Question Booklet Number

7079

M.Sc. (Semester-I) Examination, 2022-23

Booklet Series
A

PHYSICS

Atomic and X-Ray Spectroscopy

(To be filled in by the Candidate / निम्न पूर्तियां परीक्षार्थी स्वयं भरें)

Roll No. (in figures) _____
अनुक्रमांक (अंकों में)

Roll No. (in words) _____
अनुक्रमांक (शब्दों में)

Enrolment No. (in figures)

| Time : 1 : 30 Hours
| समय : 1 : 30 घण्टे

| Maximum Marks : 75
| अधिकतम अंक : 75

Name of College
कॉलेज का नाम

Signature of Invigilator
कक्ष निरीक्षक के हस्ताक्षर

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.
2. The booklet contains 75 questions. Examinee is required to answer any 50 questions in the OMR Answer-Sheet provided and not in the question booklet. In case Examinee attempts more than 50 Questions, ***first*** 50 attempted questions will be evaluated. 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 immediately replaced.

(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 75 प्रश्न हैं। परीक्षार्थी को किन्हीं 50 प्रश्नों को दी गई OMR उत्तर-पत्रक पर ही हल करना है। परीक्षार्थी द्वारा 50 से अधिक प्रश्नों को हल करने की स्थिति में ***प्रथम*** 50 उत्तरों को ही मूल्यांकित किया जाएगा। सभी प्रश्नों के अंक समान हैं।
3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR उत्तर-पत्रक को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका, जिसमें कुछ भाग छपने से छूट गये हों या प्रश्न एक से अधिक बार छप गये हों या किसी भी प्रकार की कमी हो, उसे तुरन्त बदल लें।

(शेष निर्देश अन्तिम पृष्ठ पर)

1. The spectral term for $L=2$ and $S=1$ is given by -

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

(B) $^3D_1$

(C) $^3S_1$

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

2. Angular momentum quantisation is directly established by -

(A) Stern-Gerlach Experiment

(B) Franck-Hertz Experiment

(C) Photo-electric Effect

(D) Compton Effect

3. L-S coupling occurs often in -

(A) All atoms

(B) Lighter atoms

(C) Heavier atoms

(D) Occurs only in nuclei

4. Which of the following series lies in ultra-violet region-

(A) Pfund Series

(B) Lyman Series

(C) Balmer Series

(D) Paschen Series

5. The ground state of any atom is -

(A) singlet

(B) doublet

(C) triplet

(D) all are possible

6. In the spectrum of Hydrogen, the H line is obtained, due to the transition from -

(A) n = 2 to n = 1

(B) n = 3 to n = 2

(C) n = 4 to n = 3

(D) n = 5 to n = 4

7. For the electron in p-sub shell of L-shell, the values of n, l, s and j are;

(A) $n = 2, l = 1, s = \frac{1}{2}, j = \frac{1}{2}, \frac{3}{2}$

(B) $n = 1, l = 2, s = \frac{1}{2}, j = \frac{1}{2}$

(C) $n = 2, l = 0, s = \frac{1}{2}, j = \frac{1}{2}, \frac{3}{2}$

(D) $n = 2, l = 1, s = \frac{1}{2}, j = \frac{3}{2}$

8. The values of L, S and J in the ground state of Sodium atom, are -

(A) $L = 1, S = \frac{1}{2}, J = \frac{1}{2}, \frac{3}{2}$

(B) $L = 0, S = \frac{1}{2}, J = \frac{1}{2}$.

(C) $L = 0, 1, S = 1, J = 1, 3$

(D) $L = 1, S = \frac{1}{2}, J = 3/2$

9. For a single electron system-

(A) all energy states are singlet

(B) all energy states are doublet

(C) ground state is singlet & other are doublet ,

(D) ground state is singlet & other are triplet

10. The intensity of spectral line will be maximum, if ;

(A) $\Delta L = -1, \Delta J = -1$.

