CHAPTER 2

ATOMIC STRUCTURE

MaxMarks :212

	Write the correct set of four quantum numbers for the valence electron (outermost electron) of potassium (Z = 19).	1
2	Which series of lines of the hydrogen spectrum lies in the visible region?	1
3	How many electrons in an atom have the following quantum numbers? $n = 3$, $l = 0$.	1
4	Write electronic configuration of Cu^+ (atomic no. of Cu = 29).	1
5	Calculate the number of electrons which will together weigh one gram.	1
6	An orbital has $l = 3$, what are the possible values of m?	1
7	What is the shape of orbital with $l = 2$ and $l = 3$?	1
8	An element has atomic number 11 and the mass number 23. How many numbers of neutrons, protons and electrons does it have?	1
9	Give the value of n and l for 2s orbital.	1
10	What is the value of Bohr's radius for the first orbit of hydrogen atom?	1
11	In which of the following set of quantum numbers an electron will have the highest energy? (i) 3, 2, 1, ½ (ii) 4, 2, –1, –½ (iii) 4, 1, 0, –½ (iv) 5, 0, 0, ½.	1
12	What are the values of 'n' and 'l' for 4f-orbital?	1
13	Out of X-rays, infra-red, visible rays and microwaves, which has largest frequency?	1
14	How many electrons are present in NO_3^-?	1
15	Why is energy of electron negative?	1

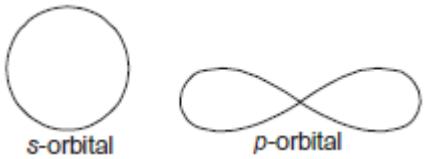
16 Which quantum number is not obtained from solution of Schrodinger wave equation? 1

17 Give values of n, l, m and s for an unpaired electron in Cu (29). 1

18 An electron has $s = +½$ and $m = -1$, it cannot be present in which of the orbital and why? 1

19 Write electronic configuration of (i) $Na^+(11)$ and (ii) $Cl^-(17)$. 1

20 What is physical significance of the lines in the following depictions of atomic orbital? 1



21 How does change in velocity of a moving particle alter the wavelength of the particle? 1

22 State physical significance of ψ^2. 1

23 What are the possible values of 'm' for 3d orbitals? 1

24 What is the possible value of angular momentum quantum number (l) for the unpaired electron in the atom of an element whose atomic number is 17? 1

25 How many electrons and protons are present in the anion of Li_3N? 1

26 Write the atomic number of the element in which filling of 3d sub-shell in the atom just starts. 1

27 Why is following electronic configuration not correct for ground state of Cr atom?
(Atomic number = 24) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^4$ 1

28 An electron has a speed of 40 m s^{-1} accurate upto 99.99%. What is the uncertainty in locating its position? [Given, $m_e = 9.11 \times 10^{-31}$ kg] 2

29 The mass of an electron is 9.1×10^{-31} kg. If its K.E. (kinetic energy) is 3×10^{-25} J, then calculate its velocity. 2

30 What is the energy in joules required to shift the electron of the hydrogen atom from the first Bohr orbit to the fifth Bohr orbit. What is the wavelength of the light emitted when the electron returns to the ground state? 2

31 Calculate the uncertainty in position of an electron if uncertainty in its velocity is 0.001%. Mass of electron = 9.1×10^{-31} kg, velocity of 2

electron = 300 m s^{-1}. (h = 6.626 × 10^{-34} kg m^2 s^{-1})

32 Explain giving reason, which of the following sets of quantum numbers are not possible: 2

(*i*) $n = 1,\ l = 1,\ m_l = 0,\ m_s = +\frac{1}{2}$

(*ii*) $n = 0,\ l = 2,\ m_l = -2,\ m_s = -\frac{1}{2}$

33 What is the maximum number of emission lines when the excited electron of a H atom in n = 6, drops to the ground state? 2

34 One of the spectral lines of caesium has a wavelength of 456 nm. Calculate the frequency of this line (c = 3.0 × 108 m s^{-1}). 2

35 The frequency of the strong yellow line in the spectrum of sodium is 5.09 × 1014 s^{-1}. Calculate the wavelength of the light in nanometre. 2

36 Using *s*, *p*, *d*, *f* notations, describe the orbital with following quantum numbers. 2
(i) n = 1, l = 0;
(ii) n = 2, l = 0;
(iii) n = 3, l = 1;
(iv) n = 4, l = 2
(v) n = 4, l = 3.

