CHAPTER 13

Atomic Structure

EXERCISE I (JEE MAIN)

Fundamental Particles

1. Gases are bad conductors of electricity. Their conductivity may be increased by
   (a) increasing the pressure as well as potential difference between the electrodes.
   (b) decreasing the pressure as well as potential difference between the electrodes.
   (c) decreasing the pressure and/or increasing the potential difference between the electrodes.
   (d) increasing the pressure and/or decreasing the potential difference between the electrodes.

2. Which of the following is true for cathode ray?
   (a) It is not deflected by magnetic field.
   (b) It is an electromagnetic wave.
   (c) It emits X-ray, when strikes a metal.
   (d) It consist all the negative particles present in the atoms.

3. The specific charge of cathode rays
   (a) depends on the nature of the gas.
   (b) depends on the material of the discharge tube.
   (c) depends on the potential difference between cathode and anode.
   (d) is a universal constant.

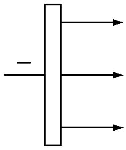
4. Which of the following is not a fundamental particle?
   (a) Electron (b) Proton
   (c) Neutron (d) X-rays

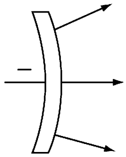
5. The presence of charge particles in the atoms was first confirmed by
   (a) Rutherford (b) Thomson
   (c) Faraday (d) Goldstein

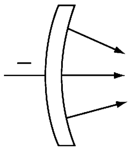
6. From the discharge tube experiment, it is concluded that
   (a) mass of proton is fractional.
   (b) matter contains electrons.
   (c) matter contains nucleus.
   (d) positive rays are heavier than protons.

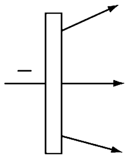
7. The cathode rays experiment demonstrated that
   (a) α-particles are the nuclei of He atoms.
   (b) the e/m ratio for the particles of the cathode rays varies gas to gas.
   (c) cathode rays are streams of negatively charged particles.
   (d) the mass of an atom is essentially all contained its very small nucleus.

8. Which of the following is not the possible path of cathode rays ejecting from the surface of cathode?

(a) 

(b) 

(c) 

(d) 

9. Cathode rays are made up of electrons. Anode rays are made up of
   (a) only protons.
   (b) only nucleus of atoms.
   (c) positive residue of atoms.
   (d) only from all the positive particles present in the atoms.

10. Which of the following is incorrect statement?
   (a) Cathode rays are emitted out from the surface of cathode.
   (b) Cathode rays travel in straight line.
   (c) Anode rays are heavier than cathode rays.
   (d) Anode rays are emitted out from the surface of anode.

11. The *e*/*m* ratio of anode rays produced in the discharge tube, depends on the
   (a) nature of the gas filled in the tube
   (b) nature of anode material
   (c) nature of cathode material
   (d) all of these

12. When lithium vapours were filled in the discharge tube for anode rays experiment, the anode rays were found to contain only Li^+ ions ($A = 7$, $Z = 3$). Each particle of anode ray is, therefore, containing
   (a) 1 proton only
   (b) 3 protons and 4 neutrons only
   (c) 3 protons, 4 neutrons and 2 electrons
   (d) 3 protons, 3 neutrons and 3 electrons

13. In an oil drop experiment, the following charges (in arbitrary units) were found on a series of oil droplets: 4.5×10^{-18}, 3.0×10^{-18}, 6.0×10^{-18}, 7.5×10^{-18}, 9.0×10^{-18}. The charge on electron (in the same unit) should be
   (a) 3.0×10^{-18} (b) 9.0×10^{-18}
   (c) 1.5×10^{-18} (d) 1.6×10^{-19}

14. In Wilson cloud chamber experiment, two particles were found to show equal deviations but in opposite directions. The names positron and negatron were given to these particles by Anderson. Hence, Negatron is
   (a) neutron (b) neutrino
   (c) proton (d) electron

15. Which of the following particle is not deflected in the magnetic field?
   (a) Electron (b) Proton
   (c) Neutron (d) Deuteron

16. Which of the following particle have non zero *e*/*m* ratio?
   (a) Neutron
   (b) Neutrino
   (c) Positron
   (d) Neutral meson

17. The *e*/*m* ratio is maximum for
   (a) Na^+ (b) Al^{3+}
   (c) H^+ (d) Mg^{2+}

18. The potential difference between cathode and anode in a cathode ray tube is V. The speed acquired by the electrons is proportional to
   (a) V (b) $\sqrt{V}$
   (c) V^2 (d) $1/\sqrt{V}$

19. The ratio of specific charges of α–particle and deuteron is
   (a) 1:2 (b) 2:1
   (c) 1:1 (d) 4:1

20. *e*/*m* ratio of a particle of charge 2 unit and mass 4 amu is
   (a) 4.8×10^7 C/kg (b) 0.5 C/kg
   (c) 4.8×10^4 C/kg (d) 8×10^{-20} C/kg

Rutherford's Atomic Models

21. Atoms have void spaces. It was first suggested by

(a) Rutherford (b) Thomson
(c) Lenard (d) Dalton

22. 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.

23. Which of the following is not a conclusion of Rutherford's atomic model?

(a) Most of the part inside an atom is empty.
(b) Almost all mass of an atom is concentrated in the nucleus.
(c) The size of nucleus is very small in comparison to the size of atom.
(d) Electron revolves round the nucleus in definite orbits.