(B) $\Delta L = -1, \Delta J = +1$

(C) $\Delta L = +1, \Delta J = -1$

(D) $\Delta L = -1, \Delta J = 0$

11. The transition $^1D_2 \rightarrow {}^3P_0$ is not possible, because,

(A) $\Delta L = 1$

(B) $\Delta r = 0$

(C) $\Delta S = 0$

(D) $\Delta J = 2$

12. In which of the following transitions, the energy will be maximum -

(A) n = 2 to n = 1

(B) n = 3 to n = 2

(C) n = 4 to n = 3

(D) n = 5 to n = 4

13. For d-electron, the possible sub-orbits are ,

(A) 1

(B) 3 ,

(C) 5

(D) 7

14. In alkali spectra, the common limit of sharp series and defuse series is obtained at,

(A) lowest s-level

(B) lowest p-level

(C) lowest d-level

(D) lowest f-level

15. The Spectroscopic term $^2P_{3/2}$, gives the value of spin is equal to,

(A) 2

(B) 1

(C) 3/2

(D) 1/2

16. The physical quantity, which represent the degree of penetration of atomic core, is called -

(A) radiation defect

(B) field defect

(C) quantum defect

(D) classical defect

17. According to spin-orbit interaction, on increasing the value of principal quantum number 'n', the separation between spectral lines,

(A) decreases

(B) increases.

(C) remains constant

(D) none of the above

18. The maximum number of electrons in the orbit with n=3, is,

(A) 2

(B) 8

(C) 14

(D) 18

19. Bohr magneton μ_B is expressed as,

(A) $\mu_e = \frac{ech}{4\pi m}$

(B) $\mu_e = \frac{eh}{4\pi mc}$

(C) $\mu_e = \frac{4\pi mc}{eh}$

(D) $\mu_e = \frac{4\pi m}{ech}$

20. The ratio of the number of terms and J values in L-S coupling to j-j coupling is given by,

(A) 1 : 2

(B) 2 : 1

(C) 1 : 1

(D) 1 : 3

21. The spectroscopic terms for two p-electrons system are ,

(A) $^1S_0$, $^3P_{1,2,3}$, $^1D_1$

(B) $^1S_1$, $^1P_1$, $^3D_{1,2,3}$

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

(D) $^1S_0$, $^3P_{0,1,2}$, $^1D_2$

22. In the spectra of alkaline earths, all members of triplet defuse series, are composed of,

(A) three lines

(B) six lines

(C) nine lines

(D) twelve lines

23. The single level of 4p 4d electrons is splitted into,

(A) 12 levels

(B) 16 levels

(C) 36 levels

(D) 48 levels

24. For two-electron system, if $l_1 = 2$ and $l_2 = 1$, then following L-S coupling, the value of J, will be,

(A) 4, 3, 2

(B) 4, 3, 2, 1

(C) 4, 3, 2, 1, 0

(D) 3, 2, 1, 0

25. How many electrons can be associated with the same set of quantum numbers -

(A) 8

(B) 4

(C) 2

(D) 1

26. Hyperfine structure of spectral line is obtained by considering-

(A) relativistic mass of electron

(B) nuclear spin

(C) electron spin

(D) phase-space quantization

27. Introducing the nuclear spin, the total angular momentum of the whole atom is given by F=L+S+I. Then the selection rule for electric dipole transition is,

(A) F = 0

(B) F = ±1

(C) F = 0, ±1

(D) $F = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \ldots\ldots$

28. The effect of electric field on the spectral lines is called ,

(A) Isotopic effect

(B) Zeeman effect

(C) Paschen back effect

(D) Stark-effect .

29. The anomalous Zeeman effect can be explained by,

(A) classical theory only

(B) quantum theory only

(C) classical and quantum theory both ,

(D) field theory only

30. When the spectral line is viewed perpendicular to the magnetic field, the three components are observed. All three components are,

(A) plane polarised

(B) circularly polarised

(C) elliptically polarised .