37 Calculate the number of protons, neutrons and electrons in $^{80}_{35}Br$. 2

38 Red light has wavelength 750 nm, whereas violet light has wavelength 400 nm. Calculate the frequency and energy (c = 3 × 108 m s^{-1}, h = 6.63 × 10^{-34} J s). 2

39 Calculate wave number of the line having frequency 5 × 10^{16} Hz. 2

40 An element of atomic weight Z consists of two isotopes of mass number Z – 1 and Z + 2. Calculate the % of higher isotope. 2

41 Calculate the total number of electrons present in 1 mol of CH_4? 2
[Atomic number of C = 6, H = 1]

42 The Vividh Bharati station of All India Radio, Delhi, broadcasts on a frequency of 1,368 kHz (kilohertz). Calculate the wavelength of the electromagnetic radiation emitted by transmitter. Which part of the electromagnetic spectrum does it belong to? 2

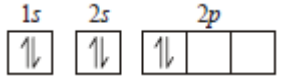
43 A 100-watt bulb emits monochromatic light of wavelength 400 nm. Calculate the number of photons emitted per second by the bulb. 2

44	The threshold frequency v_0 for a metal is 7.0 × 1014 s^{-1}. Calculate the kinetic energy of an electron emitted when radiation of v = 1.0 × 10^{15} s^{-1} hits the metal.	2
45	What will be the wavelength of a ball of mass 0.1 kg moving with a velocity of 10 m s^{-1}?	2
46	The mass of an electron is 9.1 × 10^{-31} kg. If its K.E. is 3.0 × 10^{-25} J, calculate its wavelength. What part of electromagnetic spectrum does it belong to?	2
47	Using '*s*', '*p*', '*d*', '*f*' notations, describe the orbital with the following quantum numbers. (i) n = 2, l = 1 (ii) n = 4, l = 0 (iii) n = 5, l = 3 (iv) n = 3, l = 2	2
48	What is the number of photons of light with a wavelength of 4000 pm that provide 1 J of energy?	2
49	The quantized energy of an electron in hydrogen atom for the nth level is given by $E_n = -\frac{1.312}{n^2} \times 10^6\ \text{J mol}^{-1}$. Calculate the energy required to remove the electron completely from an excited hydrogen atom when its quantized level, n is 3. (NA = 6.02 × 1023 mol^{-1}).	2
50	On the basis of Heisenberg's uncertainty principle, show that electron cannot exist within the atomic nucleus. (Nuclear radius = 10^{-15} m, h = 6.626 × 10^{-34} J s)	2
51	Calculate the wavelength of an electron that has been accelerated in a particle accelerator through a potential difference of 100 million volts. (1 eV = 1.6 × 10^{-19} J, me = 9.1 × 10^{-31} kg, h = 6.6 × 10^{-34} J s, c = 3.0 × 108 m s^{-1}).	2
52	Calculate the velocity of a particle of mass 0.1 mg which is associated with a wavelength of 3.3 × 10^{-29} m (h = 6.6 × 10^{-34} kg m^2 s^{-1}).	2
53	Calculate the energy per photon associated with the following radiations: (i) Radiation of frequency = 3 × 10^{15} s^{-1} (ii) Radiation of wavelength = 40 nm. (h = 6.62 × 10^{-34}J s; c = 3 × 10^8 m s^{-1})	2
54	Two particles A and B are in motion. The momentum of particle 'B' is half of 'A'. If the wavelength associated with the particle 'A' is 5 × 10^{-8} m, calculate the wavelength associated with the particle 'B'.	2
55	The ionisation energy of hydrogen atom is 1.312 × 106 J mol^{-1}. Calculate the energy required to excite an electron in a hydrogen atom from the ground state to the first excited state. (Avogadro's constant = 6.023 × 10^{23})	2

56 Calculate the kinetic energy of a moving electron which has a wavelength of 4.8 pm. (Mass of electron = 9.11×10^{-31} kg, $h = 6.63 \times 10^{-34}$ J s) 2

57 In photoelectric effect experiment, irradiation of a metal with light of frequency 5×10^{20} s^{-1} yields electrons with maximum K.E. = 6.63×10^{-14} J. 2
Calculate v_0 (threshold frequency) for the metal.

