω is vibrational constant and rotational constants for v=0 and v=1 are equal (B_1=B_0=B), then what is wave number corresponding to spectral line of R and P branch lines of diatomic hetro-nuclear linear molecule :

(A) $\bar{v}_P = \omega + 2B + 2BJ; \bar{v}_R = \omega - 2BJ$

(B) $\bar{v}_P = \omega + 2B - 2BJ; \bar{v}_R = \omega - 2BJ$

(C) $\bar{v}_P = \omega - 2B + 2BJ; \bar{v}_R = \omega + 2BJ$

(D) $\bar{v}_P = \omega - 2B - 2BJ; \bar{v}_R = \omega + 2BJ$

72. On increasing the temperature of diatomic gas which one is observed :

(A) The P and R branch extends on both sides and more lines are observed.

(B) The intensity maxima in both branches move farther away at high J values.

(C) The height of intensity maxima decreases.

(D) All of the above

73. What is the value of m for spectral lines in P and R branch spectra of diatomic hetro-nuclear linear molecule? If wave number expression for PR branch given given by :

$$\overline{v}_{PR} = \overline{v} + (B_1 + B_0)\, m + (B_1 - B_0)\, m^2$$

(A) $m = J+1, J = 1,2,3,.....$ and $m = -J; J = 0,1,2,.......$

(B) $m = J+1, J = 1,2,3,.....$ and $m = -J; J = 1,2,3,.......$

(C) $m = J+1, J = 0,1,2,.....$ and $m = -J; J = 1,2,3,.......$

(D) $m = J+1, J = 0,1,2,.....$ and $m = -J; J = 0,1,2,.......$

74. Which statement is not true for P, Q and R branch of vibrational rotational spectrum ?

(A) Selection rule for R branch, $\Delta v = +1, \Delta J = +1, J = 0,1,2,3,...$

(B) Selection rule for P branch, $\Delta v = +1, \Delta J = -1, J = 1,2,3,...$

(C) Selection rule for Q branch, $\Delta v = +1, \Delta J = 0, J = 1,2,3,...$

(D) It is obtained for linear diatomic moleclue.

75. The correct statement for absorption Electronic spectra :

(A) It consists of series of bands. Bands are of v' progression corresponding to v"=0.

(B) The bands comes closer along higher wave number side as first separation in wave number increases with increases in v'.

(C) The second separation in wave number of energy bands is constant and is equal to anharmonicity

(D) All of the above

76. Which one provides a correct difference between Vibrational-rotational spectra and electronic rotational spectra?

(A) First one has red degraded bands while other has both red and violet degraded bands.

(B) Separation in spectral lines for Ist is much less than the second.

(C) The difference of rotational constant for higher to lower vibrational states (Bv' – Bv") is much small for the Ist than the second.

(D) All of the above.

77. Which statement is correct for rotational lines corresponding to a vibrational band of electronic spectra?

(A) Both red and violet degraded bands are obtained in electronic band system.

(B) If Bv' – Bv"=–ve, then Line spacing increases in P branch while decreases in R branch and a head (red degraded) is formed in R Branch.

(C) If Bv' – Bv" = + ve , then Line spacing decreases in P branch and a head (violet degraded) is formed in P Branch. Normally head in Q branch is not found.

(D) All of the Above

78. The intensity distribution of absorption or emission band in electronic spectra is explained on the basis of :

(A) Deslendre Table

(B) Selection rule

(C) Frank Condon Principle

(D) All of Above

79. Which one is correct for Electronic spectra of molecule ?

(A) It is obtained in Ultraviolet-Visible (UV-Vis) range of spectrum.

(B) It consists of Electronic, vibrational, and rotational transitions.

(C) The absorption intensity of electronic transitions is governed by Beer-Lambert law.

(D) All of the above

80. The correct under Frank Condon Principle is :

(A) There will be only two intensity maxima corresponding to v" of v'-progression.

(B) If $r_e' = r_e''$, condon parabola becomes line across diagonal $(\Delta v = 0)$.

(C) If $r_e' > r_e''$, condon parabola widens and if If re'>>re", condon parabola have only low v' or v" progression.

(D) All of the above

81. The correct statement for Emission Electronic spectra :

(A) It consists of large number of bands. The bands are result of vibrational transition defined by progression and sequence.

(B) Band for which V'=fixed, V"=varies, V" progression; for which V'=varies, V"=fixed, V' progression; for which $\Delta V = 0, \pm 1, \pm 2, ...$ called sequence.

(C) It is explained on the basis of Deslandre Table. The diagonal defines sequence while column and row defines progression.

(D) All of the above

82. For heavier isotopic mass, which one is correct in case of rotational spectra?

(A) Rotational constant is small and spectral line comes at lower wave number.

(B) Rotational constant is large and spectral line comes at higher wave number.

(C) Rotational constant is small and spectral line comes at higher wave number.

(D) Rotational constant is large and spectral line comes at lower wave number.

83. Which is true for Raman spectra ?

(A) It is scattered light spectrum of Visible or UV light from gas, liquid or solid.

(B) It has two branch spectra named as stokes and antistokes line. Stokes lines have high wavelength and intensity while other has lower wavelength and intensity.

