ATOMIC STRUCTURE

UNIT EXERCISE
Not To Be Discussed in Class

SECTION - 1 : SINGLE CHOICE CORRECT QUESTIONS

1. Which of the following quantum number will be for 5d sub-shell ?
(A) $n = 5, l = 2$ (B) $n = 6, l = 3$ (C) $n = 4, l = 0$ (D) $n = 5, l = 4$

2. What is the maximum number of electrons in the possible sub-shells for $n + l = 4$?
(A) 8 (B) 6 (C) 12 (D) 16

3. Which of the following should be the possible sub-shells for $n + l = 7$?
(A) 7s 6p 5d 4f (B) 4f 5p 6s 4d (C) 7s 6p 5d 6d (D) 4f 4d 6p 7s

4. An atom has a mass of 0.02 kg and uncertainty in its velocity is 9.218×10^{-6} m/s then uncertainty in position is ($h = 6.626 \times 10^{-34}$ Js)
(A) 2.86×10^{-28} m (B) 2.86×10^{-32} cm (C) 1.5×10^{-27} m (D) 3.9×10^{-10} m

5. Energy of H- atom in the ground state is –13.6 eV, Hence energy in the second excited state is-
(A) –6.8 eV (B) –3.4 eV (C) –1.51 eV (D) –4.3 eV

6. Uncertainty in position of a particle of 25 g in space is 10^{-5} m. Hence uncertainty in velocity (ms^{-1}) is (Planck's constant $h = 6.6 \times 10^{-34}$ Js)
(A) 2.1×10^{-28} (B) 2.1×10^{-34} (C) 0.5×10^{-34} (D) 5.0×20^{-24}

7. The orbital angular momentum for an electron revolving in an orbit is given by $\sqrt{\ell(\ell+1)} \cdot \frac{h}{2\pi}$. This momentum for an s-electron will be given by
(A) $\sqrt{2} \cdot \frac{h}{2\pi}$ (B) $+\frac{1}{2} \cdot \frac{h}{2\pi}$ (C) zero (D) $\frac{h}{2\pi}$

8. The number of d-electrons retained in Fe^{2+} (At. no. of Fe = 26) ion is :
(A) 6 (B) 3 (C) 4 (D) 5

9. The de Broglie wavelength of a tennis ball of mass 60 g moving with a velocity of 10 metres per second is approximately :
(A) 10^{-25} metres (B) 10^{-33} metres (C) 10^{-31} metres (D) 10^{-16} metres

10. In Balmer series of lines of hydrogen spectrum, the third line from the red end corresponds to which one of the following inter-orbit jumps of the electron for Bohr orbits in an atom of hydrogen ?
(A) $2 \to 5$ (B) $3 \to 2$ (C) $5 \to 2$ (D) $4 \to 1$

11. Which of the following sets of quantum number is correct for an electron in 4f orbital ?
(A) $n = 3, l = 2, m = -2, s = +\frac{1}{2}$ (B) $n = 4, l = 4, m = -4, s = -\frac{1}{2}$
(C) $n = 4, l = 3, m = +1, s = +\frac{1}{2}$ (D) $n = 4, l = 3, m = +4, s = +\frac{1}{2}$

12. Consider the ground state of Cr atom (Z = 24). The numbers of electrons with the azimuthal quantum numbers, $l = 1$ and 2 are, respectively
(A) 16 and 5 (B) 12 and 5 (C) 16 and 4 (D) 12 and 4

13. The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be (Rydberg constant = 1.097×10^{7} m^{-1}) :
(A) 9.1×10^{-8} nm (B) 192 nm (C) 406 nm (D) 91 nm

14. Which one of the following sets of ions represents the collection of isoelectronic species ?
(A) Na^+, Mg^{2+}, Al^{3+}, Cl^- (B) Na^+, Ca^{2+}, Sc^{3+}, F^- (C) K^+, Cl^-, Mg^{2+}, Sc^{3+} (D) K^+, Ca^{2+}, Sc^{3+}, Cl^-

15. In a multi-electron atom, which of the following orbitals described by the three quantum members will have the same energy in the absence of magnetic and electric fields ?
(a) n = 1, l = 0, m = 0
(b) n = 2, l = 0, m = 0
(c) n = 2, l = 1, m = 1
(d) n = 3, l = 2, m = 1
(e) n = 3, l = 2, m = 0
(A) (d) and (e) (B) (c) and (d) (C) (b) and (c) (D) (a) and (b)

16. Of the following sets which one does not contain isoelectronic species ?
(A) BO_3^{3-}, CO_3^{2-}, NO_3^- (B) SO_3^{2-}, CO_3^{2-}, NO_3^- (C) CN^-, N_2, C_2^{2-} (D) PO_4^{3-}, SO_4^{2-}, ClO_4^-

17. Which of the following statements in relation to the hydrogen atom is correct ?
(A) 3s, 3p and 3d orbitals all have the same energy
(B) 3s and 3p orbitals are of lower energy than 3d orbitals
(C) 3p orbital is lower in energy than 3d orbital
(D) 3s orbitals is lower in energy than 3p orbital

18. According to Bohr's theory angular momentum of electron in 5^{th} shell is :-
(A) 1.0 h/π (B) 10 h/π (C) 2.5 h/π (D) 25 h/π