58 (i) What is the main difference between electromagnetic waves theory and Planck's quantum theory.
(ii) Which rule is violated in the following orbital diagram: 3



59 Calculate the wave number for the longest wavelength transition in the Balmer series of atomic hydrogen (RH = 1.09677×10^7 m^{-1}). 3

60 (i) What are isoelectronic species? Give example.
(ii) Write the number of unpaired electrons in phosphorus.
(Atomic number of phosphorus = 15) 3
(iii) A golf ball has a mass of 40 g and speed of 45 m/s. If the speed can be measured with inaccuracy of 2%, calculate the uncertainty in the position.

61 (i) Give the number of electrons in the species H_2^+ and O_2^-.
(ii) Using *s*, *p*, *d* notations, describe the orbital with the following quantum numbers:
(a) $n = 3$, $l = 1$, $m = 0$, 3
(b) $n = 1$, $l = 0$
(iii) State Heisenberg's uncertainty principle.

62 When electromagnetic radiation of wavelength 300 nm falls on the surface of sodium, electrons are emitted with a kinetic energy of 1.68×10^5 J mol^{-1}. What is the minimum energy needed to remove an electron from sodium? What is the maximum wavelength that will cause a photoelectron to be emitted? ($h = 6.626 \times 10^{-34}$ J s) 3

63 Find energy of each of the photons which
(i) corresponds to light of frequency 3×10^{15} Hz. 3
(ii) having wavelength of 0.50 Å.

64 A photon of wavelength 4×10^{-7} m strikes on metal surface, the work function of the metal being 2.13 eV. Calculate (i) the energy of the photon (eV), (ii) the kinetic energy of the emission, and (iii) the velocity of the photoelectron. (1 eV = 1.602×10^{-19} J). 3

65 A 25-watt bulb emits monochromatic yellow light of wavelength of 0.57 μm. Calculate the rate of emission of quanta per second. 3

66 How much energy is required to ionise a H-atom if the electron occupies $n = 5$ orbit? Compare your answer with the ionization enthalpy of H-atom (energy required to remove the electron from $n = 1$ orbit). 3

67 (i) The energy associated with the first orbit in the hydrogen atom is -2.18×10^{-18} J/atom. What is the energy associated with the fifth orbit? 3
(ii) Calculate the radius of Bohr's fifth orbit for hydrogen atom.

68 The electron energy in hydrogen atom is given by $E_n = (-2.18 \times 10^{-18})/ n^2$ joules. Calculate the energy required to remove an electron completely from the $n = 2$ orbit. What is the longest wavelength (in Å) of light that can be used to cause this transition? 3

69 Calculate the wavelength of an electron moving with a velocity of 2.05×107 m s^{-1}. 3

70 (i) Write the electronic configuration of the following ions:
(a) H^- (b) Na^+ (c) O^{2-} (d) F^-
(ii) What are the atomic numbers of elements whose outermost electrons are represented by (a) $3s^1$, (b) $2p^3$ and (c) $3p^5$? 3
(iii) Which atoms are indicated by the following configurations?
(a) [He] $2s^1$ (b) [Ne] $3s^2\ 3p^3$
(c) [Ar] $4s^2\ 3d^1$

71 (i) Using *s*, *p*, *d* notations, describe the orbitals with the following quantum number.
(a) $n = 1$, $l = 0$; (b) $n = 3$; $l = 1$;
(c) $n = 4$; $l = 2$; and (d) $n = 4$; $l = 3$
(ii) Explain, giving reasons, which of the following sets of quantum numbers are not possible. 3

$(a)\ n = 0,\ l = 0,\ m_l = 0,\ m_s = +\frac{1}{2}$

$(b)\ n = 1,\ l = 0,\ m_l = 0,\ m_s = -\frac{1}{2}$

$(c)\ n = 1,\ l = 1,\ m_l = 0,\ m_s = +\frac{1}{2}$

$(d)\ n = 2,\ l = 1,\ m_l = 0,\ m_s = -\frac{1}{2}$

$(e)\ n = 3,\ l = 3,\ m_l = -3,\ m_s = +\frac{1}{2}$

$(f)\ n = 3,\ l = 1,\ m_l = 0,\ m_s = +\frac{1}{2}$

(iii) How many electrons in an atom may have the following quantum numbers?