(D) unpolarised

31. In normal Zeeman effect, the change in frequency of spectral line is given by,

(A) $\Delta\nu = \frac{4\pi m_e}{eB}$

(B) $\Delta\nu = \frac{m_e}{4\pi eB}$

(C) $\Delta\nu = \frac{4\pi B}{e\, m_e}$

(D) $\Delta\nu = \frac{eB}{4\pi m_e}$

32. Paschen back effect is just like a,

(A) Stark effect

(B) Anomalous Zeeman effect .

(C) Normal Zeeman effect

(D) Isotopic effect

33. The wavelength of X-ray is of the order of,

(A) 1 cm .

(B) 1 mm

(C) 1 Å .

(D) 1 μm

34. The doublets observed in alkali spectra are due to -

(A) Screening of the K-electrons

(B) Spin-orbit interactions of the electrons.

(C) Pressure of Isotopes

(D) None of these

35. The minimum wavelength of X-ray, produced by an electron beam accelerated through a potential difference of V, is given by,

(A) $\frac{eV}{hc}$

(B) $\frac{h}{eV}$

(C) $\frac{eV}{2\pi hc}$

(D) $\frac{hc}{eV}$

36. Mosley's law was given to explain the lines of following series in the characteristic X-ray spectra,

(A) K-Series

(B) M-Series

(C) L-Series

(D) All Series

37. X-ray spectrum arises due to

(A) increase in wavelength of lines of K and L series

(B) decrease in frequency of lines of K and L series

(C) removal of electron from the inner orbit of the atom

(D) absorption of the electron by the target atom

38. For the production of characteristic K_β line of X-rays, the electron transition takes place from,

(A) n = 2 to n = 1

(B) n = 3 to n = 1

(C) n = 3 to n = 2

(D) n = 4 to n = 2

39. X-rays are,

(A) positively charged particles

(B) negatively charged particles

(C) optical rays

(D) electromagnetic rays

40. The characteristic X-ray spectra shows the characteristics of the,

(A) electron emitted

(B) material of the target

(C) photographic plate

(D) electromagnetic field

41. In the continuous X-ray spectra, the shorter wavelength limit (λ_{min}) depends on,

(A) accelerating voltage

(B) material of the target

(C) current in the filament

(D) all the above

42. The voltage required to produce X-rays of wavelength 1Å is,

(A) 1.2375×10^5 Volt.

(B) 1.2375×10^4 Volt

(C) 1.2375×10^3 Volt

(D) 1.2375×10^2 Volt

43. The difference between soft and hard X-rays is of,

(A) Velocity

(B) Polarisation

(C) Intensity

(D) Frequency.

44. Penetrating power of X-rays does not depend on,

(A) Current in filament

(B) Wavelength

(C) Energy

(D) Potential difference

45. The constant a in Mosley's law related with Rydberg constant as -

(A) $R = \left|\frac{4a}{3c}\right|$

(B) $R = \left|\frac{3c}{4a}\right|$

(C) $R = \left(\frac{a}{2c}\right)$

(D) $R = \frac{2c}{a}$

Where, c=Velocity of light

46. The target of an X-ray tube is subjected to an excitation voltage V. The wavelength of the emitted X-rays is proportional to-

(A) $\frac{1}{\sqrt{V}}$

(B) $\sqrt{V}$

(C) $\frac{1}{V}$

(D) V

47. In Zeeman effect, a spectral line, upon the application of magnetic field, splits into more than three components because of -

(A) Energy levels, split into 2J+1 components.

(B) In magnetic field $\Delta M_J=0, \pm 1$ no longer holds.

(C) Variation of Lande g-factor from one level to another.

(D) None of the above.