24. Which of the following is not a correct statement according to Rutherford's atomic model?

(a) 99% of mass of an atom is centred in the nucleus.
(b) Most of the part inside the atom is empty.
(c) The size of nucleus is very small in comparison to the atoms.
(d) Electrons revolve round the nucleus.

25. When β-particles are sent through a tin metal foil, most of them go straight through the foil as

(a) β-particles are much heavier than electron
(b) most part of the atom is empty space
(c) β-particles are positively charged
(d) β-particles moves with high velocity

26. A proton and a deuteron are projected towards the stationary gold nucleus, in different experiments, with the same speed. The distance of closest approach will be

(a) same for both
(b) greater for proton
(c) greater for deuteron
(d) depends on speed

27. Two particles, A and B, having same *e*/*m* ratio are projected towards silver nucleus, in different experiments, with the same speed. The distance of closest approach will be

(a) same for both
(b) greater for A
(c) greater for B
(d) depends on speed

28. α-particles are projected towards the nucleus of following metals, with the same kinetic energy. Towards which metal, the distance of closest approach will be minimum?

(a) Cu ($Z = 29$)
(b) Ag ($Z = 47$)
(c) Au ($Z = 79$)
(d) Ca ($Z = 20$)

29. In the different experiments, α-particles, proton, deuteron and neutron are projected towards gold nucleus with the same kinetic energy. The distance of closest approach will be minimum for

(a) α-particle (b) proton
(c) deuteron (d) neutron

30. The following charged particles accelerated from rest, through the same potential difference, are projected towards gold nucleus in different experiments. The distance of closest approach will be maximum for

(a) α–particle
(b) proton
(c) deuteron
(d) same for all

31. In the Rutherford scattering experiment, the number of alpha particles scattered at an angle θ = 60° is 36 per minute. The number of alpha particles per minute scattered at angles θ = 90° is (Assume all other conditions to be identical.)

(a) 144 (b) 9
(c) 36 (d) 16

32. If nucleus and atom are considered as perfect spheres with the diameters 4×10^{-15} m and 2×10^{-10} m, respectively, then the ratio of the volumes of nucleus and atom should be

(a) 2×10^{-5}:1 (b) 8×10^{-15}:1
(c) 1.25×10^{14}:1 (d) 8×10^{15}:1

33. With what velocity should an α–particle travel towards the nucleus of a copper atoms so as to arrive at a distance 10^{-13} m from the nucleus of the copper atom? $(4.8 \times \sqrt{29 \times 60} = 200, N_A = 6 \times 10^{23})$

(a) 2×10^3 ms^{-1}
(b) 4×10^{10} ms^{-1}
(c) 2×10^5 ms^{-1}
(d) 2×10^7 ms^{-1}

34. An α-particle accelerated through *V* volt is fired towards a nucleus. It distance of closest approach is *r*. If a proton accelerated through the same potential is fired towards the same nucleus, the distance of closest approach of the proton will be

(a) *r* (b) 2*r*
(c) *r*/2 (d) *r*/4

35. The distance of closest approach of an α-particle fired towards a nucleus with momentum 'P' is *r*. What will be the distance of closest approach when the momentum of the α-particle is 2P?

(a) 2*r* (b) 4*r*
(c) *r*/2 (d) *r*/4

Planck's Quantum Theory, Photoelectric Effect and Moseley's Experiment

36. Small packets of light is called

(a) proton (b) quanta
(c) photon (d) spectrum

37. A radio station emits the radiations of 400 kHz. The metre band of station is

(a) 400 (b) 750
(c) 1333.33 (d) 7.5

38. Which of the following electromagnetic radiation have greater frequency?

(a) X–rays
(b) Ultraviolet rays
(c) Radio waves
(d) Visible rays

39. As its closest approach, the distance between the Mars and the Earth is found to be 60 million km. When the planets are at this closest distance, how long would it take to send a radio massage from a space probe of Mars of Earth?

(a) 5 s (b) 200 s
(c) 0.2 s (d) 20 s

40. Two electromagnetic radiations have wave numbers in the ratio 2:3. Their energies per quanta will be in the ratio

(a) 3:2 (b) 9:4
(c) 4:9 (d) 2:3

41. A radio station is emitting the radiations of frequency 2×10^4 Hz. If its frequency is doubled,

(a) wavelength will be doubled
(b) energy per quanta will be doubled
(c) wave number will be halved
(d) all of these

42. The eyes of a certain member of the reptile family pass a single visual single to the brain when the visual receptors are stuck by photons of wavelength 662.6 nm. If a total energy of 3.0×10^{-14} J is required to trap the signal, what is the minimum number of photons that must strike the receptor?

