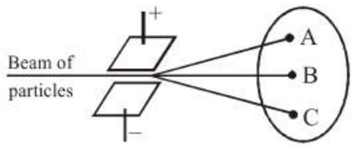
STRUCTURE OF ATOM

FACT/DEFINITION TYPE QUESTIONS

1. Which of the scientist were able to prove that atom is no longer non-divisible?
   (a) Dalton (b) Michael Faraday
   (c) Thomson (d) Chadwick
2. Which of the following is never true for cathode rays ?
   (a) They possess kinetic energy.
   (b) They are electromagnetic waves.
   (c) They produce heat.
   (d) They produce mechanical pressure.
3. Cathode rays are deflected by
   (a) an electric field only (b) magnetic field only
   (c) by both (d) by none
4. Which of the following statement is not correct about the characteristics of cathode rays?
   (a) They start from the cathode and move towards the anode.
   (b) They travel in straight line in the absence of an external electrical or magnetic field.
   (c) Characteristics of cathode rays do not depend upon the material of electrodes in cathode ray tube.
   (d) Characteristics of cathode rays depend upon the nature of gas present in the cathode ray tube.
5. Which of the following statements about the electron is incorrect?
   (a) It is negatively charged particle
   (b) The mass of electron is equal to the mass of neutron.
   (c) It is a basic constituent of all atoms.
   (d) It is a constituent of cathode rays.
6. While performing cathode ray experiments, it was observed that there was no passage of electric current under normal conditions. Which of the following can account for this observation ?
   (a) Dust particles are present in air
   (b) Carbon dioxide is present in air
   (c) Air is a poor conductor of electricity under normal conditions
   (d) None of the above
7. Which is not true with respect to cathode rays?
   (a) A stream of electrons
   (b) Charged particles
   (c) Move with speed same as that of light
   (d) Can be deflected by magnetic fields
8. What is the optimum conditions required to study the conduction of electricity through gases.
   (a) High pressure and low voltage
   (b) High pressure and high voltage
   (c) Low pressure and high voltage
   (d) Low pressure and low voltage
9. In discharge tube experiment stream of negatively charged particles travel from
   (a) anode to cathode (b) cathode to anode
   (c) Both (a) and (b) (d) Electrons does not travel
10. Millikan performed an experiment method to determine which of the following ?
    (a) Mass of the electron (b) Charge of the electron
    (c) e/m ratio of electron (d) Both (a) and (b)
11. The discovery of neutron became very late because :
    (a) neutrons are present in nucleus
    (b) neutrons are chargeless
    (c) neutrons are fundamental particles
    (d) all of the above
12. Which is correct statement about proton ?
    (a) Proton is nucleus of deuterium
    (b) Proton is α-particle
    (c) Proton is ionized hydrogen molecule
    (d) Proton is ionized hydrogen atom
13. The lightest particle is :
    (a) α -particle (b) positron
    (c) proton (d) neutron
14. When beryllium is bombarded with alpha particles (Chadwick's experiment) extremely penetrating radiations, which cannot be deflected by electrical or magnetic field are given out. These are :
    (a) A beam of protons
    (b) Alpha rays
    (c) A beam of neutrons
    (d) A beam of neutrons and protons

15. Neutron is discovered by
(a) Chadwick (b) Rutherford
(c) Yukawa (d) Dalton

16. Suppose beam containing all three fundamental subatomic particles are allowed to pass through an electric field as shown in figure. The subatomic particles detected at three points A, B and C on the screen respectively are ?



(a) Protons, neutrons, electrons
(b) Electrons, neutrons, protons
(c) Electrons, protons, neutrons
(d) Neutrons, protons, electrons

17. Which of the following properties of atom could be explained correctly by Thomson Model of atom?
(a) Overall neutrality of atom.
(b) Spectra of hydrogen atom.
(c) Position of electrons, protons and neutrons in atom.
(d) Stability of atom.

18. Arrange the following in terms of penetrating power.
α-rays, β-rays, γ-rays
(a) $\alpha > \beta > \gamma$ (b) $\alpha < \beta < \gamma$
(c) $\alpha > \beta < \gamma$ (b) $\alpha > \gamma > \beta$

19. Which of the rays are not deflected by the electric and magnetic field ?
(a) γ-rays (b) X-rays
(c) β-rays (d) Both (a) and (b)

20. Rutherford's experiment on the scattering of α -particles showed for the first time that the atom has :
(a) electrons (b) protons
(c) nucleus (d) neutrons'

21. When atoms are bombarded with alpha particles, only, a few in million suffer deflection, others pass out undeflected. This is because
(a) the force of repulsion on the moving alpha particle is small
(b) the force of attraction between alpha particle and oppositely charged electrons is very small
(c) there is only one nucleus and large number of electrons
(d) the nucleus occupies much smaller volume compared to the volume of the atom

22. Rutherford's α-particle dispersion experiment concludes
(a) all positive ions are deposited at small part
(b) all negative ions are deposited at small part
(c) proton moves around the electron
(d) neutrons are charged particles.

23. Rutherford's experiment which established the nuclear model of the atom used a beam of
(a) β-particles which impinged on a metal foil and got absorbed
(b) γ-rays which impinged on a metal foil and ejected electrons
(c) helium atoms, which impinged on a metal foil and got scattered
(d) helium nuclei, which impinged on a metal foil and got scattered

24. Which of the following scientists explained his model on the basis of centrifugal force ?
(a) Thomson (b) Dalton
(c) Millikan (d) Rutherford

25. The number of neutrons in dipositive zinc ion with mass number 70 is
(a) 34 (b) 36
(c) 38 (d) 40

26. The number of electrons in $\left[{}^{40}_{19}\text{K}\right]^{1-}$ is
(a) 20 (b) 40
(c) 18 (d) 19

27. Which of the following does not contain number of neutrons equal to that of ${}^{40}_{18}\text{Ar}$?
(a) ${}^{41}_{19}\text{K}$ (b) ${}^{43}_{21}\text{Sc}$
(c) ${}^{40}_{21}\text{Sc}$ (d) ${}^{42}_{20}\text{Ca}$

28. Number of protons, neutrons and electrons in the element ${}_{89}\text{X}^{231}$ is
(a) 89, 89, 242 (b) 89, 142, 89
(c) 89, 71, 89 (d) 89, 231, 89

29. An element has atomic number 11 and mass number 24. What does the nucleus contain?
(a) 11 protons, 13 neutrons
(b) 11 protons, 13 neutrons, 13 electrons
(c) 13 protons, 11 neutrons
(d) 13 protons, 11 electrons

30. The number of electrons and neutrons of an element is 18 and 20 respectively. Its mass number is
(a) 2 (b) 17
(c) 37 (d) 38

31. 'A' represents mass no. and Z represents atomic no. then α - decay is characterized by
(a) Z increases by 2, A decreases by 4
(b) Z decreases by 2, A increases by 4
(c) Z decreases by 2, A decreases by 4
(d) Z increases by 2, A increases by 4.

32. Nucleons are
(a) only neutrons
(b) neutrons + protons
(c) neutrons + protons + electrons
(d) neutrons + electrons

33. Atoms with same mass number but different atomic numbers are called
(a) isotopes (b) isobars
(c) isochores (d) None of these

34. Which of the following pairs will have same chemical properties ?

(a) $^{14}_{6}C$ and $^{15}_{7}N$ (b) O^{2-} and F^{-}

(c) $^{40}_{18}Ar$ and $^{40}_{19}K$ (d) $^{35}_{17}Cl$ and $^{37}_{17}Cl$

35. What is the difference between two species if one has atomic mass = 14 and atomic number = 7 whereas the other has atomic mass = 14 and atomic number = 6 ?

(a) Neutrons (b) Protons

(c) Electrons (d) All of these

36. From the data given below A, B, C and D respectively are,

(A) 10 e^-, atomic no. 11 (B) 10 e^-, atomic no. 6

(C) 10 e^-, atomic no. 10 (D) 10 e^-, atomic no. 9

(a) Na^+, C^{4-}, Ne, F^- (b) C^{4-}, Ne, Na^-, F^-

(c) F^-, Na^+, Ne, C^{4-} (d) F^-, Na^+, C^{4-}, Ne

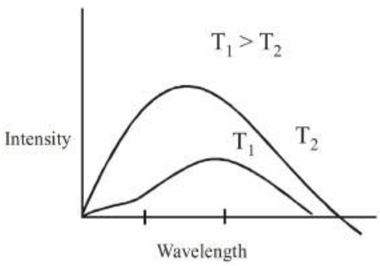
37. If the wavelength of the electromagnetic radiation is increased to thrice the digital value, then what will be the percent change in the value of frequency of the electromagnetic radiation.

(a) Increases by 33% (b) Decreases by 33%

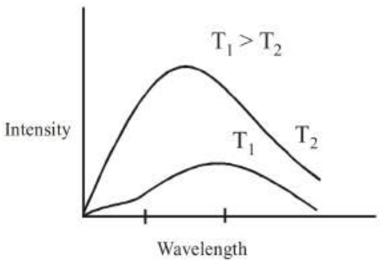
(c) Increases by 66% (d) Decreases by 66%

38. Which is the correct schematic representation of the graph of black body radiation.

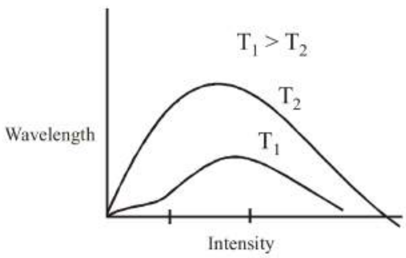
(a)



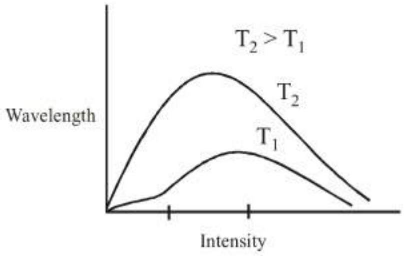
(b)



(c)



(d)



39. The ideal body, which emits and absorbs radiations of all frequencies, is called a black body and the radiation emitted by such a body is called

(a) white body radiation (b) black body radiation

(c) black body emission (d) None of these

40. Which one of the following is not the characteristic of Planck's quantum theory of radiation ?

(a) The energy is not absorbed or emitted in whole number or multiple of quantum

(b) Radiation is associated with energy

(c) Radiation energy is not emitted or absorbed continuously but in the form of small packets called quanta

(d) This magnitude of energy associated with a quantum is proportional to the frequency.

41. Which of the following is related with both wave nature and particle nature ?

(a) Interference (b) $E = mc^2$

(c) Diffraction (d) $E = h\nu$

42. The value of Planck's constant is 6.63×10^{-34} Js. The velocity of light is 3.0×10^8 m s^{-1}. Which value is closest to the wavelength in nanometers of a quantum of light with frequency of 8×10^{15} s^{-1} ?