48. The expression for Spin-orbit Interaction Energy after 'Thomas precession' is -

(A) $\Delta E_{so} = \frac{e}{2m^2c^2}\frac{1}{r}\frac{dv(r)}{dr}\vec{S}.\vec{L}$

(B) $\Delta E_{so} = \frac{e}{2m^2c^2}\frac{dv(r)}{dr}\vec{S}.\vec{L}$

(C) $\Delta E_{so} = \frac{e}{2m^2c^2}\frac{dv(r)}{dr}j$

(D) None of these

49. The value of one Bohr magneton is approximately -

(A) 10^{23} A.m^2

(B) 10^{-23} A.m^2

(C) 10^{10} A.m^2

(D) 10^{-10} A.m^2

50. Which of the following states exist?

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

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

(C) $2\ ^2P_{5/2}$

(D) $2\ ^2P_{7/2}$

51. The principal series of spectral lines of Lithium is obtained by transition between -

(A) nS and 2p , n > 2

(B) nD and 2P , n > 2

(C) nP and 2S , n > 2

(D) nF and 3D , n > 3

Which of the interactions cause the non-conservation of orbital angular momentum of the electrons in an atom?

A) Spin-orbit Interactions

B) Spin-spin Interactions

C) Spin - nucleus Interactions

D) None of these

Which of the following has the order of increasing energy?

(A) $^1D_2$, $^3D_2$, $^3F_2$

(B) $^3F_2$, $^3D_2$, $^1D_2$

(C) $^3D_2$, $^3F_2$, $^1D_2$

(D) $^1D_2$, $^3F_2$, $^3D_2$

The K_β line of X-rays emitted from an atom with principal quantum numbers n = 1, 2, 3---- arises from the transition-

(A) n = 4 – n = 2

(B) n = 3 – n = 2

(C) n = 5 – n = 2

(D) n = 3 – n = 1

55. The variation of the intensity of X-rays with the thickness of the absorbing material is given by -

(A) $I = I_0 \exp(-\mu x)$

(B) $I = I_0 \exp(\mu x)$

(C) $I = I_0 \exp\left(\frac{-\mu}{x}\right)$

(D) $I = I_0 \exp\left(\frac{\mu}{x}\right)$

56. Cut off wavelength of X-Ray coming from an X-Ray tube depends on-

(A) target material

(B) accelerating voltage

(C) separation between the target and the filament

(D) temperature of the filament

57. The energy E of K_α X-Rays emitted from targets of different atomic number 'Z' varies as -

(A) Z^2

(B) $Z^{2/3}$

(C) Z

(D) $Z^{1/2}$

58. The continuous X-Ray spectrum is the result of the -

(A) Photoelectric effect

(B) Inverse photoelectric effect

(C) Compton effect

(D) Auger effect

59. According to Kossel's explanation of characteristic X-Ray spectra-

(A) higher quantum energies are required for the production of X-Ray spectra.

(B) Generally Low quantum energies are required for the production of X-Ray spectra.

(C) Energy not required.

(D) None of the above.

60. The difference between X-Ray spectra and optical spectra is -

(A) The frequencies in X-Ray spectra are about thousand times higher than those in optical spectra.

(B) The X-Ray spectra arise from electron transition among the inner completed shells of very firmly bound electrons and the optical spectra arise from transition of the outermost electrons of the atom.

(C) X-Ray emission spectra are entirely different from X-Ray absorption spectra while optical spectra, emission and absorption spectra are identical.

(D) All of the above.

61. "The frequency of each corresponding K-line is approximately proportional to the square of the atomic number of the emitting element". The above statement is given by -

(A) Stern and Garlach

(B) Mosley

(C) Frank and Hertz

(D) Davisson and Germer

62. The Selection Rules for a strong electric field are -

(A) $\Delta Mj=1$ for π component

(B) $\Delta Mj=0$ for σ component

(C) $\Delta Mj=0, \pm1$ for π and σ component respectively.