(a) 1.0×10^5 (b) 1.0×10^6
(c) 1000 (d) 1

43. A photon of 400 nm is absorbed by a gas molecule and then the molecule re-emits two photons. One re-emitted photon has wavelength 500 nm. Assuming that there is no change in the energy of molecule, the wavelength of second re-emitted photon is

(a) 100 nm (b) 2000 nm
(c) –100 nm (d) 900 nm

44. A green bulb and a red bulb are emitting the radiations with equal power. The correct relation between numbers of photons emitted by the bulbs per second is

(a) $n_g = n_r$ (b) $n_g < n_r$
(c) $n_g > n_r$ (d) unpredictable

45. A dye emits 50% of the absorbed energy as fluorescence. If the number of quanta absorbed and emitted out is in the ratio 1:2 and it absorbs the radiation of wavelength '*x*' Å, then the wavelength of the emitted radiation will be

(a) *x* Å (b) 0.5 *x* Å
(c) 4*x* Å (d) 0.25 *x* Å

46. Wavelength of photon which have energy equal to average of energy of photons with $\lambda_1 = 4000$ Å and $\lambda_2 = 6000$ Å will be

(a) 5000 Å (b) 4800 Å
(c) 9600 Å (d) 2400 Å

47. Bond dissociation on energy of Br_2 is 200 kJ/mole. The longest wavelength of photon that can break this bond would be ($N_A \times hc = 0.12$)

(a) 6.0×10^{-5} m (b) 1.2×10^{-5} m
(c) 6.0×10^{-7} m (d) 1.2×10^{-7} m

48. Wavelength of photon having energy 1 eV would be

(a) 1.24×10^{-4} m
(b) 1.24×10^{-6} m
(c) 1.24×10^{-5} m
(d) 1.24×10^{4} m

49. In the emission of photoelectrons, the number of photoelectrons emitted per unit time depends upon

(a) energy of the incident radiation
(b) intensity of the incident radiation
(c) frequency of the incident radiation
(d) wavelength of the incident radiation

50. Radiations of frequency, ν, are incident on a photosensitive metal. The maximum kinetic energy of photoelectrons is *E*. When the frequency of the incident radiations is doubled, what is the maximum kinetic energy of the photoelectrons?

(a) 2*E* (b) *E*/2
(c) $E + h\nu$ (d) $E - h\nu$

51. A photo sensitive surface is receiving light of wavelength 5000 Å at the rate of 10^{-7} J/s. The number of photons received per second is

(a) 2.5×10^{11} (b) 3.0×10^{32}
(c) 2.5×10^{18} (d) 2.5×10^{9}

52. In order to increase the kinetic energy of ejected photoelectrons, there should be an increase in

(a) intensity of radiation
(b) wavelength of radiation
(c) frequency of radiation
(d) both wavelength and intensity of radiation

53. The threshold wavelength for ejection of electrons from a metal is 330 nm. The work function for the photoelectric emission from the metal is ($h = 6.6 \times 10^{-34}$ J-s)

(a) 1.2×10^{-18} J
(b) 6.0×10^{-19} J
(c) 1.2×10^{-20} J
(d) 6.0×10^{-12} J

54. The ratio of wavelengths of K_α-characteristic X-rays produced when iron ($Z = 26$) and scandium ($Z = 21$) are used as anticathode, is

(a) 26:21 (b) 4:5
(c) 16:25 (d) 25:16

55. The wavelength of the K_α line for an element of atomic number 57 is λ. What is the wavelength of k_α line for the element of atomic number 29?

(a) λ (b) 2λ
(c) 4λ (d) $\lambda/4$

Bohr's Atomic Model

56. Bohr's model may be applied to

(a) Na^{10+} ion (b) He atom
(c) Be^{2+} ion (d) C^{6+} ion

57. If the radius of first orbit of H–atom is x Å, then the radius of the second orbit of Li^{2+} ion will be

(a) x Å (b) $\frac{4x}{3}$ Å
(c) $\frac{9x}{2}$ Å (d) $4x$ Å

58. According to Bohr model, the radius of Ne^{9+} ion in ground state should be

(a) 0.529 Å (b) 0.0529 Å
(c) 5.29 Å (d) 52.9 Å

59. The ratio of spacing between the third and fourth orbit to the spacing between sixth and seventh orbit of H–atom is

(a) 7:13 (b) 13:7
(c) 16:49 (d) 1:1

60. What would be the approximate quantum number, n, for a circular orbit of hydrogen, 1×10^{-5} cm in diameter?

(a) 31 (b) 43
(c) 40 (d) 39

61. If the mass of electron is doubled, the radius of first orbit of H-atom becomes approximately

(a) 0.529 Å (b) 0.265 Å
(c) 1.058 Å (d) 0.32 Å

62. The ratio of circumference of third and second orbits of He^+ ion is

(a) 3:2 (b) 2:3
(c) 9:4 (d) 4:9

63. If the mass of electron is doubled, the speed of electron revolving round Li^{2+} nucleus will

(a) remain same
(b) be doubled
(c) be halved
(d) be quadrupled

64. What is the orbit number of the He^+ ion in which electron have speed $\frac{1}{205.67}$ times the speed of light?

(a) 1 (b) 2
(c) 3 (d) 4

65. The speed of electron revolving in the fourth orbit of a hydrogen-like atom or ion is 1094 km/s. The atom or ion is

(a) H (b) He^+
(c) Li^{2+} (d) Be^{3+}

66. Escape velocity for earth is 11.2 km/s. The orbit number for H-atom in which speed of electron is about 19.54 times the escape velocity is