(a) 3×10^7 (b) 2×10^{-25}

(c) 5×10^{-18} (d) 4×10^1

43. In the photo-electron emission, the energy of the emitted electron is

(a) greater than the incident photon

(b) same as than of the incident photon

(c) smaller than the incident photon

(d) proportional to the intensity of incident photon

44. When a metal surface is exposed to solar radiations

(a) The emitted electrons have energy less than a maximum value of energy depending upon frequency of incident radiations

(b) The emitted electrons have energy less than maximum value of energy depending upon intensity of incident radiation

(c) The emitted electrons have zero energy

(d) The emitted electrons have energy equal to energy of photons of incident light

45. In photoelectric effect, at which frequency electron will be ejected with certain kinetic energy (ν_0 = threshold frequency).

(a) $\nu > \nu_0$ (b) $\nu_0 > \nu$

(c) $\nu_0 \geq \nu$ (d) $\nu \geq \nu_0$

46. In continous spectrum light of (i) wavelength is deviated the ii
(a) (i) = longest, least (b) (ii) = shortest, least
(c) (i) = shortest, most (d) (i) = longest, most

47. Which of the following statements do not form a part of Bohr's model of hydrogen atom ?
(a) Energy of the electrons in the orbits are quantized
(b) The electron(s) in the orbit nearest to the nucleus has the lowest energy
(c) Electrons revolve in different orbits around the nucleus
(d) The position and velocity of the electrons in the orbit cannot be determined simultaneously

48. An electron from one Bohr stationary orbit can go to next higher orbit
(a) by emission of electromagnetic radiation
(b) by absorption of any electromagnetic radiation
(c) by absorption of electromagnetic radiation of particular frequency
(d) without emission or absorption of electromagnetic radiation

49. For a Bohr atom angular momentum M of the electron is ($n = 0, 1, 2, ...$):
(a) $\frac{nh^2}{4\pi}$ (b) $\frac{n^2h^2}{4\pi}$
(c) $\frac{\sqrt{nh^2}}{4\pi}$ (d) $\frac{nh}{2\pi}$

50. According to Bohr's theory, the angular momentum of an electron in 5^{th} orbit is
(a) $10\, h/\pi$ (b) $2.5\, h/\pi$
(c) $25\, h/\pi$ (d) $1.0\, h/\pi$

51. In Bohr's model, atomic radius of the first orbit is y, the radius of the 3^{rd} orbit, is
(a) $y/3$ (b) y
(c) $3y$ (d) $9y$

52. The radius of 1^{st} Bohr's orbit for hydrogen atom is 'r'. The radius of second Bohr's orbit is
(a) 4r (b) r^3
(c) $4r^2$ (d) $r^{1/3}$

53. The third line of the Balmer series, in the emission spectrum of the hydrogen atom, is due to the transition from the
(a) fourth Bohr orbit to the first Bohr orbit
(b) fifth Bohr orbit to the second Bohr orbit
(c) sixth Bohr orbit to the third Bohr orbit
(d) seventh Bohr orbit to the third Bohr orbit

54. Which one of the following pairs is not correctly matched ?
(a) Rutherford-Proton
(b) J.J. Thomson-Electron
(c) J.H. Chadwick-Neutron
(d) Bohr-Isotopes

55. If r is the radius of the first orbit, the radius of n^{th} orbit of H-atom is given by
(a) rn^2 (b) rn
(c) r/n (d) $r^2 n^2$

56. The radius of hydrogen atom in the ground state is 0.53 Å. The radius of Li^{2+} ion (atomic number = 3) in a similar state is
(a) 0.17 Å (b) 0.265 Å
(c) 0.53 Å (d) 1.06 Å

57. The energy of an electron in the n^{th} Bohr orbit of hydrogen atom is
(a) $-\frac{13.6}{n^4}$eV (b) $-\frac{13.6}{n^3}$eV
(c) $-\frac{13.6}{n^2}$eV (d) $-\frac{13.6}{n}$eV

58. The energy of second Bohr orbit of the hydrogen atom is -328 kJ mol^{-1}; hence the energy of fourth Bohr orbit would be:
(a) -41 kJ mol^{-1} (b) -82 kJ mol^{-1}
(c) -164 kJ mol^{-1} (d) -1312 kJ mol^{-1}

59. In a hydrogen atom, if energy of an electron in ground state is 13.6. eV, then that in the 2^{nd} excited state is
(a) 1.51 eV (b) 3.4 eV
(c) 6.04 eV (d) 13.6 eV.

60. The energy of an electron in second Bohr orbit of hydrogen atom is :
(a) -5.44×10^{-19}eV (b) -5.44×10^{-19}cal
(c) -5.44×10^{-19}kJ (d) -5.44×10^{-19}J

61. The energy of electron in first energy level is -21.79×10^{-12} erg per atom. The energy of electron in second energy level is :
(a) -54.47×10^{-12} erg atom^{-1}
(b) -5.447×10^{-12} erg atom^{-1}
(c) -0.5447×10^{-12} erg atom^{-1}
(d) -0.05447×10^{-12} erg atom^{-1}

62. The ionisation potential of a hydrogen atom is -13.6 eV. What will be the energy of the atom corresponding to n = 2.
(a) -3.4 eV (b) -6.8 eV
(c) -1.7 eV (d) -2.7 eV

63. The line spectrum of He^+ ion will resemble that of
(a) hydrogen atom (b) Li^+ ion
(c) helium atom (d) lithium atom

64. What does negative sign in the electronic energy for hydrogen atom convey.
(a) Energy of electron when n = ∞
(b) The energy of electron in the atom is lower than the energy of a free electron in motion
(c) The energy of electron in the atom is lower than the energy of a free electron of rest
(d) The energy of electron decreases as it moves away from nucleus

65. In which of the following Bohr's stationary state, the electron will be at maximum distance from the nucleus ?
(a) IInd (b) Ist
(c) Vth (d) IIIrd

66. The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be (Rydberg constant = $1.097\times10^7\ m^{-1}$)
(a) 406 nm (b) 192 nm
(c) 91 nm (d) 9.1×10^{-8} nm

67. The frequency of radiation emitted when the electron falls from $n = 4$ to $n = 1$ in a hydrogen atom will be (Given : ionization energy of H=2.18×10^{-18}J atom^{-1} and $h = 6.625\times10^{-34}$ J s)
(a) $1.54\times10^{15}\ s^{-1}$ (b) $1.03\times10^{15}\ s^{-1}$
(c) $3.08\times10^{15}\ s^{-1}$ (d) $2.00\times10^{15}\ s^{-1}$

68. Which of the following transitions of electrons in the hydrogen atom will emit maximum energy?
(a) $n_5 \rightarrow n_4$ (b) $n_4 \rightarrow n_3$
(c) $n_3 \rightarrow n_2$ (d) all will emit same energy

69. The first emission line of hydrogen atomic spectrum in the Balmer series appears is (R = Rydberg constant)
(a) $\frac{5}{36}R\ cm^{-1}$ (b) $\frac{3}{4}R\ cm^{-1}$
(c) $\frac{7}{144}R\ cm^{-1}$ (d) $\frac{9}{400}R\ cm^{-1}$

70. According to the Bohr theory, which of the following transitions in the hydrogen atom will give rise to the least energetic photon ?
(a) n = 6 to n = 1 (b) n = 5 to n = 4
(c) n = 6 to n = 5 (d) n = 5 to n = 3

71. The wavelength (in cm) of second line in the Lyman series of hydrogen atomic spectrum is (Rydberg constant = R cm^{-1})
(a) $\left(\frac{8R}{9}\right)$ (b) $\left(\frac{9}{8R}\right)$
(c) $\left(\frac{4}{3R}\right)$ (d) $\left(\frac{3R}{4}\right)$

72. The shortest wavelength in hydrogen spectrum of Lyman series when $R_H = 109678\ cm^{-1}$ is
(a) 1002.7Å (b) 1215.67Å
(c) 1127.30Å (d) 911.7Å

73. What is the expression of frequency (ν) associated with absorption spectra of the photon.
(a) $\nu = \frac{R_H}{h}\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) n_i > n_f$
(b) $\nu = \frac{R_H}{h}\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) n_f > n_i$
(c) $\nu = -\frac{R_H}{h}\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) n_f > n_i$
(d) All the above are correct

74. Bohr model can explain :
(a) the solar spectrum
(b) the spectrum of hydrogen molecule
(c) spectrum of any atom or ion containing one electron only
(d) the spectrum of hydrogen atom only

75. Which of the following statements do not form a part of Bohr's model of hydrogen atom ?
(a) Energy of the electrons in the orbits are quantized
(b) The electron in the orbit nearest the nucleus has the lowest energy
(c) Electrons revolve in different orbits around the nucleus
(d) The position and velocity of the electrons in the orbit cannot be determined simultaneously.

76. Bohr's theory can be applied to which of the following ions.
(a) Na^+ (b) Be^{2+}
(c) Li^+ (d) Li^{2+}

77. Bohr's model is not able to account for which of the following.
(a) Stability of atom.
(b) Spectrum of neutral helium atom.
(c) Energy of free electron at rest.
(d) Calculation of radii of the stationary states.

78. If electron, hydrogen, helium and neon nuclei are all moving with the velocity of light, then the wavelength associated with these particles are in the order
(a) Electron > hydrogen > helium > neon
(b) Electron > helium > hydrogen > neon
(c) Electron < hydrogen < helium < neon
(d) Neon < hydrogen < helium < electron

79. 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^{-31} metres (b) 10^{-16} metres
(c) 10^{-25} metres (d) 10^{-33} metres
Planck's constant, $h = 6.63\times10^{-34}$ Js

80. If the energy difference between the ground state of an atom and its excited state is 4.4×10^{-4} J, the wavelength of photon required to produce the transition :
(a) 2.26×10^{-12} m (b) 1.13×10^{-12} m
(c) 4.52×10^{-16} m (d) 4.52×10^{-12} m

81. The mass of a photon with a wavelength equal to 1.54×10^{-8} cm is
(a) 0.8268×10^{-34} kg (b) 1.2876×10^{-33} kg
(c) 1.4285×10^{-32} kg (d) 1.8884×10^{-32} kg

82. If the Planck's constant $h = 6.6\times10^{-34}$ Js, the de Broglie wavelength of a particle having momentum of 3.3×10^{-24} kg ms^{-1} will be
(a) 0.002 Å (b) 0.5Å
(c) 2Å (d) 500Å

83. The values of Planck's constant is 6.63×10^{-34} Js. The velocity of light is 3.0×10^8 m s^{-1}. Which value is closest to the wavelength in nanometres of a quantum of light with frequency of 8×10^{15} s^{-1}?
(a) 5×10^{-18} (b) 4×10^1
(c) 3×10^7 (d) 2×10^{-25}

84. The de Broglie wavelength of a car of mass 1000 kg and velocity 36 km/hr is :
(a) 6.626×10^{-34} m (b) 6.626×10^{-38} m
(c) 6.626×10^{-31} m (d) 6.626×10^{-30} m

85. Heisenberg uncertainty principle can be explained as
(a) $\Delta x \geq \frac{\Delta P \times h}{4\pi}$ (b) $\Delta x \times \Delta P \geq \frac{h}{4\pi}$
(c) $\Delta x \times \Delta P \geq \frac{h}{\pi}$ (d) $\Delta P \geq \frac{\pi h}{\Delta x}$

86. Heisenberg's uncertainity principle is applicable to
(a) atoms only (b) electron only
(c) nucleus only (d) any moving object

87. The position of both, an electron and a helium atom is known within 1.0 nm. Further the momentum of the electron is known within 5.0×10^{-26} kg ms^{-1}. The minimum uncertainty in the measurement of the momentum of the helium atom is
(a) 50 kg ms^{-1} (b) 80 kg ms^{-1}
(c) 8.0×10^{-26} kg ms^{-1} (d) 5.0×10^{-26} kg ms^{-1}

88. 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) 1.92×10^{-2} m (b) 3.84×10^{-2} m
(c) 19.2×10^{-2} m (d) 5.76×10^{-2} m

89. The uncertainty in the position of an electron (mass = 9.1×10^{-28} g) moving with a velocity of 3.0×10^4 cm s^{-1} accurate upto 0.011% will be
(a) 1.92 cm (b) 7.68 cm
(c) 0.175 cm (d) 3.84 cm.