(D) $\Delta Mj=\pm2$ for π component

63. The Interaction energy of Paschen-Back effect is -

(A) $(m_l + 3m_s)\,\mu_B \cdot B$

(B) $(m_l + \frac{1}{2} m_s)\,\mu_B \cdot B$

(C) $(m_l + \frac{3}{2} m_s)\,\mu_B \cdot B$

(D) $(m_l + 2m_s)\,\mu_B \cdot B$

64. Selection rules for the weak electric field Stark effect -

(A) $\Delta Mj=\pm1$ gives π component, $\Delta Mj=0$ gives σ component

(B) $\Delta Mj=\pm1$ gives σ component, $\Delta Mj=0$ gives π component,

(C) $\Delta Mj=\pm2$ gives π component, $\Delta Mj=\pm\frac{1}{2}$ gives σ component,

(D) None of the above

65. The Stark shift for the ground state (n=1) of Hydrogen atom is____

(A) exactly equal to n^2

(B) nearly equal to n^2

(C) proportional to weak field

(D) Zero

66. Zeeman effect is the splitting of spectral line in the presence of -

(A) Electric field

(B) Magnetic field

(C) Inert environment

(D) Vaccume

67. According to which principle "No two electron in an atom can exist in same quantum state"-

(A) Vector Atom Model

(B) Afbau Principle

(C) Heisenberge's Uncertainty Principle

(D) Pauli-exclusion Principle

68. Which electron transition causes D_1 spectral line in spectrum of sodium?

(A) $4\,^2P_{\frac{1}{2}} \rightarrow 3\,^2S_{\frac{1}{2}}$

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

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

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

69. The value of the Lande g-factor for a fine structure level defined by the quantum numbers, L=1, J=2 and S=1 is -

(A) $^{11}/_{6}$

(B) $^{4}/_{3}$

(C) $^{8}/_{3}$

(D) $\frac{3}{2}$

70. The direction of Orbital magnetic moment is -

(A) towards the direction of angular momentum

(B) Opposite to the direction of angular momentum

(C) Parallel to the direction of angular momentum

(D) Perpendicular to the direction of angular momentum.

71. The terms (J_1, J_2), arising from $2s^1 3d^1$ electronic configuration in j-j coupling scheme are -

(A) $\left|\frac{1}{2}, \frac{3}{2}\right|_{2,1}$ and $\left|\frac{1}{2}, \frac{5}{2}\right|_{3,2}$

(B) $\left|\frac{1}{2}, \frac{1}{2}\right|_{1,0}$ and $\left|\frac{1}{2}, \frac{3}{2}\right|_{2,1}$

(C) $\left|\frac{1}{2}, \frac{1}{2}\right|_{1,0}$ and $\left|\frac{1}{2}, \frac{5}{2}\right|_{3,2}$

(D) $\left|\frac{3}{2}, \frac{1}{2}\right|_{2,1}$ and $\left|\frac{1}{2}, \frac{5}{2}\right|_{3,2}$

72. If an atom is in the $^1D_2$ state, the angle between its orbital and spin angular momentum vectors ($\hat{L}$ and $\hat{S}$) is -

(A) $\cos^{-1}\left(\frac{2}{\sqrt{3}}\right)$

(B) $\cos^{-1}\left(\frac{1}{2}\right)$

(C) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$

(D) $\cos^{-1}\left(\frac{\sqrt{3}}{2}\right)$

73. Alkali spectra gives -

(A) Principle Series

(B) Sharp Series

(C) Diffuse Series

(D) All of the above

74. The correct relation is -

(A) $\frac{|\hat{\mu}_l|}{|\hat{L}|} = \frac{e}{2m}$

(B) $\frac{|\hat{\mu}_l|}{|\hat{L}|} = \frac{2m}{e}$

(C) $\frac{|\hat{\mu}_l|}{2m} = \frac{e}{\hat{L}}$

(D) $\frac{|\hat{\mu}_l|}{|\hat{L}|} = 1$

75. The maximum number of electrons in a subshell with orbital quantum number l is :

(A) $(2l + 1)$

(B) $(2l - 1)$

(C) $2 . (2l + 1)$

(D) $2 . (2l - 1)$