19. Uncertainty in the position of an electron (mass = 9.1×10^{-31} Kg) moving with a velocity 300 ms^{-1}, accurate upto 0.001%, will be :- (h = 6.63×10^{-34} Js)
(A) 5.76×10^{-2} m (B) 1.92×10^{-2} m (C) 3.84×10^{-2} m (D) 19.2×10^{-2} m

20. Which of the following sets of quantum numbers represents the highest energy of an atom ?
(A) n = 3, l = 1, m = 1, s = +½
(B) n = 3, l = 2, m = 1, s = +½
(C) n = 4, l = 0, m = 0, s = +½
(D) n = 3, l = 0, m = 0, s = +½

21. For which orbital angular probability distribution is maximum at an angle of 45° to the axial direction :-
(A) $d_{x^2-y^2}$ (B) d_{z^2} (C) d_{xy} (D) P_x

22. Which orbit would be the first to have 'g' subshell :-
(A) 3^{rd} (B) 4^{th} (C) 5^{th} (D) 6^{th}

23. The decreasing order of energy of the 3d, 4s, 3p, 3s orbitals is :-
(A) 3d > 3s > 4s > 3p (B) 3s > 4s > 3p > 3d (C) 3d > 4s > 3p > 3s (D) 4s > 3d > 3s > 3p

24. If n and ℓ are respectively the principle and azimuthal quantum numbers, then the expression for calculating the total number of electrons in any orbit is :-
(A) $\sum_{\ell=1}^{\ell=n} 2(2\ell+1)$ (B) $\sum_{\ell=1}^{\ell=n-1} 2(2\ell+1)$ (C) $\sum_{\ell=0}^{\ell=n+1} 2(2\ell+1)$ (D) $\sum_{\ell=0}^{\ell=n-1} 2(2\ell+1)$

25. If wavelength is equal to the distance travelled by the electron in one second, then :-
(A) $\lambda = \frac{h}{pv}$ (B) $\lambda = \frac{h}{m}$ (C) $\lambda = \sqrt{\frac{h}{p}}$ (D) $\lambda = \sqrt{\frac{h}{m}}$

26. According to Schrodinger model nature of electron in an atom is as :-
(A) Particles only
(B) Wave only
(C) Both simultaneously
(D) Sometimes waves and sometimes particle

27. Which describes orbital :-
(A) ψ (B) ψ^2 (C) $|\psi^2|\psi$ (D) All

28. In order to have the same wavelength for the electron (mass m_e) and the neutron (mass m_n) their velocities should be in the ratio (electron velocity/neutron velocity) :-
(A) m_n/m_e (B) $m_n \times m_e$ (C) m_e/m_n (D) one

29. The quantum numbers +1/2 and –1/2 for the electron spin represent :-
(A) Rotation of the electron in clockwise and anticlockwise direction respectively.
(B) Rotation of the electron in anticlockwise and clockwise direction respectively.
(C) Magnetic moment of the electron pointing up and down respectively.
(D) Two quantum mechanical spin states which have no classifical analogue.

30. Which is true about ψ :-
(A) ψ represents the probability of finding an electron around the nucleus
(B) ψ represent the amplitude of the electron wave
(C) Both A and B
(D) None of these

31. Consider an electron in the n^{th} orbit of a hydrogen atom in the Bohr model. The circumference of the orbit can be expressed in terms of the de Broglie wavelength λ of the electron as :-
(A) (0.529) $n\lambda$ (B) $\sqrt{n}\lambda$ (C) (13.6) λ (D) $n\lambda$

32. A particle X moving with a certain velocity has a debroglie wave length of 1A°. If particle Y has a mass of 25% that of X and velocity 75% that of X, debroglies wave length of Y will be :-
(A) 3 A° (B) 5.33 A° (C) 6.88 A° (D) 48 A°

33. What are the values of the orbital angular momentum of an electron in the orbitals 1s, 3s, 3d and 2p :-
(A) $0, 0, \sqrt{6}\hbar, \sqrt{2}\hbar$ (B) $1, 1, \sqrt{4}\hbar, \sqrt{2}\hbar$ (C) $0, 1, \sqrt{6}\hbar, \sqrt{3}\hbar$ (D) $0, 0, \sqrt{20}\hbar, \sqrt{6}$

34. If m = magnetic quantum number and ℓ = azimuthal quantum number then :-
(A) $m = \ell + 2$ (B) $m = 2\ell^2 + 1$ (C) $\ell = \frac{m-1}{2}$ (D) $\ell = 2m + 1$

35. The number of unpaired electrons in Mn^{4+} (Z = 25) is :-
(A) Four (B) Two (C) Five (D) Three

36. After np orbitals are filled, the next orbital filled will be :-
(A) (n + 1) s (B) (n + 2) p (C) (n + 1) d (D) (n + 2) s

37. The value of the magnetic moment of a particular ion is 2.83 Bohr magneton. The ion is :-
(A) Fe^{2+} (B) Ni^{2+} (C) Mn^{2+} (D) Co^{3+}

38. In Bohr's model of the hydrogen atom the ratio between the period of revolution of an electron in the orbit of n = 1 to the period of the revolution of the electron in the orbit n = 2 is :-
(A) 1 : 2 (B) 2 : 1 (C) 1 : 4 (D) 1 : 8