(a) 4 (b) 8
(c) 10 (d) infinite

67. The ratio of the speed of the electron in the ground state of hydrogen atom to the speed of light in vacuum is

(a) 1:1 (b) 1:100
(c) 1:137 (d) 2:3

68. An electron revolves round Li^{2+} nucleus at a distance of 1.587 Å. The speed of electron should be

(a) 2.188×10^6 m/s
(b) 6.564×10^6 m/s
(c) 7.293×10^5 m/s
(d) 7.293×10^6 m/s

69. How much distance an electron revolving in 3rd orbit of He^+ ion will travel in one second

(a) 1.458×10^6 m
(b) 3.28×10^6 m
(c) 4.862×10^5 m
(d) 2.917×10^6 m

70. The ratio of time taken by electron in revolutions round the H-nucleus in the second and third orbits is

(a) 2:3 (b) 4:8
(c) 8:27 (d) 27:8

71. For hydrogen atom, the number of revolutions of the electron per second in the orbit of quantum number, n, is proportional to

(a) n^3 (b) $\sqrt{n}$
(c) n^{-3} (d) n^{-1}

72. Which of the following is not a permissible value of angular momentum of electron in H-atom?

(a) $1.5 \dfrac{h}{\pi}$ (b) $0.5 \dfrac{h}{\pi}$

(c) $1.25 \dfrac{h}{\pi}$ (d) all of these

73. If an electron in H-atom jumps from one orbit to other, its angular momentum doubles. The distance of electron from nucleus becomes ____ times the initial distance.

(a) 2 (b) 4
(c) $\dfrac{1}{2}$ (d) $\dfrac{1}{4}$

74. The angular momentum of electron revolving in the second orbit of H-atom is 'x' J·s. The angular momentum of electron in the second orbit of He^+ ion should be

(a) x J·s (b) $2x$ J·s
(c) $0.5x$ J·s (d) $4x$ J·s

75. The angular momentum of electron revolving round nucleus of H–atom is directly proportional to

(a) r (b) $r^{1/2}$
(c) $r^{-1/2}$ (d) r^{-1}

76. What is the angular speed of an electron revolving in the third orbit of He^+ ion?

(a) 6.12×10^{15} s^{-1}
(b) 1.63×10^{-16} s
(c) 1.92×10^{16} s^{-1}
(d) 1.95×10^{15}s^{-1}

77. The force of attraction on electron by the nucleus is directly proportional to

(a) $\dfrac{n^3}{Z^4}$ (b) $\dfrac{Z^3}{n^4}$

(c) $\dfrac{n^4}{Z^2}$ (d) $\dfrac{Z^2}{n^4}$

78. The K.E. of electron in He^+ will be maximum in

(a) third orbit
(b) first orbit
(c) seventh orbit
(d) infinite orbit

79. As the orbit number increases, the K.E. and P.E. for an electron:

(a) both increases
(b) both decreases
(c) K.E. increases but P.E. decreases
(d) P.E. increases but K.E. decreases

80. The ratio of energies of first excited state of He^+ ion and ground state of H–atom is

(a) 1:1 (b) 4:1
(c) 1:4 (d) 16:1

81. For which atom or ion, the energy level of the second excited state is 13.6 eV?

(a) H (b) He^+
(c) Li^{2+} (d) Li

82. The orbit from which when electron will jump in other orbit, energy may be absorbed but not emitted out, will be

(a) first orbit
(b) second orbit
(c) seventh orbit
(d) infinite orbit

83. In the Bohr's model of the hydrogen atom, let r, v and E represent the orbit radius, speed of an electron and the total energy of the electron, respectively. Which of following relation is proportional to the orbit number n?

(a) $v \cdot r$ (b) r/E
(c) r/V (d) $r \cdot E$

84. The ratio of potential energy of electron in the third orbit of Li^{2+} ion to the kinetic energy of electron in the fourth orbit of He^+ ion should be

(a) 8:1 (b) –8:1
(c) –16:1 (d) 1:1

85. Which of the following quantity for an electron revolving round the H-nucleus is independent to the mass of electron?

(a) distance from nucleus
(b) K.E.
(c) P.E
(d) speed

86. The potential energy of electron revolving in the ground state of H atom is

(a) –13.6 eV
(b) –6.8 eV
(c) –27.2 eV
(d) Zero

87. An electron is revolving round the nucleus of He^+ ion with speed 2.188×10^6 m/s. The potential energy of the electron is

(a) –13.6 eV (b) –6.8 eV
(c) –27.2 eV (d) Zero

88. As the orbit number increases, the difference in two consecutive energy levels

(a) remain constant
(b) increases
(c) decreases
(d) is unpredictable

89. The amount of energy released when an electron jumps from the seventh excited state to the first excited state in He^+ ion is

(a) 13.32 eV (b) 53.28 eV
(c) 12.75 eV (d) 26.08 eV

90. The energy different will be minimum for which of the following energy levels of H-atom?

(a) $n = 2$ and $n = 3$
(b) $n = 3$ and $n = 4$
(c) $n = 1$ and $n = 2$
(d) $n = 1$ and $n = 4$

91. For which transition in H-atom, the amount of energy released will be maximum?

(a) $n = 4$ to $n = 2$
(b) $n = 5$ to $n = 2$
(c) $n = 2$ to $n = 1$
(d) $n = 7$ to $n = 2$

92. How much energy is needed for an electron revolving in the second orbit of He^+ ion, in order double its angular momentum?