90. The Heisenberg uncertainity principle will be most significant for which of the following object ?
(a) Object A of mass 9.11×10^{-30} kg
(b) Object B of mass 9.11×10^{-28} g
(c) Object C of mass 9.11×10^{-24} mg
(d) Object D of mass 9.11×10^{-28} kg

91. The orientation of an atomic orbital is governed by
(a) Spin quantum number
(b) Magnetic quantum number
(c) Principal quantum number
(d) Azimuthal quantum number

92. For which one of the following sets of four quantum numbers, an electron will have the heighest energy?

	n	l	m	s
(a)	3	2	1	1/2
(b)	4	2	–1	1/2
(c)	4	1	0	–1/2
(d)	5	0	0	–1/2

93. Which of the following sets of quantum numbers is correct for an electron in 4f orbital ?
(a) $n=4, \ell=3, m=+1, s=+½$
(b) $n=4, \ell=4, m=-4, s=-½$
(c) $n=4, \ell=3, m=+4, s=+½$
(d) $n=3, \ell=2, m=-2, s=+½$

94. What is the correct orbital designation of an electron with the quantum number, $n=4$, $\ell=3$, $m=-2$, $s=1/2$?
(a) 3s (b) 4f
(c) 5p (d) 6s

95. Which of the following represents correct set of the four quantum numbers for an electron in a 4d subshell ?
(a) 4, 2, 1, 0 (b) 4, 2, 1, – 1/2
(c) 4, 3, 2, + 1/2 (d) 4, 3, –2, – 1/2

96. The total number of electrons that can be accommodated in all orbitals having principal quantum number 2 and azimuthal quantum number 1 is
(a) 2 (b) 4
(c) 6 (d) 8

97. For azimuthal quantum number $\ell=3$, the maximum number of electrons will be
(a) 2 (b) 6
(c) 0 (d) 14

98. Which of the following is **not** permissible arrangement of electrons in an atom?
(a) $n=5, l=3, m=0, s=+1/2$
(b) $n=3, l=2, m=-3, s=-1/2$
(c) $n=3, l=2, m=-2, s=-1/2$
(d) $n=4, l=0, m=0, s=-1/2$

99. Which of the following sets of quantum numbers represents the highest energy of an atom?
(a) $n=3, l=0, m=0, s=+1/2$
(b) $n=3, l=1, m=1, s=+1/2$
(c) $n=3, l=2, m=1, s=+1/2$
(d) $n=4, l=0, m=0, s=+1/2$

100. Which set of quantum numbers are not possible?

	n	l	m	s
(a)	3	2	0	+1/2
(b)	2	2	1	+1/2
(c)	1	0	0	–1/2
(d)	3	2	–2	+1/2

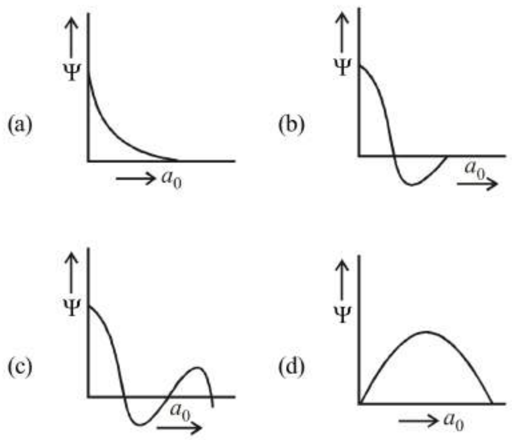
101. What will be the sum of all possible values of l and m for $n=5$?
(a) 12 (b) 13
(c) 4 (d) 9

102. The following quantum numbers are possible for how many orbital(s) $n=3, l=2, m=+2$?
(a) 1 (b) 3
(c) 2 (d) 4

103. The orbitals are called degenerate when
(a) they have the same wave functions
(b) they have the same wave functions but different energies
(c) they have different wave functions but same energy
(d) they have the same energy

104. The number of spherical nodes in 3p orbitals are
(a) one (b) three
(c) two (d) None of these

105. Which of the following graph correspond to one node



106. If there are five radial nodes, then what can be the correct representation of the orbital for n = 8.
(a) 8d (b) 8s
(c) 8p (d) 8f

107. What can be the representation of the orbital having 3 angular nodes and $n = 5$.
(a) 5d (b) 5f
(c) 5p (d) 5s

108. The number of orbitals present in the fifth shell will be
(a) 25 (b) 10
(c) 50 (d) 20

109. Arrange the orbital of same shell in the increasing order of shielding strength of the outer shell of electrons.
s, f, d, p
(a) s < p < d < f (b) s > p < d < f
(c) s > p > d < f (d) s > p > d > f

110. Which of the following is not correct for electronic distribution in the ground state ?
(a) Co [Ar] [⇅] [⇅][⇅][ ][ ][ ]
(b) Ni [Ar] [⇅] [⇅][⇅][⇅][ ][ ]
(c) Cu [Ar] [⇅] [⇅][⇅][⇅][⇅][ ]
(d) All of the above

111. The electronic configuration of gadolinium (Atomic number 64) is
(a) [Xe] $4f^8 5d^0 6s^2$ (b) [Xe] $4f^3 5d^5 6s^2$
(c) [Xe] $4f^6 5d^2 6s^2$ (d) [Xe] $4f^7 5d^1 6s^2$

112. The order of filling of electrons in the orbitals of an atom will be
(a) 3*d*, 4*s*, 4*p*, 4*d*, 5*s* (b) 4*s*, 3*d*, 4p, 5*s*, 4*d*
(c) 5*s*, 4p, 3*d*, 4*d*, 5s (d) 3*d*, 4*p*, 4*s*, 4*d*, 5*s*

113. The number of *d*-electrons retained in Fe^{2+} (At. no. of Fe = 26) ion is
(a) 4 (b) 5
(c) 6 (d) 3

114. 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) anionic form

115. Number of unpaired electrons in N^{2+} is
(a) 2 (b) 0
(c) 1 (d) 3

116. An ion has 18 electrons in the outermost shell, it is
(a) Cu^+ (b) Th^{4+}
(c) Cs^+ (d) K^+

117. In a given atom no two electrons can have the same values for all the four quantum numbers. This is called
(a) Hund's Rule (b) Aufbau principle
(c) Uncertainty principle (d) Pauli's exclusion principle

118. The electronic configuration of Cu (atomic number 29) is
(a) $1s^2, 2s^2 2p^6, 3s^2 3p^6, 4s^2 3d^9$
(b) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^1$
(c) $1s^2, 2s^2 2p^6, 3p^2 3p^6, 4s^2 4p^6, 5s^2 5p^1$
(d) $1s^2, 2s^2 2p^6, 3p^2 3p^6, 4s^2 4p^6 3d^3$

119. The orbital diagram in which the Aufbau principle is violated is :

	2s	**2p**
(a)	[↑↓]	[↑↓][↑][ ]
(b)	[↑]	[↑↓][↑][↑]
(c)	[↑↓]	[↑][↑][↑]
(d)	[↑↓]	[↑↓][↑][↑]

120. If n = 6, the correct sequence for filling of electrons will be :
(a) ns → (n – 2) f → (n – 1) d → np
(b) ns → (n – 1) d → (n – 2) f → np
(c) ns → (n – 2) f → np → (n – 1) d
(d) ns → np (n – 1) d → (n – 2) f

121. Maximum number of electrons in a subshell of an atom is determined by the following:
(a) $2l + 1$ (b) $4l - 2$
(c) $2n^2$ (d) $4l + 2$

122. The correct order of increasing energy of atomic orbitals is
(a) $5p < 4f < 6s < 5d$ (b) $5p < 6s < 4f < 5d$
(c) $5p < 5d < 4f < 6s$ (d) None of these

123. For which element, the valence electron will be present in the highest energy orbital.

(a) $_3Li$ (b) $_{16}S$

(c) $_{20}Ca$ (d) $_{21}Sc$

124. Which of the following electronic configuration of d-orbital will have highest affinity for gaining an electron?

(a) | ↑↓ | ↑↓ | ↑↓ | ↑ | ↑ |

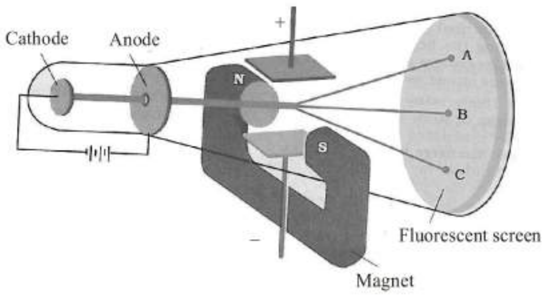
(b) | ↑↓ | ↑↓ | ↑ | ↑ | ↑ |

(c) | ↑↓ | ↑ | ↑ | ↑ | ↑ |

(d) | ↑↓ | ↑↓ | ↑↓ | ↑↓ | ↑ |

STATEMENT TYPE QUESTIONS

125. On the basis of figure given below which of the following statement(s) is/are correct ?



(i) At point B, when only electric field is applied.

(ii) At point C, when both electric and magnetic field is applied.

(iii) At point B, when both electric and magnetic fields are balanced.

(iv) At point C, when only magnetic field is applied.

Which of the following is/are correct?

(a) (i) and (ii) (b) only (iii)

(c) (iii) and (iv) (d) (i) and (iii)

126. Which of the following statements are not correct about electromagnetic radiation ?

(i) Electromagnetic waves require medium to travel.

(ii) Different electromagnetic radiations travel at same speed in vaccum.

(iii) The oscillating electric and magnetic fields produced by oscillating charged particles are perpendicular to each other, but not to the direction of propagation.

(iv) The oscillating electric field and magnetic field are perpendicular to each other, and also to the direction of propagation.