39. Let υ_1 be the frequency of the series limit of the Lyman series, υ_2 be the frequency of the first line of the lyman series, and υ_3 be the frequency of the series limit of the Balmer series :-
(A) $\upsilon_1 - \upsilon_2 = \upsilon_3$ (B) $\upsilon_2 - \upsilon_1 = \upsilon_3$ (C) $\upsilon_3 = 1/2\ (\upsilon_1 - \upsilon_3)$ (D) $\upsilon_1 + \upsilon_2 = \upsilon_3$

40. The energies of energy levels A, B and C for a given atom are in the sequence $E_A < E_B < E_C$. If the radiations of wavelengths λ_1, λ_2 and λ_3 are emitted due to the atomic transitions C to B, B to A and C to A respectively then which of the following relations is correct :-
(A) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (B) $\lambda_3 = \lambda_1 + \lambda_2^2$ (C) $\lambda_3 = \lambda_1 + \lambda_2$ (D) $\lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$

41. The wavelengths of photons emitted by electron transition between two similar levels in H and He^+ are λ_1 and λ_2 respectively. Then :-
(A) $\lambda_2 = \lambda_1$ (B) $\lambda_2 = 2\lambda_1$ (C) $\lambda_2 = \lambda_1/2$ (D) $\lambda_2 = \lambda_1/4$

42. If first ionization potential of an atom is 16 V, then the first excitation potential will be :-
(A) 10.2 V (B) 12 V (C) 14 V (D) 16 V

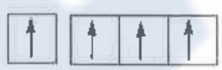
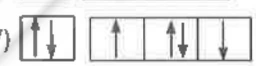
43. In which transition minimum energy is emitted :-
(A) $\infty \rightarrow 1$ (B) $2 \rightarrow 1$ (C) $3 \rightarrow 2$ (D) $n \rightarrow (n-1)$ $(n \geq 4)$

44. No. of visible lines when an electron returns from 5^{th} orbit to ground state in H spectrum :-
(A) 5 (B) 4 (C) 3 (D) 10

45. Which of the following has maximum number of unpaired electron (atomic number of Fe 26)
(A) Fe (B) Fe (II) (C) Fe (III) (D) Fe (IV)

46. Suppose a particle has four quantum numbers such that the permitted values are:
$n = 1, 2, 3$........
$l = (n-1), (n-3), (n-5)$ ....but no negative value
$j = \left(\ell + \frac{1}{2}\right)$ or $\left(\ell - \frac{1}{2}\right)$, the later is not negative
$m = -j$ in integer step to $+j$ what are the other permitted values for $n = 2$?
(A) $l = 1,\ j = \frac{3}{2}, m = -\frac{3}{2}$ (B) $l = 0,\ j = \frac{1}{2}; m = -\frac{1}{2}$
(C) $l = 1,\ j = \frac{1}{2}; m = -\frac{3}{2}$ (D) All of these

47. Which of the following is / are false.
(A) Multiplicity in Fe^{3+} is greater than Co^{3+}.
(B) Ti^{3+}, Cr^{+}, Sc^{2+} ions are diamagnetic.
(C) Value of $(n + l + m)$ for last electron in Na is 3.
(D) Number of neutron in 1.07 gm $Fe(OH)_3$ is 3.25×10^{23}

48. The orbital diagram in which Hund's rule is violated is
(I) 
(II) 
(III) 
(IV) 
(A) I & II (B) II & III (C) III & IV (D) II & IV

49. Match the column:
('l' and 'm' are respectively the azimuthal and magnetic quantum numbers)

Column I	**Column II**
(I) Total number of values of (l) for a shell	(P) $0, 1, 2,$ ....$(n-1)$
(II) Values of (l) for a shell	(Q) $+l,$ .....$+2, +1, 0, -1, -2,$ ....$-l$
(III) Total number of values of (m) for a subshell	(R) $(2l + 1)$
(IV) Values of (m) for a subshell	(S) n

(A) (I) S (II) P (III) R (IV) Q (B) (I) S (II) R (III) P (IV) Q
(C) (I) P (II) S (III) R (IV) Q (D) (I) P (II) R (III) Q (IV) S

50. Which of the following statements regarding subshell filling order for a neutral atom is/are correct ?
(I) Electrons are assigned to the 4s subshell before they are assigned to the 3d subshell
(II) Electrons are assigned to the 4f subshell before they are assigned to the 6s subshell
(III) Electrons are assigned to the 4d subshell before they are assigned to the 5p subshell
(A) I only (B) II only (C) I and III (D) I, II and III

51. If the nitrogen atom had electronic configuration $1s^7$, it would have energy lower that of normal ground state configuration $1s^2 2s^2 2p^3$, because the electrons would be closer to the nucleus. Yet $1s^7$ is not observed because it violates :-
(A) Heisenberg uncertainty principle (B) Hunds rule
(C) Pauli's exclusion principle (D) Bohr postulate of stationary orbits

52. The explanation for the presence of three unpaired electrons in the nitrogen atom can be given by
(A) Pauli's exclusion principle (B) Hund's rule
(C) Aufbau's principle (D) Uncertainity principle

53. Which of the following has the maximum number of unpaired electrons ?
(A) Mg^{2+} (B) Ti^{3+} (C) V^{3+} (D) Fe^{2+}

54. The electrons, identified by n & l ;
(i) $n = 4$, $l = 1$ (ii) $n = 4$, $l = 0$ (iii) $n = 3$, $l = 2$.
(iv) $n = 3$, $l = 1$ can be placed in order of increasing energy, from the lowest to highest as :
(A) (iv) < (ii) < (iii) < (i) (B) (iii) < (ii) < (iv) < (i)
(C) (i) < (iii) < (ii) < (iv) (D) (iii) < (i) < (iv) < (ii)