(a) 40.8 eV (b) 2.55 eV
(c) 10.2 eV (d) 12.09 eV

93. The ionization energy of a hypothetical atom is 50 eV. If this atom obey Bohr's atomic model, the energy of electron in its fifth orbit will be

(a) –1250 eV (b) + 2 eV
(c) –2 eV (d) +1250 eV

94. An electron revolving round H-nucleus in ground state absorbs 10.2 eV energy. Its angular momentum increases by

(a) $\frac{h}{2\pi}$ (b) $\frac{h}{\pi}$
(c) $\frac{2h}{\pi}$ (d) $\frac{h}{4\pi}$

95. The ionization energy of He^+ ion is x eV. The ionization energy of Be^{3+} ion should be

(a) $4x$ eV (b) $2x$ eV
(c) $\frac{x}{4}$ eV (d) $\frac{x}{2}$ eV

96. The excitation energy of an electron from second orbit to third orbit of a hydrogen-like atom or ion with +Ze nuclear charge is 47.2 eV. If the energy of H-atom in lowest energy state is –13.6 eV, the value of Z is

(a) 4 (b) 5
(c) 6 (d) 7

97. Electromagnetic radiations of wavelength 240 nm are just sufficient to ionize sodium atom. The ionization energy of sodium (in kJ/mol) is

(a) 5.167 (b) 498.58
(c) 118.83 (d) 51.67

98. The ionization energy of He-atom in ground state may be

(a) 13.6 eV (b) 54.4 eV
(c) 108.8 eV (d) 27.0 eV

99. The binding energy for the third electron in the ground state of Li-atom should be

(a) 108.8 eV (b) 122.4 eV
(c) 30.6 eV (d) 27.2 eV

100. Suppose that means were available for stripping 29 electrons from $_{30}Zn$ in vapours of this metal. The ionization energy for the last electron is

(a) 11.5 keV (b) 12.24 keV
(c) 13.6 eV (d) 408 eV

Spectrum

101. Suppose the mass of electron decreased by 25%. How will it affect the Rydberg constant?

(a) It remains unchanged.
(b) It becomes one-fourth.
(c) It reduces to 75% of its original value.
(d) It is doubled.

102. The charge on the electron and proton is reduced to half. Let the present value of the Rydberg constant is R. What will be the new value of the Rydberg constant?

(a) $\frac{R}{2}$ (b) $\frac{R}{4}$
(c) $\frac{R}{8}$ (d) $\frac{R}{16}$

103. Rydberg is

(a) also called Rydberg constant and is the universal constant.
(b) unit of wavelength and one Rydberg equals 1.09×10^7 m.
(c) unit of wave number and one Rydberg equals 1.09×10^7 m^{-1}.
(d) unit of energy and one Rydberg equals 13.6 eV.

104. For the same electronic transition in the following atom or ion, the frequency of the emitted radiation will be maximum for

(a) H-atom
(b) D-atom
(c) He^+ ion
(d) Li^{2+} ion

105. An electron jumps from the fourth orbit to the first orbit in a H-atom. The number of photons liberated out will be

(a) 1 (b) 2
(c) 3 (d) 6

106. The wavelength of radiation emitted out in the transition $n = 4$ to $n = 1$ in Li^{2+} ion is

(a) $\frac{135R}{16}$ (b) $\frac{16}{135R}$

(c) $\frac{16R}{135}$ (d) $\frac{135}{16R}$

107. What is the frequency of the second line of the Paschen series in the spectrum of He^{+} ion?

(a) $\frac{64\ R.C}{225}$ (b) $\frac{64\ R}{225}$

(c) $\frac{225}{64\ R}$ (d) $\frac{225\ C}{64\ R}$

108. What is the wave number of the radiation of lowest frequency in the Lyman series of the spectrum of Li^{2+} ion?

(a) $\frac{4}{27R}$ (b) $\frac{27R}{4}$

(c) $\frac{27RC}{4}$ (d) $\frac{4C}{27R}$

109. The wavelength of a spectral line obtained by an electronic transition is inversely proportional to

(a) Number of transit electrons
(b) Nuclear charge of the atom
(c) Energy difference of the related energy levels
(d) Speed of the transit electron

110. In H-atom, wave number ratio is 108:7 is for

(a) first Lyman and first Balmer transition
(b) first Lyman and first Brackett transition
(c) first Lyman and first Paschen transition
(d) first Lyman and second Balmer transition

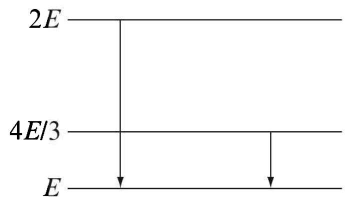
111. Wave number of the first line in the Balmer series of Be^{3+} is 2.5×10^{5} cm^{-1}. Wave number of the second line of the Paschen series of Li^{2+} is

(a) 7.2×10^{4} cm^{-1}
(b) 7.2×10^{5} cm^{-1}
(c) 7.2×10^{-4} cm^{-1}
(d) 1.8×10^{4} cm^{-1}

112. When an electron jumps from nth orbit to 1st orbit, in an imaginary atom obeying Bohr's model, it emit two radiations of wavelengths 400 nm and 300 nm. The frequency of radiation emitted out in the transition $n = n$ to $n = 1$ will be

(a) 7.5×10^{14} Hz
(b) 1.0×10^{15} Hz
(c) 8.75×10^{14} Hz
(d) 1.75×10^{15} Hz

113. The given diagram indicates the energy levels of a certain atom. When the system moves from $2E$ level to E level, a photon of wavelength λ is emitted. The wavelength of the photon emitted during its transition from $4E/3$ level to E level is.



(a) λ/3 (b) 3λ/4
(c) 4λ/3 (d) 3λ

114. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of He^{+} spectrum?