(C) Classically it is explained on the basis of polarization. The shift in frequency of both lines from incident is equal to v_0 or $2v_r$.

(D) All of the above

84. The shift in wave number of vibrational and rotational Raman lines under quantum approach are :

(A) 2ω, 4B (J – 3/2)

(B) 2ω, 4B (J + 3/2)

(C) ω, 4B (J + 3/2)

(D) ω, 4B (J – 3/2)

85. Which statement is true for intensity of rotational Raman lines?

(A) Odd J lines are three times intense than even lines for molecule having fermions like nuclei.

(B) Even J line are two time intense than odd line for molecule having Boson like nuclei.

(C) For zero spin nuclei molecule, even lines are absent.

(D) All of the above

86. Correct statement for He-Ne Laser is:

(A) It is a gas Laser.

(B) It is a four level laser.

(C) Wavelength of laser is 632.8 nm.

(D) All of the above

87. The true statement for Ruby Laser is :

(A) It is a solid state Laser

(B) Is a three level laser.

(C) Wavelength of laser is 694.3 nm.

(D) All of the above

88. What is the term value $G(v)$ corresponding to vibrational energy in terms of the vibrational quantum number v and vibrational constant ω?

(A) $G(v) = \omega(v + 1/2)$

(B) $G(v) = \omega(v - 1/2)$

(C) $G(v) = h\omega(v + 1/2)$

(D) $G(v) = h\omega(v - 1/2)$

89. Absorption of microwave radiation by unpaired electrons in a magnetic field results :

(A) Electron Spin Resonance

(B) Nuclear Magnetic Resonance

(C) Raman effect

(D) Both (A) and (B)

90. Absorption of radiofrequency radiation in the presence of a magnetic field results :

(A) Absorption electronic spectra

(B) Absorption vibrational spectra

(C) Nuclear Magnetic Resonance

(D) Electron Spin Resonance

91. Applications of NMR is :

(A) Structural determination of organic and inorganic compounds

(B) Identification of functional groups

(C) Medical imaging

(D) All of the above

92. What physical property of the nucleus is essential for observing NMR?

(A) Unpaired electron

(B) Non-zero nuclear spin

(C) High atomic mass

(D) High Atomic number

93. If g_e and μ_B are electron g factor and Bohr magnetron then energy difference between splitted states under ESR in presence of magnetic field B_0 is -

(A) $ge\mu_B B_0 / 2$

(B) $ge\mu_B B_0$

(C) $2ge\mu_B B_0$

(D) $4ge\mu_B B_0$

94. In NMR spectroscopy, nuclei resonate when :

(A) Their spin aligns with the electric field.

(B) Their spin flips in the presence of a radio frequency field.

(C) The nucleus vibrates at thermal frequency

(D) Electrons move to higher orbitals

95. Which nuclei are NMR active ?

(A) Those with both even mass and even atomic number

(B) Those with odd mass number or odd atomic number

(C) Only stable isotopes of hydrogen

(D) Only radioactive isotopes

96. The gyromagnetic ratio (γ) of a nucleus determines :

(A) Its relaxation time

(B) Its resonance frequency in a given field

(C) Its chemical environment

(D) Its molecular weight

97. The isotope effect in molecular spectra is primarily due to the change in :

(A) Electronic energy levels

(B) Nuclear charge

(C) Reduced mass of the nuclei

(D) Spin quantum number

98. The isotope effect is more prominently observed in :

(A) Electronic transitions

(B) Vibrational and rotational transitions

(C) Nuclear spin transitions only

(D) Conductivity spectra

99. If ω and B are vibrational and rotational constant, then energy of vibrating-rotator in terms of wave number corresponding to vibrational quantum number v and rotational quantum J is :

(A) $\bar{\varepsilon}\,(V, J) = \omega\left(V + \frac{1}{2}\right) + BJ\,(J+1)$

(B) $\bar{\varepsilon}\,(V, J) = \hbar\omega\left(V + \frac{1}{2}\right) + 2B\,(J+1)$

(C) $\bar{\varepsilon}\,(V, J) = \omega\left(V + \frac{3}{2}\right) + BJ\,(J+1)$

(D) $\bar{\varepsilon}\,(V, J) = \hbar\omega\left(V + \frac{1}{2}\right) + 2B\,(J+1)$

100. The selection rule of transition for rotational Raman lines is :

(A) $\Delta J = 0, \pm 1$

(B) $\Delta J = \pm 1, \pm 2$

(C) $\Delta J = 0, \pm 2$

(D) $\Delta J = 0$

Rough Work

Example :

Question :

Q.1 Ⓐ ● Ⓒ Ⓓ

Q.2 Ⓐ Ⓑ ● Ⓓ

Q.3 Ⓐ ● Ⓒ Ⓓ

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 Ⓐ ● Ⓒ Ⓓ

प्रश्न 2 Ⓐ Ⓑ ● Ⓓ

प्रश्न 3 Ⓐ ● Ⓒ Ⓓ

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।

महत्वपूर्णः 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 सिरीज की दूसरी प्रश्नपुस्तिका प्राप्त कर लें।