56. The magnetic moment of cobalt of the compund $Hg[Co(SCN)_4]$ is [Given : Co^{+2}]
(A) $\sqrt{3}$ (B) $\sqrt{8}$ (C) $\sqrt{15}$ (D) $\sqrt{24}$

57. The radius of which of the following orbit is same as that of the first Bohr's orbit of hydrogen atom?
(A) He^{+} (n = 2) (B) Li^{2+} (n = 2) (C) Li^{2+} (n = 3) (D) Be^{3+} (n = 2)

58. The magnetic moment of cobalt of the compund $Hg[Co(SCN)_4]$ is [Given : Co^{+2}]
(A) $\sqrt{3}$ (B) $\sqrt{8}$ (C) $\sqrt{15}$ (D) $\sqrt{24}$

SECTION - 2 : MULTIPLE CHOICE CORRECT QUESTIONS

59. Which of the following statements is/are incorrect ?
(A) Lanthanum is the first element of lanthanides (B) Actinium violates the Aufbau's principle.
(C) Chromium violates the Pauli's exclusion principle. (D) Total 10 exchanges are possible for d electrons in Zn.

60. Bohr's theory is not applicable to -
(A) He (B) Li^{2+} (C) He^{2+} (D) the H-atom

61. In which transition, one quantum of energy is emitted -
(A) $n = 4 \rightarrow n = 2$ (B) $n = 3 \rightarrow n = 1$ (C) $n = 4 \rightarrow n = 1$ (D) $n = 2 \rightarrow n = 1$

62. The magnitude of the spin angular momentum of an electron is given by -
(A) $S = \sqrt{s(s+1)}\dfrac{h}{2\pi}$ (B) $S = s\dfrac{h}{2\pi}$ (C) $S = \dfrac{\sqrt{3}}{2}\times\dfrac{h}{2\pi}$ (D) $S = \pm\dfrac{1}{2}\times\dfrac{h}{2\pi}$

63. A hydrogen - like atom has ground state binding energy 122.4 eV. Then :
(A) its atomic number is 3
(B) an photon of 90 eV can excite it to a higher state
(C) an 80 eV photon cannot excite it to a higher state
(D) an electron of 8.2 eV and a photon of 91.8 eV are emitted when a 100 eV electron interacts with it

64. In a hydrogen like sample two different types of photons A and B are produced by electronic transition. Photon B has it's wavelength in infrared region if photon A has more energy then B, then the photon A may belong to the region.
(A) ultraviolet (B) visible (C) infrared (D) None

65. In a H-like sample electrons make transition from 4th excited state to 2nd state then
(A) 10 different spectral lines are observed
(B) 6 different spectral lines are observed
(C) number of lines belonging to the balmier series is 3
(D) Number of lines belonging to paschen series is 2.

66. Gaseous state electronic configuration of nitrogen atom can be represented as :

(A) ↑↓ ↑↓ ↑ ↑ ↑ (B) ↑↓ ↑↓ ↑ ↓ ↑ (C) ↑↓ ↑↓ ↑ ↓ ↓ (D) ↑↓ ↑↓ ↓ ↓ ↓

67. The electronic configuration of an element is $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\,4s^1$. This represents its :

(A) excited state (B) ground state (C) cationic form (D) none

SECTION - 3 : COMPREHENSION BASED QUESTIONS

Paragraph for Q.68 to Q.73

Read the following rules and answer the questions at the end of it.

Electrons in various suborbits of an orbit are filled in increasing order to their energies.

Pairing of electrons in various orbitals of a suborbit takes place only after each orbital is half-filled.

No two electrons in an atom can have the same set of quantum number.

68. Cr (Z = 24), Mn^+ (Z = 25), Fe^{2+} (Z = 26) and Co^{3+} (Z = 27) are isoelectronic each having 24 electrons. Thus,

(A) all have configurations as [Ar] $4s^1\,3d^5$

(B) Cr and Mn^+ have configurations as [Ar] $4s^1\,3d^5$ while Fe^{2+} and Co^{3+} have configurations as [Ar]$3d^6$.

(C) all have configurations as [Ar] $3d^6$

(D) all have configurations as [Ar] $4s^2\,3d^6$

69. A compound of vanadium has a magnetic moment of 1.73 BM. Electronic configuration of the vanadium ion in the compound is :

(A) [Ar] $4s^0\,3d^1$ (B) [Ar] $4s^2\,3d^3$ (C) [Ar] $4s^1\,3d^0$ (D) [Ar] $4s^0\,3d^5$

70. Which of these ions are expected to be paramagnetic and coloured in aqueous solution ?

(A) Fe^{3+}, Ti^{3+}, Co^{3+} (B) Cu^+, Ti^{4+}, Sc^{3+} (C) Fe^{3+}, Ni^{2+}, V^{5+} (D) Cu^+, Cu^{2+}, Fe^{2+}

71. While writing the following electronic configuration of Fe some rules have been violated :

I : Aufbau rule, II : Hund's rule III : Pauli's exclusion principle

Ar	↑↑	↑	↑	↑	↑		↑↓
			3d				4s

(A) I, II (B) II, III (C) I, III (D) III

72. How many elements would be in the second period of the periodic table if the spin quantum number (m_s) could have the value of $-\frac{1}{2}, 0, +\frac{1}{2}$?