(a) $n = 4$ to $n = 2$
(b) $n = 4$ to $n = 1$
(c) $n = 2$ to $n = 1$
(d) $n = 3$ to $n = 2$

115. Number of possible spectral lines in the bracket series in hydrogen spectrum, when electrons present in the ninth excited state return to the ground state, is

(a) 36 (b) 45
(c) 5 (d) 6

Heisenberg's Uncertainty Principle

116. The uncertainty in measuring speed of a particle is zero. Uncertainty in measuring its position will be

(a) zero (b) $\frac{h}{4\pi}$

(c) $\frac{h}{4\pi m}$ (d) infinite

117. Uncertainty in measuring speed of a particle is numerically equal to uncertainty in measuring its position. The value of these uncertainties will be

(a) equal to $\sqrt{\frac{h}{4\pi m}}$

(b) less than $\sqrt{\frac{h}{4\pi m}}$

(c) greater than $\sqrt{\frac{h}{4\pi m}}$

(d) (a) or (c)

118. If uncertainty in position and momentum of a particle is numerically equal, then the minimum uncertainty in speed of the particle is

(a) $\sqrt{\frac{h}{2\pi}}$ (b) $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$

(c) $\sqrt{\frac{h}{\pi}}$ (d) $\frac{1}{m}\sqrt{\frac{h}{\pi}}$

119. The mass of a particle is 10^{-10} g and its diameter is 10^{-4} cm. If its speed is 10^{-6} cm/s with 0.0001% uncertainty in measurement, the minimum uncertainty in its position is

(a) 5.28×10^{-8} m
(b) 5.28×10^{-7} m
(c) 5.28×10^{-6} m
(d) 5.28×10^{-9} m

120. Uncertainty in the position of an electron (mass = 9.1×10^{-31} kg) moving with a velocity 300 m/s, accurate up to 0.001%, will be ($h = 6.3 \times 10^{-34}$ J s)

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

De-Broglie's Equation

121. The ratio of de-Broglie wavelength of electron and proton moving with the same speed is about

(a) 1836:1 (b) 1:1836
(c) 1:1 (d) 1:2

122. An electron makes five crests during one revolution round H-nucleus. The electron belongs from the

(a) first orbit (b) fourth orbit
(c) fifth orbit (d) sixth orbit

123. The circumference of the third orbit of He^+ ion is x m. The de-Broglie wavelength of electron revolving in this orbit will be

(a) $\frac{x}{3}$ m (b) $3x$ m

(c) $\frac{x}{9}$ m (d) $9x$ m

124. The momentum of a photon of wavelength 6626 nm will be

(a) 10^{-28} kg ms^{-1} (b) 10^{-25} kg ms^{-1}
(c) 10^{-31} kg m^{-1} (d) zero

125. If λ be the de-Broglie wavelength of a thermal neutron at 27°C. The wavelength of the same neutron at 927°C is

(a) λ (b) 0.5λ
(c) 2λ (d) 0.25λ

Quantum Numbers

126. The energy of different orbitals in an atom or ion having only one electron, depends on
(a) n only
(b) n and l only
(c) n, l and m only
(d) n, l, m and s

127. The size of an orbital is given by
(a) principal quantum number
(b) azimuthal quantum number
(c) magnetic quantum number
(d) spin quantum number

128. The types and number of orbitals belonging from the fifth orbit are, respectively,
(a) 5, 25 (b) 25, 5
(c) 4, 16 (d) 5, 5

129. The electron in the same orbital may be identified with the quantum number
(a) n (b) l
(c) m (d) s

130. The orbital angular momentum of an electron is 2s orbital is
(a) $+\frac{1}{2}\cdot\frac{h}{2\pi}$ (b) 0
(c) $\frac{h}{2\pi}$ (d) $\sqrt{2}\,\frac{h}{2\pi}$

131. The orbital angular momentum of a 4p electron will be
(a) $4.\frac{h}{2\pi}$ (b) $\sqrt{2}.\frac{h}{2\pi}$
(c) $\sqrt{6}.\frac{h}{4\pi}$ (d) $\sqrt{2}.\frac{h}{4\pi}$

132. The probability of finding P_y electron is zero in
(a) XY-plane (b) YZ-plane
(c) XZ-plane (d) Y-axis

133. The quantum number which determines the shape of the orbital is
(a) Magnetic quantum no.
(b) Azimuthal quantum no.
(c) Principal quantum no.
(d) Spin quantum no.

134. Orbital with maximum symmetry is
(a) p-orbital (b) s-orbital
(c) d_{xy}-orbital (d) d_{z^2}-orbital

135. In presence of external magnetic field, p-orbital is
(a) 3-fold degenerate
(b) 5-fold degenerate
(c) 7-fold degenerate
(d) non-degenerate

136. The number of orbitals of g-type
(a) 5 (b) 7
(c) 9 (d) 11

137. Which of the following orbital does not exist according to quantum theory?
(a) 5g (b) 4f
(c) 5h (d) 6h

138. Which of the following set of quantum numbers is permissible?
(a) 4, 1, +2, +1/2 (b) 4, 2, –1, +1/2
(c) 4, 0, 0, 1 (d) 4, 4, +2, –1/2

139. Number of orbitals represented by $n = 3$, $l = 2$ and $m = +2$ is
(a) 1 (b) 2
(c) 3 (d) 4

140. 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 classical analogue.