(a) (i), (ii) and (iii) (b) (ii) and (iii)

(c) (i) and (iii) (d) (i) and (iv)

127. Which of the following statement(s) is/are incorrect regarding photoelectric effect?

(i) The number of electrons ejected is proportional to the intensity of light.

(ii) There is some time lag between the striking of light beam on the metal surface and the ejection of electrons.

(iii) The kinetic energy of ejected electrons depends upon the brightness of light.

(iv) The kinetic energy of the ejected electron is proportional to the frequency of the incident radiation.

(a) (i) and (ii) (b) (ii) and (iii)

(c) (ii) only (d) (ii) and (iv)

128. For Balmer series in the spectrum of atomic hydrogen, the wave number of each line is given by $\bar{v} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

where R_H is a constant and n_1 and n_2 are integers. Which of the following statement(s) is (are) correct?

(i) As wavelength decreases, the lines in the series converge.

(ii) The integer n_1 is equal to 2.

(iii) The ionization energy of hydrogen can be calculated from the wave number of these lines.

(iv) The line of longest wavelength corresponds to $n_2 = 3$.

(a) (i), (ii) and (iii) (b) (ii), (iii) and (iv)

(c) (i), (i) and (iv) (d) (ii) and (iv)

129. Which of the following statements of quantum mechanics was in agreement with Bohr's model?

(i) The path of an electron in an atom can never be determined accurately.

(ii) The energy of electrons in atom is quantized i.e., can only have specific values.

(iii) An orbital cannot contain more than two electrons.

(a) Only (i) (b) (i) and (ii)

(c) Only (ii) (d) (ii) and (iii)

130. Which of the following statements concerning the quantum numbers are correct ?

(i) Angular quantum number determines the three-dimensional shape of the orbital.

(ii) The principal quantum number determines the orientation and energy of the orbital.

(iii) Magnetic quantum number determines the size of the orbital.

(iv) Spin quantum number of an electron determines the orientation of the spin of electron relative to the chosen axis.

The correct set of option is

(a) (i) and (ii) (b) (i) and (iv)

(c) (iii) and (iv) (d) (ii), (iii) and (iv)

MATCHING TYPE QUESTIONS

131. Match the columns.

Column-I		Column-II	
(A)	${}_1^1H, {}_1^2H$ and ${}_1^3H$	(p)	Isobars
(B)	${}_6^{14}C$ and ${}_7^{14}N$	(q)	Isotopes
(C)	Na^+ and Mg^{2+}	(r)	Isoelectronic species

(a) A – (p), B – (q), C – (r)
(b) A – (q), B – (p), C – (r)
(c) A – (r), B – (q), C – (p)
(d) A – (p), B – (r), C – (q)

132. Match the columns.

Column-I		Column-II	
(A)	X-rays	(p)	$\nu = 10^0 - 10^4$ Hz
(B)	UV	(q)	$\nu = 10^{10}$ Hz
(C)	Long radio waves	(r)	$\nu = 10^{16}$ Hz
(D)	Microwave	(s)	$\nu = 10^{18}$ Hz

(a) A – (s), B – (r), C – (p), D – (q)
(b) A – (r), B – (s), C – (p), D – (q)
(c) A – (s), B – (p), C – (r), D – (q)
(d) A – (s), B – (r), C – (q), D – (p)

133. Match the columns.

Column-I		Column-II	
(A)	$\lvert\Psi\rvert^2$	(p)	Energy can be emitted or absorbed in packets
(B)	de Brolie	(q)	Significant only for motion of microscopic objects.
(C)	Heisenberg	(r)	The probability of finding an electron at a point within an atom
(D)	Planck's	(s)	Every object in motion has a wave character.

(a) A – (q), B – (s), C – (r), D – (p)
(b) A – (r), B – (p), C – (q), D – (s)
(c) A – (r), B – (s), C – (q), D – (p)
(d) A – (s), B – (p), C – (r), D – (q)

134. Match the columns.

Column-I (Quantum number)		Column-II (Information provided)	
(A)	Principal quantum number	(p)	orientation of the orbital
(B)	Azimuthal quantum number	(q)	energy and size of orbital
(C)	Magnetic quantum number	(r)	spin of electron
(D)	Spin quantum number	(s)	shape of the orbital

(a) A – (q), B – (s), C – (p), D – (r)
(b) A – (s), B – (q), C – (p), D – (r)
(c) A – (q), B – (p), C – (s), D – (r)
(d) A – (q), B – (s), C – (r), D – (p)

135. Match the columns.

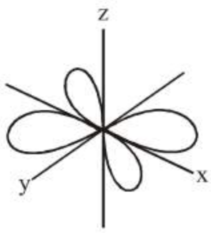
Column-I (Sub shell)		Column-II (Number of orbitals)		Column-III (Angular/Azimuthal Quantum Number)	
(A)	d	(p)	1	(i)	1
(B)	f	(q)	3	(ii)	2
(C)	s	(r)	5	(iii)	0
(D)	p	(s)	7	(iv)	3

(a) A – (r) – (ii), B – (s) – (iv), C – (p) – (iii), D – (q) – (i)
(b) A – (q) – (i), B – (s) – (iv), C – (p) – (iii), D – (r) – (ii)
(c) A – (p) – (iii), B – (s) – (iv), C – (r) – (ii), D – (q) – (i)
(d) A – (r) – (ii), B – (p) – (iii), C – (s) – (iv), D – (q) – (i)

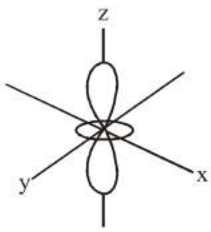
136. Match the columns.

Column-I **Column-II**

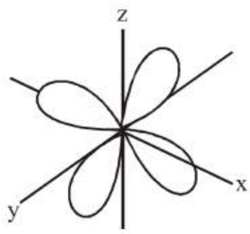
(A) $d_{x^2-y^2}$ (p)



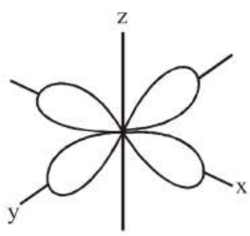
(B) d_{xy} (q)



(C) d_{yz} (r)



(D) d_{z^2} (s)



(a) A – (p), B – (s), C – (r), D – (q)
(b) A – (s), B – (p), C – (r), D – (q)
(c) A – (s), B – (p), C – (q), D – (r)
(d) A – (s), B – (r), C – (p), D – (q)

137. Match the columns

Column-I (Rules)		Column-II (Statements)
(A) Hund's Rule	(p)	No two electrons in an atom can have the same set of four quantum numbers.
(B) Aufbau Principle	(q)	Half-filled and completely filled orbitals have extra stablity.
(C) Pault Exclusion Principle	(r)	Pairing of electrons in the orbitals belonging to the same subshell does not take place until each orbital is singly occupied.
(D) Heisenberg's Uncertainty Principle	(s)	It is impossible to determine the exact position and exact momentum of a subatomic particle simultaneously.
	(t)	In the ground state of atoms, orbitals are filled in the order of their increasing energies.

(a) A – (r), B – (p), C – (t), D – (s)
(b) A – (r), B – (t), C – (s), D – (p)
(c) A – (r), B – (t), C – (p), D – (s)
(d) A – (t), B – (r), C – (p), D – (s)

138. Match the columns.

Column-I (Atom / Ion)		Column-II (Electronic configuration)
(A) Cu	(p)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$
(B) Cu^{2+}	(q)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$
(C) Zn^{2+}	(r)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$
(D) Cr^{3+}	(s)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9$
	(t)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$

(a) A – (s), B – (r), C – (p), D – (t)
(b) A – (r), B – (s), C – (p), D – (t)
(c) A – (r), B – (s), C – (t), D – (p)
(d) A – (r), B – (s), C – (p), D – (s)

ASSERTION-REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

139. **Assertion :** The position of an electron can be determined exactly with the help of an electron microscope.
Reason : The product of uncertainty in the measurement of its momentum and the uncertainty in the measurement of the position cannot be less than a finite limit.

140. **Assertion :** The radius of the first orbit of hydrogen atom is 0.529Å.
Reason : Radius of each circular orbit (r_n) - 0.529Å (n^2/Z), where n = 1, 2, 3 and Z = atomic number.

141. **Assertion :** All isotopes of a given element show the same type of chemical behaviour.
Reason : The chemical properties of an atom are controlled by the number of electrons in the atom.

142. **Assertion :** Black body is an ideal body that emits and absorbs radiations of all frequencies.
Reason : The frequency of radiation emitted by a body goes from a lower frequency to higher frequency with an increase in temperature.

143. **Assertion :** It is impossible to determine the exact position and exact momentum of an electron simultaneously.
Reason : The path of an electron in an atom is clearly defined.

CRITICAL THINKING TYPE QUESTIONS

144. What is the ratio of mass of an electron to the mass of a proton?
(a) 1 : 2 (b) 1 : 1
(c) 1 : 1837 (d) 1 : 3

145. The increasing order for the values of e/m (charge/mass) is
(a) e, p, n, α (b) n, p, e, α
(c) n, p, α, e (d) n, α, p, e

146. In which of the following the amount of deviation from their path in the presence of electric and magnetic field will be maximum?
(a) N^{2-} (b) N^{3-}
(c) N^- (d) N

147. The deflection of the particles from their path in presence of electric and magnetic field will be maximum in which of the following.
(a) O (b) N
(c) U (d) He

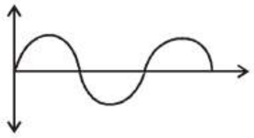
148. Which of the following pairs have identical values of e/m?
(a) A proton and a neutron
(b) A proton and deuterium
(c) Deuterium and an α-particle
(d) An electron and γ-rays

149. If the alpha-particles are projected against the following atoms Fe, Be, Mg, Al then increasing order in which the alpha-particle feel repulsion will be
(a) Be, Mg, Al, Fe (b) Be, Al, Mg, Fe
(c) Mg, Al, Mg, Fe (d) Al, Mg, Fe, Be

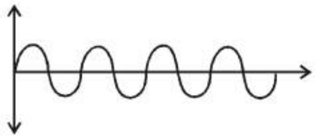
150. Chlorine exists in two isotopic forms, C1-37 and C1-35 but its atomic mass is 35.5. This indicates the ratio of C1-37 and C1-35 is approximately
(a) 1 : 2 (b) 1 : 1
(c) 1 : 3 (d) 3 : 1

151. The number of electrons, neutrons and protons in a species are equal to 10, 8 and 8 respectively. The proper symbol of the species is
(a) $^{16}O_8$ (b) $^{18}O_8$
(c) $^{18}Ne_{10}$ (d) $^{16}O_8^{2-}$

152. What will be the difference between electromagnetic radiation shown in A and B respectively ?



(A)



(B)

(i) Velocity (ii) Wavelength
(iii) Frequency (iv) Energy
(a) (ii) only (b) (ii) and (iv)
(c) (ii), (iii) and (iv) (d) (iv) only