(A) 8 (B) 10 (C) 12 (D) 18

73. The sub-shell that arises after *f* sub-shell is called g sub-shell.

(A) it contains 18 electrons and 9 orbitals

(B) it corresponds to ℓ = 4 and first occurs in 5th energy level

(C) a g-orbital can have maximum of two electrons

(D) all the above statements are true.

SECTION - 4 : MATRIX - MATCH QUESTIONS

74.

Column-I	Column-II
(A) Aufbau principle	(p) Line spectrum in visible region
(B) de broglie	(q) Orientation of an electron in an orbital
(C) Angular momentum	(r) Photon
(D) Hund's rule	(s) λ = h/mv
(E) Balmer series	(t) Electronic configuration
(F) Planck's law	(u) mvr

75. Given in hydrogenic atom r_n, V_n, E, K_n stand for radius, potential energy, total energy and kinetic energy in n^{th} orbit. Find the value of U,v,x,y.

Column - I	Column - II
(A) $U = \frac{V_n}{K_n}$	(p) 1
(B) $\frac{1}{r_n} \propto E^x$	(q) –2
(C) $r_n \propto Z^y$ (Z = Atomic number)	(r) –1
(D) v = (Orbital angular momentum of electron in its lowest energy)	(s) 0

SECTION - 5 : NUMERICAL ANSWER BASED QUESTIONS

76. Calculate the number of exchange pairs of electrons present in configuration of Cu according to Aufbau principle considering 3d orbitals.

77. How many electrons are present in P–shell.

78. According to Aufbau's Principle, the maximum of electron that can be accomodated in the outermost orbit (ab) and the penultimate orbit (cd) is :

79. Identify number of correct statements.
(A) Weight of 0.002 gm–atom of fluorine is 38 mg.
(B) Average atomic weigth of an element is the weight of most of the atoms.
(C) The value of 'l' for 5th electron of any element (Z > 5) will be same.
(D) In case of CO weight of carbon atoms is equal to weight of oxygen atoms.
(E) The value of 'm' must be zero for last electron of Ne.
(F) To obtain 0.1 mole of $K_2SO_4.Al_2(SO_4)_3.24H_2O$ weight of oxygen required is 64 g.
(G) N^{-3} and P^{-3} are isoelectronic.
(H) Hydrogen(H) and Deuterium (D) are isobars.

80. Find the number of electrons having the value of azimuthal quantum number 'l' = 1 for Cd^{2+}.

81. Calculate the binding energy per mole when threshold wavelength of photon is 240 nm.

82. The wavelength of a certain line in the Paschen series is 1093.6 nm. What is the value of n_{high} for this line [$R_H = 1.0973 \times 10^{+7}\ m^{-1}$].

SECTION - 6 : SUBJECTIVE QUESTIONS

83. A gas of identical H-like atom has some atoms in the lowest (ground) energy level A and some atoms in a particular upper (excited) energy level B and there are no atoms in any other energy level. The atoms of the gas make transition to a higher energy level by absorbing monochromatic light of photon energy 2.7 eV. Subsequently, the atoms emit radiation of only six different photons energies. Some of the emitted photons have energy 2.7 eV. Some have more and some have less than 2.7 eV.
(a) Find the principal quantum number of initially excited level B.
(b) Find the ionisation energy for the gas atoms.
(c) Find the maximum and the minimum energies of the emitted photons.

84. An energy of 68 eV is required to excite a hydrogen like atom from its second Bohr orbit to the third. The nuclear charge is Ze. Find the value of Z, the kinetic energy of the electron in the first Bohr orbit and the wavelength of the radiation required to eject the electrons from the first Bohr orbit to infinity.

85. The ionisation energy of a H-like Bohr atom is 4 Rydbergs.

(i) What is the wavelength of radiation emitted when the e^- jumps from the first excited state to the ground state?

(ii) What is the radius of first Bohr orbit for this atom? [1 Rydberg = 2.18×10^{-18} J]

86. Photon having wavelength 12.4 nm was allowed to strike a metal plate having work function 25 eV. Calculate the -

(a) Maximum kinetic energy of photoelectrons emitted in eV.

(b) Wavelength of electron with maximum kinetic energy in A°.

(c) Calculate the uncertainity in wavelength of emitted electron, if the uncertainity in the momentum is 6.62×10^{-28} kg m/sec.

87. The angular momentum of an electron in a Bohr's orbit of H-atom is 3.1652×10^{-34} kg-m^2/sec. Calculate the wave number in terms of Rydberg constant (R) of the spectral line emitted when an electron falls from this level to the ground state. (Use h = 6.626×10^{-34} Js).

88. Wavelength of the Balmer H_α line (first line) is 6565 Å. Calculate the wavelength of H_β (second line).

89. Calculate the energy emitted when electrons of 1.0 g atom of hydrogen undergo transition giving the spectral line of lowest energy in the visible region of its atomic spectrum.

90. A photon having λ = 854 Å causes the ionization of a nitrogen atom. Give the I.E. per mole of nitrogen in KJ.

91. Calculate energy of electron which is moving in the orbit that has its radius, Sixteen times the radius of first Bohr orbit for H-atom.