Schrodinger's Equation

141. The number of nodal planes in $2p_x$ orbital is
(a) zero
(b) 1
(c) 2
(d) infinite

142. Which orbital is represented by the complete wave function, ψ_{410}?
(a) 4s (b) 3p
(c) 4p (d) 4d

143. Number of nodal surface in 5s orbital is
(a) 5 (b) 4
(c) 3 (d) 0

144. The orbital having two nodal surfaces is
(a) 1s (b) 2s
(c) 3s (d) 2p

145. The number of radial nodes of 3s, 3p and 3d electrons are, respectively,
(a) 0, 1, 2 (b) 2, 1, 0
(c) 2, 2, 2 (d) 1, 3, 5

Electronic Configuration

146. The process of successive addition of protons to the nucleus followed by an addition of the same number of electrons to the available orbitals in the sequence of increasing energy to obtain the electronic configuration of many electronic configuration of many electron atom, is known as
(a) Pauli's exclusion principle
(b) Hund's rule
(c) Heisenberg's uncertainty principal
(d) Aufbau principle

147. When the value of azimuthal quantum number is 3, the maximum and minimum values of spin multiplicity are
(a) 1, 8 (b) 8, 1
(c) 6, 1 (d) 7, 0

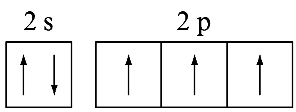
148. A completely filled *d*-orbital (d^{10}) is of
(a) Spherical symmetry
(b) Octahedral symmetry
(c) Tetrahedral symmetry
(d) Unsymmetry

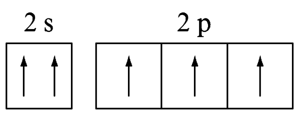
149. An atom have d^8 configuration. The maximum number of electrons in the same spin is
(a) 5 (b) 3
(c) 8 (d) 2

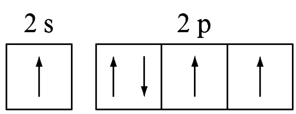
150. The number of orbitals having $(n + l) < 5$ is
(a) 9 (b) 8
(c) 4 (d) 10

151. The total number of orbital for $(n + l) = 4$ is
(a) 4 (b) 16
(c) 32 (d) 9

152. Which of the following configuration is violating Pauli's exclusion principle?

(a) 

(b) 

(c) 

(d) (b) and (c)

153. If there are three possible values (–1/2, 0, +1/2) for the spin quantum number, then the maximum capacity of second orbit will become of
(a) 8 electrons
(b) 6 electrons
(c) 12 electrons
(d) 27 electrons

154. The electrons, identified by quantum numbers *n* and *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) ii < iv < i < iii
(c) i < iii < ii < iv
(d) iii < i < iv < ii

155. If the numbers of orbitals of a particular type were $(3l+1)$, but spin quantum numbers were only +1/2 and –1/2, then d-type orbitals will contain a maximum of ___ electrons.
(a) 10 (b) 14
(c) 7 (d) 5

156. 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's uncertainty principle
(b) Hund's rule
(c) Pauli's exclusion principle
(d) Bohr postulate of stationary orbits

157. Which quantum number differs for the two electrons present in K-shell of an atom?
(a) Principal quantum number
(b) Azimuthal quantum number
(c) Magnetic quantum number
(d) Spin quantum number

158. Correct set of four quantum numbers for the unpaired electron of chloride atom is
(a) 3, 2, 0, +1/2
(b) 3, 1, 0, +1/2
(c) 3, 1, +1, 0
(d) 3, 0, –1, +1/2

159. Correct set of four quantum numbers for the valence electron of rubidium ($Z = 37$) is
(a) 5, 0, 0, +1/2
(b) 5, 1, 0, +1/2
(c) 5, 1, 1, +1/2
(d) 6, 0, 0, +1/2

160. Correct set of quantum numbers defining the highest energy electron in scandium (I) ion is
(a) $n = 3, l = 1, m = 0, s = -1/2$
(b) $n = 3, l = 0, m = 0, s = -1/2$
(c) $n = 4, l = 0, m = 0, s = +1/2$
(d) $n = 3, l = 2, m = 2, s = +1/2$

161. How many unpaired electrons are present in ground state of chromium ($Z = 24$)?
(a) 1 (b) 5
(c) 6 (d) 0

162. K and L shell of an element are completely filled and there are 16 electrons in M-shell and 2-electrons in N-shell. The atomic number of the element is
(a) 18 (b) 28
(c) 22 (d) 26

163. The penultimate and outermost orbit of an element contains 10 and 2 electrons, respectively. If the outermost orbit is fourth orbit, the atomic number of the element should be
(a) 12 (b) 22
(c) 32 (d) 40

164. The number of unpaired electron in G. S., first E.S. and second E.S. of S (Z = 16) are, respectively,
(a) 0, 2 and 4 (b) 2, 4 and 6
(c) 0, 4 and 6 (d) 2, 4 and 4

165. The electronic structure of zinc ($Z = 30$) is 2, 8, 18, 2. The electronic structure of gallium ($Z = 31$) will be
(a) 2, 8, 18, 2, 1
(b) 2, 8, 19, 2
(c) 2, 8, 18, 3
(d) 2, 8, 19, 3