153. Arrange the electromagnetic radiations a, b, c, d and e in increasing order of energy. Frequencies of a, b and c are 10^{15}, 10^{14} and 10^{17} respectively whereas wavelength of (d) and (e) are 350 nm and 100 nm respectively ?
(a) a, b, c, d, e (b) a, b, d, e, c
(c) a, d, b, e, c (d) b, d, a, e, c

154. An electron, e_1 is moving in the fifth stationary state, and another electron e_2 is moving in the fourth stationary state. The radius of orbit of electron, e_1 is five times the radius of orbit of electron, e_2 calculate the ratio of velocity of electron e_1 (v_1) to the velocity of electron e_2 (v_2).
(a) 5 : 1 (b) 4 : 1
(c) 1 : 5 (d) 1 : 4

155. The Li^{2+} ion is moving in the third stationary state, and its linear momentum is 7.3×10^{-34} kg ms^{-1}. Calculate its angular momentum.
(a) 1.158×10^{-45} kg m^{2}s^{-1}
(b) 11.58×10^{-48} kg m^{2}s^{-1}
(c) 11.58×10^{-47} kg m^{2}s^{-1}
(d) 12×10^{-45} kg m^{2}s^{-1}

156. The Bohr orbit radius for the hydrogen atom (n = 1) is approximately 0.530 Å. The radius for the first excited state (n = 2) orbit is (in Å)
(a) 0.13 (b) 1.06
(c) 4.77 (d) 2.12

157. According to Bohr's theory the energy required for an electron in the Li^{2+} ion to be emitted from n = 2 state is (given that the ground state ionization energy of hydrogen atom is 13.6 eV)
(a) 61.2 eV (b) 13.6 eV
(c) 30.6 eV (d) 10.2 eV

158. Among species H, Li^{2+}, He^+, Be^{3+} and Al^{3+} Bohr's model was able to explain the spectra of
(a) All of these
(b) None of these
(c) all other species except Be^{3+}
(d) all other species except Al^{3+}

159. Which of the following levels of H and He^+ have same energy respectively ?
(A) 1, 2 (B) 3, 4
(C) 2, 4 (D) 3, 6
(a) A and D (b) A and B
(c) C and D (d) A, C and D

160. Bohr radius of nth orbit of an atom is given by the expression:
(a) $r = \dfrac{n^2h^2}{4\pi^2me^2}$ (b) $r = \dfrac{nh}{4\pi^2mZe^2}$
(c) $r = \dfrac{n^2h^2}{4\pi^2mZ}$ (d) $r = \dfrac{n^2h^2}{4\pi^2me^2Z}$

161. The ratio between kinetic energy and the total energy of the electrons of hydrogen atom according to Bohr's model is
(a) 2 : 1 (b) 1 : 1
(c) 1 : –1 (d) 1 : 2

162. The potential energy of electron present in ground state of Li^{2+} ion is represented by :
(a) $\dfrac{+3e^2}{4\pi\varepsilon_0 r}$ (b) $\dfrac{-3e}{4\pi\varepsilon_0 r}$
(c) $\dfrac{-3e^2}{4\pi\varepsilon_0 r^2}$ (d) $\dfrac{-3e^2}{4\pi\varepsilon_0 r}$

163. In hydrogen atomic spectrum, a series limit is found at 12186.3 cm^{-1}. Then it belong to
(a) Lyman series (b) Balmer series
(c) Paschen series (d) Brackett series

164. Which transition in the hydrogen atomic spectrum will have the same wavelength as the transition, n = 4 to n = 2 of He^+ spectrum?
(a) n = 4 to n = 3 (b) n = 3 to n = 2
(c) n = 4 to n = 2 (d) n = 2 to n = 1

165. Arrange the following elements in the order of ease of detection of wave properties, in the de Broglie experiment.
H, Li, Be, B, K
(a) H < Be, B < Li < K. (b) H > Li > K > Be > B
(c) H > Li > Be > B > K (d) H < Li < Be < B < K

166. A 600 W mercury lamp emits monochromatic rediation of wavelength 331.3 nm. How many photons are emitted from the lamp per second ? (h = 6.626×10^{-34} Js; velocity of light = 3×10^8 ms^{-1})
(a) 1×10^{19} (b) 1×10^{20}
(c) 1×10^{21} (d) 1×10^{23}

167. Calculate the velocity of ejected electron from the metal surface when light of frequency 2×10^{15} Hz fall on the metal surface and the threshold frequency is 7×10^{14} Hz for metal ?
(a) 1.37×10^6 (b) 1.26×10^6
(c) 1.45×10^7 (d) 1.37×10^7

168. What is the wavelength (in m) of the electron emitted in the above question (Q. no. 167) ?
(a) 5.308×10^{-10} (b) 5.89×10^{-11}
(c) 4.37×10^{-13} (d) 3.98×10^{-10}

169. The velocity of particle A is 0.1 ms^{-1} and that of particle B is 0.05 ms^{-1}. If the mass of particle B is five times that of particle A, then the ratio of de-Broglie wavelengths associated with the particles A and B is
(a) 2 : 5 (b) 3 : 4
(c) 6 : 4 (d) 5 : 2

170. Two fast moving particles X and Y are associated with de Broglie wavelengths 1 nm and 4 nm respectively. If mass of X in nine times the mass of Y, the ratio of kinetic energies of X and Y would be
(a) 3 : 1 (b) 9 : 1
(c) 5 : 12 (d) 16 : 9

171. Uncertainty in position of a n electron (mass = 9.1×10^{-28} g) moving with a velocity of 3×10^4 cm/s accurate upto 0.001% will be (use h/4π) in uncertainty expression where h = 6.626×10^{-27} erg-second).
(a) 1.93 cm (b) 3.84 cm
(c) 5.76 cm (d) 7.68 cm

172. The measurement of the electron position is associated with an uncertainty in momentum, which is equal to 1×10^{-18} g cm s^{-1}. The uncertainty in electron velocity is, (mass of an electron is 9×10^{-28} g)
(a) 1×10^9 cm s^{-1} (b) 1×10^6 cm s^{-1}
(c) 1×10^5 cm s^{-1} (d) 1×10^{11} cm s^{-1}

173. In an atom, an electron is moving with a speed of 600 m/s with an accuracy of 0.005%. Certainity with which the position of the electron can be located is (h = 6.6×10^{-34} kg m^2s^{-1}, mass of electron, $e_m = 9.1 \times 10^{-31}$ kg)
(a) 5.10×10^{-3} m (b) 1.92×10^{-3} m
(c) 3.84×10^{-3} m (d) 1.52×10^{-4} m

174. If uncertainty in position and momentum are equal, then uncertainty in velocity is :
(a) $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$ (b) $\sqrt{\frac{h}{2\pi}}$
(c) $\frac{1}{m}\sqrt{\frac{h}{\pi}}$ (d) $\sqrt{\frac{h}{\pi}}$

175. Which of the following sets of quantum numbers is correct?
(a) $n = 5, l = 4, m = 0, s = +½$
(b) $n = 3, l = 3, m = +3, s = +½$
(c) $n = 6, l = 0, m = +1, s = -½$
(d) $n = 4, l = 2, m = +2, s = 0$

176. Which combinations of quantum numbers, n, ℓ, m and s for the electron in an atom does not provide a permissible solution of the wave equation ?
(a) $3, 2, 1, \frac{1}{2}$ (b) $3, 1, 1, -\frac{1}{2}$
(c) $3, 3, 1, -\frac{1}{2}$ (d) $3, 2, -2, \frac{1}{2}$

177. An electron has principal quantum number 3. The number of its (i) subshells and (ii) orbitals would be respectively
(a) 3 and 5 (b) 3 and 7
(c) 3 and 9 (d) 2 and 5

178. The electrons identified by quantum numbers n and ℓ :
(A) $n = 4, \ell = 1$ (B) $n = 4, \ell = 0$
(C) $n = 3, \ell = 2$ (D) $n = 3, \ell = 1$
can be placed in order of increasing energy as :
(a) (C) < (D) < (B) < (A) (b) (D) < (B) < (C) < (A)
(c) (B) < (D) < (A) < (C) (d) (A) < (C) < (B) < (D)

179. The five d-orbitals are designated as $d_{xy}, d_{yz}, d_{xz}, d_{x^2-y^2}$ and d_{z^2}. Choose the correct statement.
(a) The shapes of the first three orbitals are similar but that of the fourth and fifth orbitals are different
(b) The shapes of all five d-orbitals are similar
(c) The shapes of the first four orbitals are similar but that of the fifth orbital is different
(d) Ths shapes of all five d-orbitals are different

180. If the nitrogen atom has electronic configuration $1s^7$, it would have energy lower than that of the 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) Hund's rule
(c) Pauli exclusion principle
(d) Bohr postulate of stationary orbits

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. (b)
2. (b) Cathode rays are never electromagnetic waves.
3. (c) Cathode rays are made up of negatively charged particles (electrons) which are deflected by both the electric and magnetic fields.
4. (d) 5. (b) 6. (c) 7. (c)
8. (c) The electrical discharge through the gases could be observed only at low pressure and high voltage.
9. (b) The cathode rays (negatively charged particles stream) originates from cathode and move towards anode.
10. (b) Millikan determined the value of charge on the electron by using oil drop experiment.
11. (b)
12. (d) Proton is the nucleus of H-atom (H-atom devoid of its electron)
13. (b) Positron (positive electron, $+_1e^0$) is positively charged electron without any mass, so it is the lightest particle among given choices.
14. (c) As the neutron is a chargeless particle, hence, the beam of neutrons is not deflected by electrical or magnetic field.
15. (a) James Chadwick in 1932 discovered the neutrons.
16. (b) Since electrons are negatively charged particles they got deflected toward positively charged electrode whereas proton being positively charged will get deflected toward negative electrode. Since neutrons are neutral, so they went straight.
17. (a)
18. (b) α-rays have the least penetrating power, followed by β-rays (100 times that of α-rays) and γ-rays (1000 times that of α-rays).
19. (d) X- and γ-rays are not deflected by the electric and magnetic field.
20. (c) Rutherford's α-ray scattering experiment first showed the existence of a small positivily charged entity in the centre of atom, called nucleus.
21. (d) The nucleus occupies much smaller volume compared to the volume of the atom.
22. (a) All positive ions are deposited at small part. (nucleus of atom).
23. (d) Rutherford used doubly charged helium particle. (α - particle)
24. (d) Electrons are revolving around the nucleus, and centrifugal force is balancing the force of attraction.
25. (d) Number of neutrons = Mass number – Atomic number $= 70 - 30 = 40$.
26. (a) $19 + 1e^- = 20$ electrons.
27. (c) $_{18}Ar^{40}$ contains 22 neutrons and $_{21}Sc^{40}$ contains 19 neutrons. The number of neutrons = (A – Z)
28. (b) Number of p = number of e^- = 89 and neutrons $231 - 89 = 142$.
29. (a) Z = 11, A = 24. Hence protons = 11 the neutrons $(24 - 11) = 13$.
30. (d) For neutral atom . No. of p = No. of e^- = 18 and $A = Z + \text{No. of neutrons} = 18 + 20 = 38$.
31. (c) When an alpha particle is emitted from a nucleus its atomic number decreases by two and its atomic mass decreases by four e.g.