92. The electron energy in hydrogen atom is given by $E_n = \dfrac{-21.7 \times 10^{-12}}{n^2}$ ergs. Calculate the energy required to remove an e^- completely from n = 2 orbit. What is the largest wavelength in cm of light that can be used to cause this transition.

93. The velocity of e^- in a certain Bohr orbit of the hydrogen atom bears the ratio 1 : 275 to the velocity of light. What is the quantum no. "n" of the orbit and the wave no. of the radiation emitted for the transition form the quantum state (n + 1) to the ground state.

94. A doubly ionised lithium atom is hydrogen like with atomic number Z = 3. Find the wavelength of the radiation required to excite the electron in Li^{2+} from the first to the third Bohr orbit.

95. Estimate the difference in energy between I and II Bohr Orbit for a hydrogen atom. At what minimum At. no. a transition from n = 2 to n = 1 energy level would result in the emission of X-rays with $\lambda = 3.0 \times 10^{-8}$ m? Which hydrogen like species does this At. no. correspond to:

96. 1.8 g atoms of hydrogen are excited to radiations. The study of spectra indicates that 27% of the atoms are in 3rd energy level and 15% of atoms in 2nd energy level and the rest in ground state. If I.P. of H is 21.7×10^{-12} erg. Calculate.

(i) No. of atoms present in III & II energy level.

(ii) Total energy evolved when all the atoms return to ground state.

97. The vapours of Hg absorb some electrons accelerated by a potential difference of 4.5 volt as a result of it light is emitted. If the full energy of single incident e^- is supposed to be converted into light emitted by single Hg atom, find the wave no. of the light.

98. A stationary He^+ ion emitted a photon corresponding to a first line of the Lyman series. The photon liberated a photoelectron from a stationary H atom in ground state. What is the velocity of photoelectron ?

99. The hydrogen atom in the ground state is excited by means of monochromatic radiation of wavelength x A^0. The resulting spectrum consists of 15 different lines. Calculate the value of x.

100. If the average life time of an excited state of H atom is of order 10^{-8} sec, estimate how many orbits an e^- makes when it is in the state $n = 2$ and before it suffers a transition to $n = 1$ state.

101. The energy levels of hypothetical one electron atom are shown below.

0 eV —— $n = \infty$
–0.50 eV —— $n = 5$
–1.45 eV —— $n = 4$
–3.08 eV —— $n = 3$
–5.3 eV —— $n = 2$
–15.6 eV —— $n = 1$

(a) Find the ionisation potential of atom?
(b) Find the short wavelength limit of the series terminating at $n = 2$?
(c) Find the wave no. of photon emitted for the transition made by the electron from third orbit to first orbit ?
(d) Find the minimum energy that an electron will have after interacting with this atom in the ground state, if the initial kinetic energy of the electron is (i) 6eV (ii) 11 eV ?

102. Suppose 10^{-17} J of light energy is needed by the interior of the human eye to see an object. How many photons of green light ($\lambda = 550$ nm) are needed to generate this minimum amount of energy?

103. Find the number of photons of radiation of frequency $5 \times 10^{13}\ s^{-1}$ that must be absorbed in order to melt one g ice when the latent heat of fusion of ice is 330 J/g.

104. The eyes of certain member of the reptile family pass a single visual signal to the brain when the visual receptors are struck by photons of wavelength 850 nm. If a total energy of 3.15×10^{-14} J is required to trip the signal, what is the minimum number of photons that must strike the receptor?

105. To what series does the spectral lines of atomic hydrogen belong if its wave number is equal to the difference between the wave number of the following two lines of the Balmer series 486.1 and 410.2 nm. What is the wavelength of this ?

106. Calculate the threshold frequency of metal if the binding energy is 180.69 kJ mol^{-1} of electron.

107. A metal was irradiated by light of frequency $3.2 \times 10^{15}\ s^{-1}$. The photoelectron produced had its KE, 2 times the KE of the photoelectron which was produced when the same metal was irradiated with a light of frequency $2.0 \times 10^{15}\ s^{-1}$. What is work function ?

108. U.V. light of wavelength 800 A° & 700 A° falls on hydrogen atoms in their ground state & liberates electrons with kinetic energy 1.8 eV and 4 eV respectively. Calculate planck's constant.

109. A potential difference of 20 kV is applied across an X-ray tube. Find the minimum wavelength of X-ray generated.

110. The K.E. of an electron emitted from tungsten surface is 3.06 eV. What voltage would be required to bring the electron to rest.

111. What is de-Broglie wavelength of a He-atom in a container at room temperature. $\left(\text{Use } U_{avg} = \sqrt{\frac{8kT}{\pi m}}\right)$

112. Through what potential difference must an electron pass to have a wavelength of 500 A°.

113. A proton is accelerated to one tenth of the velocity of light. If its velocity can be measured with a precision ± 1%. What must be its uncertainty in position ?

114. To what effective potential a proton beam be subjected to give its protons a wavelength of 1×10^{-10}m.

115. He atom can be excited to $1s^1\ 2p^1$ by $\lambda = 58.44$ nm. If lowest excited state for He lies 4857 cm^{-1} below the above. Calculate the energy for the lower excitation state.