166. Which of the following ion have the same number of unpaired electrons as in Fe^{2+} ($Z = 26$)?
(a) Fe^{3+} ($Z = 26$)
(b) Ni^{2+} ($Z = 28$)
(c) Co^{3+} ($Z = 27$)
(d) Cr^{+} ($Z = 24$)

167. Which of the following will have magnetic moment, about 4.9 B.M.?
(a) Cr^{+} ($Z = 24$)
(b) Ti^{4+} ($Z = 22$)
(c) Fe^{2+} ($Z = 26$)
(d) Cu^{2+} ($Z = 29$)

168. Which of the following ion is diamagnetic?
(a) Sc^{3+} ($Z = 21$)
(b) Ti^{2+} ($Z = 22$)
(c) V^{3+} ($Z = 23$)
(d) Fe^{2+} ($Z = 26$)

169. Which of the following ion will have maximum magnetic moment?
(a) Fe^{3+} ($Z = 26$)
(b) Cr^{3+} ($Z = 24$)
(c) Ti^{4+} ($Z = 22$)
(d) Co^{3+} ($Z = 27$)

170. For which of the following element, all of its existing ion, M^{x+}, will be diamagnetic?
(a) Cu (b) Fe
(c) Cr (d) Na

171. The magnetic moment of Ni^{x+} ion ($Z = 28$) is about 2.82 B.M. The value of x is
(a) 2 (b) 4
(c) 1 (d) 3

172. A compound of vanadium has a magnetic moment of 1.73 BM. The electronic configuration of vanadium ion in the compound is
(a) $[Ar]3d^2$ (b) $[Ar]3d^1$
(c) $[Ar]3d^3$ (d) $[Ar]4s^1$

173. Which of the following is paramagnetic?
(a) Zn^{2+} ($Z = 30$)
(b) Ni^{2+} ($Z = 28$)
(c) Sc^{3+} ($Z = 21$)
(d) O^{2-} ($Z = 8$)

174. Which of the following ion is expected to be coloured?
(a) Zn^{2+} ($Z = 30$)
(b) Ca^{2+} ($Z = 20$)
(c) Sn^{2+} ($Z = 50$)
(d) V^{2+} ($Z = 23$)

175. Which of the following ion is expected to be colourless?
(a) Ni^{2+} ($Z = 28$) (b) Mn^{2+} ($Z = 25$)
(c) Zn^{2+} ($Z = 30$) (d) Cu^{2+} ($Z = 29$)

Answer Keys – Exercise I

Fundamental Particles

1. (c)	2. (c)	3. (d)	4. (d)	5. (c)	6. (b)	7. (c)	8. (d)	9. (c)	10. (d)
11. (a)	12. (c)	13. (c)	14. (d)	15. (c)	16. (c)	17. (c)	18. (b)	19. (c)	20. (a)

Rutherford's Atomic Models

21. (c)	22. (d)	23. (d)	24. (a)	25. (b)	26. (b)	27. (a)	28. (d)	29. (d)	30. (d)
31. (b)	32. (b)	33. (c)	34. (a)	35. (d)					

Planck's Quantum Theory, Photoelectric Effect and Moseley's Experiment

36. (c) 37. (b) 38. (a) 39. (b) 40. (d) 41. (b) 42. (a) 43. (b) 44. (b) 45. (c)
46. (b) 47. (c) 48. (b) 49. (b) 50. (c) 51. (a) 52. (c) 53. (b) 54. (c) 55. (c)

Bohr's Atomic Mode

56. (a) 57. (b) 58. (b) 59. (a) 60. (a) 61. (b) 62. (c) 63. (a) 64. (c) 65. (b)
66. (c) 67. (c) 68. (a) 69. (a) 70. (c) 71. (c) 72. (c) 73. (b) 74. (a) 75. (b)
76. (a) 77. (b) 78. (b) 79. (d) 80. (a) 81. (c) 82. (a) 83. (a) 84. (b) 85. (d)
86. (c) 87. (c) 88. (c) 89. (c) 90. (b) 91. (c) 92. (c) 93. (c) 94. (a) 95. (a)
96. (b) 97. (b) 98. (d) 99. (b) 100. (b)

Spectrum

101. (c) 102. (d) 103. (d) 104. (d) 105. (a) 106. (b) 107. (a) 108. (b) 109. (c) 110. (b)
111. (a) 112. (d) 113. (d) 114. (c) 115. (d)

Heisenberg's Uncertainty Principle

116. (d) 117. (d) 118. (b) 119. (a) 120. (b)

De-Broglie's Equation

121. (a) 122. (c) 123. (a) 124. (a) 125. (b)

Quantum Numbers

126. (a) 127. (a) 128. (a) 129. (d) 130. (b) 131. (b) 132. (c) 133. (b) 134. (b) 135. (d)
136. (c) 137. (c) 138. (b) 139. (a) 140. (d)

Schrodinger's Equation

141. (b) 142. (c) 143. (b) 144. (c) 145. (b)

Electronic Configuration

146. (d) 147. (b) 148. (a) 149. (a) 150. (d) 151. (a) 152. (b) 153. (c) 154. (a) 155. (b)
156. (c) 157. (d) 158. (b) 159. (a) 160. (c) 161. (c) 162. (b) 163. (b) 164. (b) 165. (c)
166. (c) 167. (c) 168. (a) 169. (a) 170. (d) 171. (a) 172. (b) 173. (b) 174. (d) 175. (c)