$$_ZX^A \xrightarrow{-\alpha} {}_{Z-2}X^{A-4}$$

32. (b) Nucleons are total number of protons and neutrons. Both of these are collectively known as nucleons.
33. (b) Atoms with mass number but different atomic numbers are called isobars. Examples; $^{14}_{6}C$, $^{14}_{7}N$ are isobars.
34. (d) $_{17}Cl^{35}$ and $_{17}Cl^{37}$ are isotopes, so they will have same chemical properties.
35. (d) Atomic number is equal to number of protons or number of electrons. Thus if two species have different atomic number they must contain different number of protons and electrons. Number of neutrons = Atomic mass – Atomic number. Therefore due to difference of atomic numbers two species also have different number of neutrons.
36. (a)
37. (d) $\nu_1 = \frac{c}{\lambda_1}$

$$\nu_2 = \frac{c}{\lambda_2} = \frac{c}{3\lambda_1}$$

$$\% \text{ change in frequency} = \frac{\nu_2 - \nu_1}{\nu_1} \times 100$$

$$= \frac{\frac{c}{3\lambda_1} - \frac{c}{\lambda_1}}{\frac{c}{\lambda_1}} \times 100 = \frac{-\frac{2c}{3\lambda_1} \times 100}{\frac{c}{\lambda_1}}$$

$$= -66\%$$

38. (b)
39. (b) The ideal body, which emits and absorbs radiations of all frequencies, is called a black-body and the radiation emitted by such a body is called black-body radiation.
40. (a) Energy is always absorbed or emitted in whole number or multiples of quantum.

41. (d) (i) Interference and diffraction support the wave nature of electron.

(ii) $E = mc^2$ supports the particle nature of electron.

(iii) $E = h\nu = \frac{hc}{\lambda}$ is de-Broglie equation and it supports both wave nature and particle nature of electron.

42. (d) $E = h\nu = \frac{hc}{\lambda}$ or $\lambda = \frac{c}{\nu}$

$\Rightarrow \lambda = \frac{3\times10^8}{8\times10^{15}} = 3.75\times10^{-8}\,\text{m}$

In nanometer $\lambda = 3.75\times 10$

which is closest to 4×10^1

43. (c) K.E. of emitted electron

$= h\nu - h\nu_0$ (i.e. smaller than $h\nu$).

44. (a)

45. (a) At a frequency $\nu > \nu_0$, the ejected electrons come out with certain kinetic energy.

46. (a)

47. (d) This statement is known as uncertainty principle which was given by Heisenberg it is not a Bohr's postulate.

48. (c) Since the energy difference between two consecutive Bohr orbits is quantized and the energy of higher orbit is more than that of lower orbit, so an electron from one Bohr stationary orbit can go to next higher orbit by absorption of electromagnetic radiation of particular wavelength or frequency.

49. (d) For a Bohr atom, angular momentum M of the electron

$= \frac{nh}{2\pi}$.

50. (b) Angular momentum of an electron in n^{th} orbit is given by

$mvr = \frac{nh}{2\pi}$

For $n = 5$, we have

Angular momentum of electron $= \frac{5h}{2\pi} = \frac{2.5h}{\pi}$

51. (d) $y \propto n^2$

For 1^{st} orbit $y = 1$

For III^{st} orbit $= y \propto 3^2 = 9$

So it will 9y.

52. (a) $r_n = r_1 \times n^2$ (for hydrogen atom)

$r_n = r \times n^2$

as $r_1 = r$ (given)

$r_2 = r \times 2^2$ ($n = 2$, for second Bohr's orbit)

$= 4r$

53. (b) 54. (d)

55. (a) Radius of n^{th} orbit $= r_1 n^2$. (for H-atom)

56. (a) For hydrogen atom (n) = 1 (due to ground state)

Radius of hydrogen atom (r) = 0.53 Å.

Atomic number of Li (Z) = 3.

Radius of Li^{2+} ion $= r_1 \times \frac{n^2}{Z} = 0.53\times\frac{(1)^2}{3} = 0.17$

57. (c) Energy of an electron in Bohr's orbit is given by the relationship. $E_n = -\frac{13.6}{n^2}\text{eV}$.

58. (b) We know that $E_n = \frac{-1312}{n^2}\ \text{kJ mol}^{-1}$

$n = 4$ (Fourth Bohr orbit)

Given $E_4 = \frac{-1312}{4^2} = -82\ \text{kJ mol}^{-1}$

59. (a) 2^{nd} excited state will be the 3^{rd} energy level.

$E_n = \frac{13.6}{n^2}\text{eV}$ or $E = \frac{13.6}{9}\text{eV} = 1.51\ \text{eV}$.

60. (d) For H atom, $E_n = -\frac{13.6Z^2}{n^2}\text{eV}$

For second orbit, $n = 2$

Z = At. no. = 1 (for hydrogen)

$\therefore\ E_2 = -\frac{13.6\times(1)^2}{(2)^2} = \frac{-13.6}{4}\text{eV}$

$= \frac{-13.6\times1.6\times10^{-19}}{4}\text{J} = -5.44\times10^{-19}\,\text{J}$

61. (b) If we assume the atom to be hydrogen like, energy of nth energy level

$E_n = \frac{E_1}{n^2}$ where E_1 is energy of first energy level

$E_2 = -\frac{E_1}{2^2} = -\frac{E_1}{4} = \frac{-21.79\times10^{-12}}{4}$

$= -5.447\times10^{-12}$ erg per atom.

62. (a) Energy of an electron $E = \frac{-E_0}{n^2}$

For energy level ($n = 2$)

$E = -\frac{13.6}{(2)^2} = \frac{-13.6}{4} = -3.4\ \text{eV}$.

63. (a) H, He^+ and Li^{2+} are single electron species thus show similar line spectra.

64. (c)

65. (c) Vth stationary state, as radii of stationary state is given as $r_n = n^2 \times a_0 \Rightarrow n = 5$

66. (c) $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$\frac{1}{\lambda} = 1.097\times10^7\left(\frac{1}{1} - \frac{1}{\infty}\right) = 1.097\times10^7\,\text{m}^{-1}$

$\lambda = 91.15\times10^{-9}\,\text{m} \approx 91\text{nm}$

67. (c) $\nu = \frac{1}{h} \times IE \times \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$= \frac{2.18\times10^{-18}}{6.625\times10^{-34}} \times \left[\frac{1}{1} - \frac{1}{16}\right] = 3.08\times10^{15} s^{-1}$

68. (c) ΔE for two energy levels $= 21.79\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ J/atom

69. (a) $\Delta E = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$;

First line in Balmer series results in the transition : $n_2 = 3$ to $n_1 = 2$.

70. (c) Energy of photon obtained from the transition n = 6 to n = 5 will have least energy.

$\Delta E = 13.6Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

71. (a) $\bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

For second line in lyman series

$n_2 = 3$

$\therefore \frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{3^2}\right] = R\left[\frac{1}{1} - \frac{1}{9}\right] = \frac{8R}{9}$

72. (d) The shortest wavelength in hydrogen spectrum of Lyman series is given by formula :

$\frac{1}{\lambda} = \frac{R_H}{n^2} = \frac{R_H}{1^2} = \frac{109678}{1}$

$\Rightarrow \lambda = 9.117 \times 10^{-6}$ cm

$= 911.7 \times 10^{-10}$ m $= 911.7$ Å.

73. (b)

74. (c) Bohr model can explain spectrum of any atom or ion containing one electron only (that is H-like species)

75. (d) Uncertainty principle which was given by Hiesenberg and not Bohr's postulate.

76. (d) Bohr's model can be applied to one electron system only.

77. (b) Bohr model can only explain one electron system

78. (a) $\lambda = h/mv$; for the same velocity, λ varies inversely with the mass of the particle.

79. (d) $\lambda = \frac{h}{mv} = \frac{6.6\times10^{-34}}{60\times10^{-3}\times10} = 10^{-33}$ m

80. (d) Given $\Delta E = 4.4 \times 10^{-4}$ j, $\lambda = ?$

$$\lambda = \frac{hc}{\Delta E} = \frac{6.6\times10^{-34}\times3\times10^8}{4.4\times10^{-4}} = 4.5\times10^{-22} m$$

81. (c) We know that $\lambda = \frac{h}{mv}$; $\therefore m = \frac{h}{v\lambda}$

The velocity of photon (v) $= 3 \times 10^8$ m sec^{-1}

$\lambda = 1.54\times10^{-8}$ cm $= 1.54\times10^{-10}$ meter

$\therefore m = \frac{6.626\times10^{-34} \text{ Js}}{1.54\times10^{-10} \text{m}\times3\times10^8 \text{m sec}^{-1}}$

$= 1.4285\times10^{-32}$ kg

82. (c) $\lambda = \frac{h}{p} = \frac{6.6\times10^{-34}}{3.3\times10^{-24}} = 2\times10^{-10} m = 2Å$

83. (b) $E = h\upsilon = \frac{ch}{\lambda}$; and $\upsilon = \frac{c}{\lambda}$

$8\times10^{15} = \frac{3.0\times10^8}{\lambda}$

$\therefore \lambda = \frac{3.0\times10^8}{8\times10^{15}} = 0.37\times10^{-7} = 37.5\times10^{-9}$ m $= 4\times10^1$ nm

84. (b) $\lambda = \frac{h}{mv}$

$h = 6.6 \times 10^{-34}$ J/s

$m = 1000$ kg

$v = 36$ km/hr $= \frac{36\times10^3}{60\times60}$ m/sec $= 10$ m/sec

$\therefore \lambda = \frac{6.6\times10^{-34}}{10^3\times10} = 6.6\times10^{-38}$ m

85. (b) Heisenberg uncertainity principle can be explained by the relation

$\Delta x . \Delta P \Rightarrow \frac{h}{4\pi}$

where Δx = uncertainity in position

ΔP = uncertainity in momentum

86. (d) Heisenberg's uncertainty Principle is applicable to any moving object.

87. (d) By Heisenberg uncertainty Principle $\Delta x \times \Delta p = \frac{h}{4\pi}$ (which is constant)

As Δx for electron and helium atom is same thus momentum of electron and helium will also be same therefore the momentum of helium atom is equal to 5×10^{-26} kg. m.s^{-1}.