116. A certain dye absorbs 4530 A° and fluoresence at 5080 A° these being wavelengths of maximum absorption that under given conditions 47% of the absorbed energy is emitted. Calculate the ratio of the no. of quanta emitted to the number absorbed.

117. The dissociation energy of H_2 is 430.53 kJ/mol. If H_2 is exposed to radiant energy of wavelength 253.7 nm, what % of radiant energy will be converted into K.E ?

118. Iodine molecule dissociates into atoms after absorbing light of 4500 A^0 If one quantum of radiation is absorbed by each molecule, calculate the K.E. of iodine atoms.
(Bond energy of I_2 = 240 kJ/mol)

119. What is de-Broglie wavelength associated with an e^- accelerated through potential difference of 100 kV ?

120. Calculate the de-broglie wavelength associated with motion of earth (mass 6×10^{24} kg) orbiting around the sun at a speed of 3×10^6 m/s.

121. A base ball of mass 200 g is moving with velocity 30×10^2 cm/s. If we can locate the base ball with error equal in magnitude to the λ of the light used (5000 Å), how will the uncertainty in momentum compared with the total momentum of base ball ?

122. An electron has a speed of 40 m/s, accurate up 99.99 %. What is the uncertainty in locating position?

123. Instead of principal quantum number (n), azimuthal quantum number (l) & magnetic quantum number m, a set of new quantum numbers s, t and u was introduced with similar logic but different values as defined below.

$s = 1, 2, 3, \ldots\ldots\infty$ all positive integral values.

$t = (s^2 - 1^2), (s^2 - 2^2), (s^2 - 3^2) \ldots\ldots$ No negative value

$u = -\frac{(t+1)}{2}$ to $+\frac{(t+1)}{2}$ (including zero, if any) in integral steps.

Each orbital can have maximum four electrons.
(s + t) rule is defined, similar to (n + l) rule.

(i) Number of electrons that can be accommodated in s = 2 and s = 3 shell.
(ii) Number of electrons for which s = 2, t = 3 for an element with atomic number 24.
(iii) The number of subshells in which the third shell is subdivided equal to

124. Calculate the Rydberg constant R if He^+ ions are known to have the wavelength difference between the first (of the longest wavelength) lines of Balmer and Lyman series equal to 133.7 nm.

125. Calculate the wavelength in angstrom of photon that is emitted when an e^- in Bohr orbit n = 2 returns to the orbit n = 1. The ionization potential of the ground state of hydrogen atom is 2.17×10^{-11} erg/atom.

126. One mole He^+ ions are excited. Spectral analysis showed existence of 50% ions in 3^{rd} orbit, 25% in 2^{nd} and rest in ground state. Calculate total energy evolved when all the ions return to the ground state.

127. Calculate the frequency of e^- in the first Bohr orbit in a H-atom.

128. To what series does the spectral lines of atomic hydrogen belong if its wave number is equal number is equal to the difference between the wave numbers of the following two lines of the Balmer series 486.1 and 410.2 nm? What is the wavelength of this line ?

129. Hydrogen atom in its ground state is excited by means of monochromatic radiation of wavelength 975 A°. How many different lines are possible in the resulting spectrum? Calculate the longest wavelength amongst them.

130. (a) The Schrodinger wave equation for hydrogen atom is

$$\psi_{2s} = \frac{1}{4(2\pi)^{1/2}}\left(\frac{1}{a_0}\right)^{3/2}\left(2 - \frac{r_0}{a_0}\right)e^{-r/a}$$

Where a_0 is Bohr's radius. Let the rdial node in 2s be at r_0. Then find r_0 in terms of a_0.

(b) A base ball having mass 100 g moves with velocity 100 m/s. Find out the value of wavelength of base ball.

131. (a) Calculate velocity of electron in first Bohr orbit of hydrogen atom (Given $r = a_0$)

(b) Find de-Broglie wavelength of the electron in first Bohr orbit.

(c) Find the orbital angular momentum of 2p-orbital in terms of $h/2\pi$ units.

SECTION - 7 : ASSERTION–REASON QUESTIONS

These questions contains, Statement I (assertion) and Statement II (reason).

(A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.

(B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I

(C) Statement-I is true, Statement-II is false

(D) Statement-I is false, Statement-II is true

132. **Statement-I :** Nodal plane of p_x atomic orbital is yz plane.

Because

Statement-II : In p_x atomic orbital electron density is zero in the yz plane.

133. **Statement-I :** No two electrons in an atom can have the same values of four quantum numbers.

Because

Statement-II : No two electrons in an atom can be simultaneously in the same shell, same subshell, same orbitals and have same spin.

134. **Statement-I :** p-orbital has dumb-bell shape.

Because

Statement-II : Electrons present in p-orbital can have one of three values for 'm', i.e. 0, +1, −1.

135. **Statement-I :** The ground state configuration of Cr is $3d^5\ 4s^1$.

Because

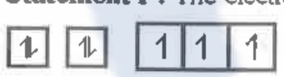
Statement-II : A set of exactly half filled orbitals containing parallel spin arrangement provide extra stability.

136. **Statement-I :** Limiting line in the balmer series has a wavelength of 36.4 μm.

Because

Statement-II : Limiting lines is obtained for a jump of electron from n = ∞ to n = 2 for Balmer series.

137. **Statement-I :** The electronic configuration of nitrogen atom is represented as :



not as

Because

Statement-II : The configuration of ground state of an atom is the one which has the greatest multiplicity.