88. (a) Given m $= 9.1 \times 10^{-31}$kg

$h = 6.6 \times 10^{-34}$Js

$\Delta v = \frac{300 \times .001}{100} = 0.003 ms^{-1}$

From Heisenberg's uncertainity principle

$\Delta x = \frac{6.62\times10^{-34}}{4\times3.14\times0.003\times9.1\times10^{-31}} = 1.92\times10^{-2}$m

89. (c) $\Delta x \cdot \Delta p = \frac{h}{4\pi}$ or $\Delta x \cdot m\Delta v = \frac{h}{4\pi}$;

$$\Delta v = \frac{0.011}{100} \times 3 \times 10^4 = 3.3\ \text{cms}^{-1}$$

$$\Delta x = \frac{6.6 \times 10^{-27}}{4 \times 3.14 \times 9.1 \times 10^{-28} \times 3.3} = 0.175\ \text{cm}$$

90. (b) $\Delta x.\Delta v$ value will be large for object of smallest mass and is therefore the most significant for calculating uncertainity.

91. (b) Magnetic quantum no. represents the orientation of atomic orbitals in an atom. For example p_x, p_y & p_z have orientation along X-axis, Y-axis & Z-axis

92. (b) The sub-shell are $3d$, $4d$, $4p$ and $4s$, $4d$ has highest energy as $n + \ell$ value is maximum for this.

93. (a) The possible quantum numbers for $4f$ electron are

$n = 4, \ell = 3, m = -3, -2 -1, 0, 1, 2, 3$ and $s = \pm\frac{1}{2}$

Of various possiblities only option (a) is possible.

94. (b) $n = 4$ represents 4^{th} orbit

$\ell = 3$ represents f subshell

$m = -2$ represents orientation of f-orbital

$s = 1/2$ represents direction of spin of electron.

$\therefore$ The orbital is $4f$.

95. (b) For $4d$ orbitals, $n = 4$, $l = 2$

$$\begin{bmatrix} \text{For } s \text{ orbital } l = 0 \\ \text{For } p \text{ orbital } l = 1 \\ \text{For } d \text{ orbital } l = 2 \end{bmatrix}$$

$m = -2, -1, 0, +1$ or $+2$

$s = +\frac{1}{2}$ and $-\frac{1}{2}$

Thus choice b having $n = 4, l = 2, d = 1$ and $s = \frac{1}{2}$ is correct.

96. (c) $n = 2$, $l = 1$ means $2p$–orbital. Electrons that can be accommodated = 6 as p sub-shell has 3 orbital and each orbital contains 2 electrons.

97. (d) $\ell = 3$ means f-subshell. Maximum no. of electrons $= 4\ell + 2 = 4 \times 3 + 2 = 14$

98. (b) $m = -l$ to $+l$, through zero thus for $l = 2$, values of m will be $-2, -1, 0, +1, +2$.

Therefore for $l = 2$, m cannot have the value -3.

99. (c) (a) $n = 3$, $\ell = 0$ means $3s$-orbital and $n + \ell = 3$

(b) $n = 3$, $\ell = 1$ means $3p$-orbital $n + \ell = 4$

(c) $n = 3$, $\ell = 2$ means $3d$-orbital $n + \ell = 5$

(d) $n = 4$, $\ell = 0$ means $4s$-orbital $n + \ell = 4$

Increasing order of energy among these orbitals is

$3s < 3p < 4s < 3d$

$\therefore$ 3d has highest energy.

100. (b) Value of $l = 0$ ....$(n-1)$

l cannot be equal to n.

101. (b) For $n = 5$, $l = n - 1 = 5 - 1 = 4$

$m = 2l + 1 = 2(4) + 1 = 9$

Sum of values of l and $m = 9 + 4 = 13$

102. (a) Quantum number $n = 3$, $l = 2$, $m = +2$ represent an orbital with

$s = \pm\frac{1}{2}$ $\left(3d_{xy} \text{ or } 3d_{x^2-y^2}\right)$

which is possible only for one electron.

103. (d) The orbitals which have same energy are called degenerate orbitals eg. p_x, p_y and p_z.

104. (a) No. of radial nodes in $3p$-orbital $= (n - \ell - 1)$

[for p ortbital $\ell = 1$]

$= 3 - 1 - 1 = 1$

105. (b)

106. (a) As $n - l - 1 = 5$ or $8 - l - 1 = 5 \Rightarrow l = 2$.

107. (b) According to given information $n = 5$ and $l = 3$.

108. (a) The number of allowed orbitals are given by n^2.

Thus when n = 5

$(5)^2 = 25$

109. (d) Spherical shaped s-orbital shields the outer shell electrons move effectively than p-orbital, which in turn shields more effectively than d-orbital and so on.

110. (d) According to Hund's rule electron pairing in p, d and f orbitals cannot occur until each orbital of a given subshell contains one electron each or is singly occupied.

111. (d) We know that atomic number of gadolinium is 64. Therefore the electronic configuration of gadolinium is [Xe] $4f^7\ 5d^1\ 6s^2$. Because the half filled and fully filled orbitals are more stable.

112. (b) The sub-shell with lowest value of $(n + \ell)$ is filled up first. When two or more sub-shells have same $(n + \ell)$ value the subshell with lowest value of 'n' is filled up first therefore the correct order is

orbital	$4s$	$3d$	$4p$	$5s$	$4d$
$n + \ell$	$4+0$	$3+2$	$4+1$	$5+0$	$4+2$
value	$=4$	$=5$	$=5$	$=5$	$=6$

113. (c) $Fe^{++}(26 - 2 = 24) = 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^0\,3d^6$ hence no. of d electrons retained is 6. [Two $4s$ electron are removed]

114. (b) This configuration represents ground state electronic configuration of Cr.

$1s^2\,2s^2\,2p^6\,3s^2 3p^6 3d^5\,4s^1$

115. (c) $N(7) = 1s^2\,2s^2\,2p^3$

$N^{2+} = 1s^2, 2s^2\,2p_x^1$

Unpaired electrons = 1.

116. (a) $Cu^+ = 29 - 1 = 28\ e^-$

thus the electronic confingration of Cu^+ is

$$Cu^+(28) = 1s^2\ 2s^2\ 2p^6\ \underbrace{3s^2\ 3p^6\ 3d^{10}}_{18e^-}$$

117. (d) This is as per the definition of Pauli's exclusion principle.

118. (b) Electronic configuration of Cu (29) is $1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^{10}\, 4s^1$ and not $1s^2, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^9 4s^2$ due to extra stability of fully filled orbitals.

119. (b) According to Aufbau principle, the orbital of lower energy (2*s*) should be fully filled before the filling of orbital of higher energy starts.

120. (a) $ns \to (n-2)f \to (n-1)d \to np$ [n = 6]

121. (d) The number of sub shell is $(2l + 1)$. The maximum number of electrons in the sub shell is $2(2l + 1) = (4l + 2)$.

122. (b)

	5*p*	4*f*	6*s*	5*d*
(n + *l*)	5 + 1	4 + 3	6 + 0	5 + 2
	6	7	6	7

Hence the order is 5p < 6s < 4f < 5d

123. (d)

124. (d) The *d*-orbital represented by option (d) will become completely filled after gaining an electron. Therefore option (d) is correct.

STATEMENT TYPE QUESTIONS

125. (c) When both electric and magnetic field is applied, electron strikes at point B, and at point C when only magnetic field is applied.

126. (c)

127. (b) For statement (ii) there is no time lag between striking of light beam and the ejection of electrons. For statement (iii) refer statement (iv).

128. (c) (i) Beyond a certain wavelength the line spectrum becomes band spectrum.

(ii) For Balmer series $n_1 = 2$

(iii) For calculation of longest wavelength use nearest value of n_2. Hence for longest wavelength in Balmer series of hydrogen spectrum,

$n_1 = 2$ & $n_2 = 3$.

129. (c) Statement (i) is related to Heisenberg's uncertainity principle. Statement (iii) belongs to Pauli's exclusion principle.

130. (b) Angular quantum number determines the 3d shape of the orbital.

Spin quantum number of an electron determines the orientation of the spin of electron relative to the chosen axis.

MATCHING TYPE QUESTIONS

131. (b) Isotopes have same atomic number. Isobars have same mass number, whereas isoelectronic species have same number of electrons although the (A) has same number of electrons but the protons they carry are same while in case of isolelectronic species number of protons they carry are different.

132. (a) **133. (c)** **134. (a)**

135. (a) For *d*-subshell ⇒ Number of orbitals = 5, $l = 2$

f-subshell ⇒ Number of orbitals = 7, $l = 3$

s-subshell ⇒ Number of orbitals = 1, $l = 0$

p-subshell ⇒ Number of orbitals = 3, $l = 1$

136. (b) **137. (c)** **138. (b)**

ASSERTION-REASON TYPE QUESTIONS

139. (d) The statement-1 is false but the statement-2 is true exact position and exact momentum of an electron can never be determined according to Heisenberg's uncertainty principle. Even not with the help of electron microscope because when electron beam of electron microscope strikes the target electron of atom, the impact causes the change in velocity and position of electron .

140. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

Radius, $r_n = \dfrac{n^2h^2}{4\pi e^2 mZ} = \dfrac{n^2}{Z} \times 0.529\text{Å}.r_n$

For first orbit of H-atom

$n = 1$

$r_1 = \dfrac{(1)^2}{1} \times 0.529\,\text{Å} = 0.529\,\text{Å}$

141. (a) **142. (b)** **143. (c)**

CRITICAL THINKING TYPE QUESTIONS

144. (c)

145. (d) $\dfrac{e}{m}$ for (i) neutron $= \dfrac{0}{1} = 0$

(ii) α-particle $= \dfrac{2}{4} = 0.5$

(iii) proton $= \dfrac{1}{1} = 1$

(iv) electron $= \dfrac{1}{1/1837} = 1837$

146. (b) N^{3-} The amount of deviation depends upon the magnitude of negative charge on the particle.

147. (d) The lesser is the mass of particle, greater is the deflection.

148. (c) Deuterium and an α-particle have identical values of *e*/*m*.

149. (a) Considering the core of an atom, higher the positive charge concentrated in the nucleus, greater the repulsion for an alpha-particle.

Coulombic force of repulsion $= \dfrac{kq_1(z_e)}{r^2}$

q_1 = charge on α-particle

(z_e) = charge on nucleus of atom

150. (c)

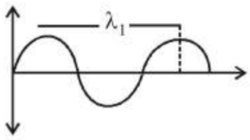
151. (d) Atomic number = No. of protons = 8

Mass number = No. of protons + No. of neutrons

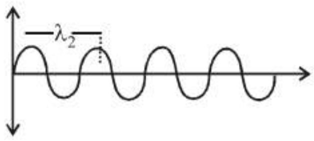
$= 8 + 8 = 16$

Since the no. of electrons are two more than the no. of protons, hence, it is a binegative species. Thus, the species is $^{16}O_8^{2-}$.