138. **Statement-I :** The configuration of B atom cannot be $1s^2\ 2s^3$.

Because

Statement-II : Hund's rule demands that the configuration should display maximum multiplicity.

139. **Statement-1 :** The groundstate configuration of Cr is [Ar] $3d^5 4s^1$

Statement-2 : The energy of atom is lesser in $3d^5\ 4s^1$ configuration compared to $3d^4\ 4s^2$ configuration.

140. **Statement-1 :** Minimum principal quantum number of an orbital belonging to 'g' sub-shell is 5.

Statement-2 : For a given value of principal quantum number (n), *l* may have values 0 to (n−1) only.

ANSWERS

- **SINGLE CHOICE CORRECT QUESTIONS**

1. (A)	**2.** (A)	**3.** (A)	**4.** (A)	**5.** (C)
6. (A)	**7.** (C)	**8.** (A)	**9.** (B)	**10.** (C)
11. (C)	**12.** (B)	**13.** (D)	**14.** (D)	**15.** (A)
16. (B)	**17.** (A)	**18.** (C)	**19.** (B)	**20.** (B)
21. (C)	**22.** (C)	**23.** (C)	**24.** (D)	**25.** (D)
26. (B)	**27.** (B)	**28.** (A)	**29.** (D)	**30.** (B)
31. (D)	**32.** (B)	**33.** (A)	**34.** (C)	**35.** (D)
36. (A)	**37.** (B)	**38.** (D)	**39.** (A)	**40.** (D)
41. (D)	**42.** (B)	**43.** (D)	**44.** (C)	**45.** (C)
46. (A)	**47.** (B)	**48.** (C)	**49.** (A)	**50.** (C)
51. (C)	**52.** (B)	**53.** (D)	**54.** (A)	**56.** (C)
57. (D)	**58.** (C)			

- **MULTIPLE CHOICE CORRECT QUESTIONS**

59. (ACD)	**60.** (AC)	**61.** (ABCD)	**62.** (AC)	**63.** (ACD)
64. (ABC)	**65.** (BCD)	**66.** (AD)	**67.** (BC)	

- **COMPREHENSION BASED QUESTIONS**

68. (B)	**69.** (A)	**70.** (A)	**71.** (D)	**72.** (C)
73. (D)				

- **MATRIX MATCH QUESTIONS**

74. (A) - (t), (B) - (s), (C) - (u), (D) - (q), (E) - (p), (F) - (r)

75. (A)- (q), (B)- (p), (C) - (r), (D) - (s)

- **NUMERICAL ANSWER BASED QUESTIONS**

76. (16)	**77.** (72)	**78.** (818)	**79.** (3)	**80.** (18)
81. (497)	**82.** (6)			

- **SUBJECTIVE QUESTIONS**

83. (a) n = 2, (b) 14.4 eV, (c) 13.5eV, 0.7eV

84. 6 ; 489.6 eV, 25.28 A°

85. 300.89 A°, 2.645×10^{-9} cm

86. (a) 75 eV ; (b) 1.414 A° ; (c) 2×10^{-14} m

87. $R\left(\frac{8}{9}\right)$

88. 4863 Å

89. 1.827×10^5 J/mol

90. 1403 kJ/mol

91. -1.36×10^{-19} Joules

92. 5.425×10^{-12} ergs, 3.7×10^{-5} cm

93. 2 ; 9.75×10^4 cm^{-1}

94. 113.74 Å

95. 10.2 eV, Z=2

96. 292.68×10^{21} atoms, 162.60×10^{21} atoms, 832.50 kJ

97. 3.63×10^6 m^{-1}

98. 3.09×10^8 cm/sec

99. 938 Å

100. 8×10^6

101. **(a)** 15.6 eV
(b) 233.9 nm,
(c) 1.008×10^7 m^{-1}
(d) (i) electron will not interact (ii) 0.7 eV

102. 28 photons

103. 10^{22}

104. 1.35×10^5

105. Brackett ; 2.63×10^{-4} m

106. 4.5×10^{14} s^{-1}

107. 319.2 kJ/mol

108. 6.57×10^{-34} Js

109. 0.62 Å

110. 3.06 V

111. 0.79 Å

112. 6.03×10^{-4} volt

113. 1.05×10^{-13} m

114. 0.0826 volts

115. 3.3×10^{-18} J

116. 0.527

117. 8.68 %

118. 2.186×10^{-20} Joules
119. 3.88 pm
120. 3.68×10^{-65} m
121. 1.75×10^{-29}
122. 0.0144 m
123. (i) 28, 76 ; (ii) (0) ; (iii) (3)
124. 1.096×10^{7} m^{-1}
125. 1220 A°
126. 331.13×10^{4}J
127. 6530×10^{12} Hz
128. $n_1 = 4$, $n_2 = 6$, 2.63×10^{-4} cm
129. six, 18800 Å
130. (a) $r_0 = 2a_0$; (b) 6.626×10^{-35} m
131. (a) 2.197×10^{6} m/s; (b) 3.31 Å; (c) $\sqrt{2}.\frac{h}{2\pi}$

- **ASSERTION–REASON QUESTIONS**

132. (A) **133.** (A) **134.** (B) **135.** (A) **136.** (A)
137. (A) **138.** (B) **139.** (A) **140.** (A)