152. (c) e/m waves shown in figure A has higher wavelength in comparison to e/m waves shown in figure B. Thus these waves also differ in frequency and energy. $\nu = \frac{c}{\lambda}$



$(A) \Rightarrow E_1 = \frac{hc}{\lambda_1}$



$(B) \Rightarrow E_2 = \frac{hc}{\lambda_2}$

$\lambda_1 > \lambda_2 \Rightarrow E_1 < E_2$

153. (d) $E = h\nu$

and $\nu = \left(\frac{c}{\lambda}\right)$

$\nu_a = 10^{15}$, $\nu_b = 10^{14}$,
$\nu_c = 10^{17}$, $\nu_d = 0.85 \times 10^{15}$

and $\nu_e = 10 \times 10^{15}$,

154. (d) From the expression of Bohr's theory, we know that

$m_e v_1 r_1 = n_1 \frac{h}{2\pi}$

& $m_e v_2 r_2 = n_2 \frac{h}{2\pi}$

$\frac{m_e v_1 r_1}{m_e v_2 r_2} = \frac{n_1}{n_2} \frac{h}{2\pi} \times \frac{2\pi}{h}$

Given, $r_1 = 5r_2, n_1 = 5, n_2 = 4$

$\frac{m_e \times v_1 \times 5r_2}{m_e \times v_2 \times r_2} = \frac{5}{4}$

$\Rightarrow \frac{v_1}{v_2} = \frac{5}{4 \times 5} = \frac{1}{4} = 1:4$

155. (b) $Z = 3$ for Li^{2+} ions

So $r_n = \frac{52.9 \times n^2}{Z}$

$n = 3, Z = 3$

$r_n = \frac{52.9 \times (3)^2}{3}$ pm

$= 158.7$ pm

Also, linear momentum $(mv) = 7.3 \times 10^{-34}$ kg ms^{-1}

Then angular momentum will be

$\omega = (mv) \times r$

$= (7.3 \times 10^{-34}$ kg ms$^{-1})$ (158.7 pm)

$= 7.3 \times 10^{-34}$ kg ms$^{-1} \times (158.7 \times 10^{-12}$ m)

$= 11.58 \times 10^{-48}$ kg m^2 s^{-1}

$= 11.58 \times 10^{-45}$ g m^{2}s^{-1}

156. (d) Given : Radius of hydrogen atom = 0.530 Å, Number of excited state $(n) = 2$ and atomic number of hydrogen atom $(Z) = 1$. We know that the Bohr radius.

$(r) = \frac{n^2}{Z} \times \text{Radius of atom} = \frac{(2)^2}{1} \times 0.530$

$= 4 \times 0.530 = 2.12$ Å

157. (c) Energy of electron in 2nd orbit of Li^{+2} $= -13.6\frac{z^2}{n^2}$

$= \frac{-13.6 \times (3)^2}{(2)^2} = -30.6$ eV

Energy required = 0 – (–30.6) = 30.6 eV

158. (d) Except Al^{3+} all contain one electron and Bohr's model could explain the spectra for one electron system, Bohr's model was not able to explain the spectra of multielectron system.

159. (d) $E_n^{H} = -2.18 \times 10^{-18}\left(\frac{Z^2}{n_H^2}\right)J = \frac{-2.18 \times 10^{-18}}{n_H^2}J$

$E_n^{He^+} = -2.18 \times 10^{-18}\left(\frac{Z^2}{n_{He^+}^2}\right)J = \frac{-2.18 \times 10^{-18} \times 4}{n_{He^+}^2}J$

$E_n^{H} = E_n^{He^+} \Rightarrow \frac{1}{n_H^2} = \frac{4}{n_{He^+}^2} \Rightarrow n_{He^+} = 2 \times n_H$

If $n_H = 1$ Then $n_{He^+} = 2$

If $n_H = 2$ Then $n_{He^+} = 4$

If $n_H = 3$ Then $n_{He^+} = 6$

160. (d) Radius of n^{th} orbit $= \frac{n^2h^2}{4\pi^2me^2Z}$

where n = no. of orbit

h = Plank's constant

e = charge on one electron

m = mass of one electron

Z = atomic number

161. (c)

162. (d) In S.I. units the P.E. $= \frac{-Ze^2}{4\pi\varepsilon_0 r}$.

For Li^{2+}, Z = 3.

$\therefore$ P.E. $= \frac{-3e^2}{4\pi\varepsilon_0 r}$.

163. (c) Series limit is the last line of the series, i.e. $n_2 = \infty$.

$$\therefore \bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R\left[\frac{1}{n_1^2} - \frac{1}{\infty^2}\right] = \frac{R}{n_1^2}$$

$$\because \bar{\upsilon} = 12186.3 = \frac{109677.76}{n_1^2}$$

$$\Rightarrow n_1^2 = \frac{109677.76}{12186.3} = 9 \Rightarrow n_1 = 3$$

$\therefore$ The line belongs to Paschen series.

164. (d) For He^+ ion, $\frac{1}{\lambda} = Z^2R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$$(2)^2 R\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = \frac{3R}{4}$$

For hydrogen atom, $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$$\frac{3R}{4} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \text{ or } \frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$$

$n_1 = 1$ and $n_2 = 2$.

165. (c) The wavelengths of elements decreases with increase in their mass. $\left(\because \lambda = \frac{h}{mv}\right)$

166. (c) Energy of a photon, $E = \frac{hc}{\lambda}$

$$= \frac{6.626\times10^{-34}(Js)\times3\times10^{8}(ms^{-1})}{331.3\times10^{-9}(m)} = 6\times10^{-19}\,J$$

No. of photons emitted per second

$$= \frac{600\,(J)}{6\times10^{-9}\,(J)} = 10^{21}$$

167. (a) $\frac{1}{2}mv^2 = h\nu - h\nu_0$

$$\Rightarrow \frac{1}{2}mv^2 = h(\nu - \nu_0)$$

$$\Rightarrow v = \sqrt{\frac{2h}{m}(\nu - \nu_0)}$$

168. (a) According to de-Broglie,

$$\lambda = \frac{h}{mv}$$

where m = mass of electron, v = velocity

169. (d) Given, $v_A = 0.1\ ms^{-1}$ and $v_B = 0.05\ ms^{-1}$ also, $m_B = 5m_A$

de-Broglie wavelength, $\lambda = \frac{h}{mv}$

$$\therefore \frac{\lambda_A}{\lambda_B} = \frac{h/m_Av_A}{h/m_Bv_B} = \frac{m_Bv_B}{m_Av_A}$$

$$= \frac{5m_A\times0.05}{m_A\times0.1} = 5\times0.5 = 2.5 = 5/2$$

$$\therefore \lambda_A : \lambda_B = 5:2$$

170. (d) de Broglie wavelength $\lambda = \frac{h}{mv}$

$$\frac{\lambda_1}{\lambda_2} = \frac{m_2v_2}{m_1v_1};\ \frac{1}{4} = \frac{1}{9}\times\frac{v_2}{v_1}$$

$$\frac{v_2}{v_1} = \frac{9}{4}$$

$$\frac{v_1}{v_2} = \frac{4}{9}$$

$$KE = \frac{1}{2}mv^2$$

$$\frac{KE_1}{KE_2} = \frac{m_1}{m_2}\times\frac{v_1^2}{v_2^2} = \frac{9}{1}\times\left(\frac{4}{9}\right)^2 = \frac{16}{9}$$

171. (a) Given mass of an electron(v) $= 9.1\times10^{-28}$ g;

Velocity of electron $(v) = 3\times10^4$ cm/s;

Accuracy in velocity $= 0.001\% = \frac{0.001}{100}$;

Actual velocity of the electron

$$(\Delta v) = 3\times10^4\times\frac{0.001}{100} = 0.3\text{ cm/s}.$$

Planck's constant $(h) = 6.626\times10^{-27}$ erg-sec.

$\therefore$ Uncertainty in the position of the electron

$$(\Delta x) = \frac{h}{4\pi m\Delta v} = \frac{6.626\times10^{-27}\times7}{4\times22\times(9.1\times10^{-28})\times0.3}$$

$= 1.93$ cm

172. (a) $\Delta p = m\Delta v$

Substituting the given values of Δx and m, we get

1×10^{-18} g cm s^{-1} $= 9\times10^{-28}$ g $\times\ \Delta v$

or $\Delta v = \frac{1\times10^{-18}}{9\times10^{-28}}$

$= 1.1\times10^9$ cm s^{-1} $\simeq 1\times10^9$ cm s^{-1}

i.e. option (a) is correct.

173. (b) According to Heisenberg uncertainty principle.

$$\Delta x.m\Delta v = \frac{h}{4\pi} \qquad \Delta x = \frac{h}{4\pi m\Delta v}$$

Here $\Delta v = \frac{600\times0.005}{100} = 0.03$

So, $\Delta x = \frac{6.6 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 0.03}$
$= 1.92 \times 10^{-3}$ meter

174. (a) We know $\Delta p.\Delta x \geq \frac{h}{4\pi}$

since $\Delta p = \Delta x$ (given)

$\therefore \ \Delta p.\Delta p = \frac{h}{4\pi}$

or $m\Delta v \, m\Delta v. = \frac{h}{4\pi}$ $[\because \Delta p = m\Delta v]$

or $(\Delta v)^2 = \frac{h}{4\pi m^2}$

or $\Delta v = \sqrt{\frac{h}{4\pi m^2}} = \frac{1}{2m}\sqrt{\frac{h}{\pi}}$

Thus option (a) is the correct option.

175. (a) For $n = 5$, l may be 0, 1, 2, 3 or 4

For $l = 4$, $m = 2l + 1 = 2 \times 4 + 1 = 9$

$= -4, -3, -2, -1, 0, +1, +2, +3, +4$

For $m = 0$, $s = +\frac{1}{2}$

Hence, (a) is correct option.

(b) For any value of n, the value of l cannot be equal or greater than value of n, hence it is incorrect.

(c) For $l = 0$, $m = 0$ hence it is incorrect.

(d) The value of s can never be zero. Thus this option is also incorrect.

176. (c) Possible values of ℓ and m depend upon the value of n

$\ell = 0$ to $(n - 1)$

$m = -\ell$ to $+\ell$ through zero

$s = +\frac{1}{2}$ and $-\frac{1}{2}$

Thus for $n = 3$,

ℓ may be 0, 1 or 2; but not 3

m may be $-2, -1, 0, +1$ or $+2$

s may be $+\frac{1}{2}$ or $-\frac{1}{2}$

177. (c)

178. (b) (A) $4p$ (B) $4s$

(C) $3d$ (D) $3p$

According to Bohr Bury's $(n + \ell)$ rule, increasing order of energy will be (D) < (B) < (C) < (A).

Note : If the two orbitals have same value of $(n + \ell)$ then the orbital with lower value of n will be filled first.

179. (c) First four orbitals contain four lobes, while fifth orbital consists of only two lobes. The lobes of d_{xy} orbital lie between x and y axis. Similarly in the case of d_{yz} and d_{zx}, their lobes lie between yz and zx axis respectively. Four lobes of $d_{x^2-y^2}$ orbital are lying along x and y axis while two lobes of d_{z^2} orbital are lying along z-axis.

180. (c) As per Pauli exclusion principle "no two electrons in the same atom can have all the four quantum numbers equal or an orbital cannot contain more than two electrons and it can accommodate two electrons only when their directions of spin are opposite".