(*a*) $n = 4,\ m_s = -\frac{1}{2}$

(*b*) $n = 3,\ l = 0.$

72 What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of He^+ spectrum? 3

73 (i) The mass of an electron is 9.1×10^{-28} g. If its K.E. is 3.0×10^{-25} J, calculate its wavelength in Angstrom.
(ii) What is photoelectric effect? 3

74 (i) Calculate the total number of electrons present in one mole of methane.
(ii) Find (a) the total number and (b) the total mass of neutrons in 7 mg of 14C.
(Assume that mass of a neutron = 1.675×10^{-27} kg).
(iii) Find (a) the total number and (b) the total mass of protons in 34 mg of NH_3 at STP.
Will the answer change if the temperature and pressure are changed? 3

75 Write the complete symbol for the atom with the given atomic number (Z) and atomic mass (A).
(i) Z = 17, A = 35 (ii) Z = 92, A = 233 (iii) Z = 4, A = 9. 3

76 Yellow light emitted from a sodium lamp has a wavelength (λ) of 580 nm. Calculate the frequency (v) and wave number $(\bar{\nu})$ of the yellow light. 3

77 2×10^8 atoms of carbon are arranged side by side. Calculate the radius of carbon atom if the length of this arrangement is 2.4 cm. 3

78 The diameter of zinc atom is 2.6 Å. Calculate (i) radius of zinc atom in pm and (ii) number of atoms present in a length of 1.6 cm if the zinc atoms are arranged side by side lengthwise. 3

79 A certain particle carries 2.5×10^{-16} C of static electric charge. Calculate the number of electrons present in it. 3

80 Nitrogen laser produces a radiation at a wavelength of 337.1 nm. If the number of photons emitted is 5.6×10^{24}, calculate the power of this laser. 3

81 Neon gas is generally used in the sign boards. If it emits strongly at 616 nm, calculate (i) the frequency of emission, (ii) distance travelled by this radiation in 30 s, (iii) energy of quantum and (iv) number of quanta present if it produces 2 J of energy. 3

82 In astronomical observations, signals observed from the distant stars are generally weak. If the photon detector receives a total of 3.15×10^{-18} J from the radiations of 600 nm, calculate the number of photons received by the detector. 3

83 If the photon of the wavelength 150 pm strikes an atom and one of its inner bound electrons is ejected out with a velocity of 1.5×10^7 m s^{-1}, calculate the energy with which it is bound to the nucleus. 3

84 Emission transitions in the Paschen series end at orbit $n = 3$ and start from orbit n and can be represented as $v = 3.29 \times 10^{15}$ (Hz) $[1/3^2 - 1/n^2]$. 3
Calculate the value of n if the transition is observed at 1285 nm. Find the region of the spectrum.

85 Calculate the wavelength for the emission transition if it starts from the orbit having radius 1.3225 nm and ends at 211.6 pm. Name the series to which this transition belongs and the region of the spectrum. 3

86 Dual behaviour of matter proposed by de Broglie led to the discovery of electron microscope often used for the highly magnified images of biological molecules and other type of material. If the velocity of the electron in this microscope is 1.6×10^6 m s^{-1}, calculate de Broglie wavelength associated with this electron. 3

87 Similar to electron diffraction, neutron diffraction microscope is also used for the determination of the structure of molecules. If the wavelength used here is 800 pm, calculate the characteristic velocity associated with the neutron. 3

88 If the velocity of the electron in Bohr's first orbit is 2.19×10^6 m s^{-1}, calculate the de Broglie wavelength associated with it. 3

89 The velocity associated with a proton moving in a potential difference of 1000 V is 4.37×10^5 m s^{-1}. If the hockey ball of mass 0.1 kg is moving with this velocity, calculate the wavelength associated with this velocity. 3

90 If the position of the electron is measured within an accuracy of ± 0.002 nm, calculate the uncertainty in the momentum of the electron. Suppose the momentum of the electron is h/4πm × 0.05 nm, is there any problem in defining 3

91 The quantum numbers of six electrons are given below. Arrange them in order of increasing energies. If any of these combination(s) has/have the same energy lists: 3

(i) $n = 4,\ l = 2,\ m_l = -2,\ m_s = -\frac{1}{2}$

(ii) $n = 3,\ l = 2,\ m_l = 1,\ m_s = +\frac{1}{2}$

(iii) $n = 4,\ l = 1,\ m_l = 0,\ m_s = +\frac{1}{2}$

(iv) $n = 3,\ l = 2,\ m_l = -2,\ m_s = -\frac{1}{2}$

(v) $n = 3,\ l = 1,\ m_l = -1,\ \ m_s = +\frac{1}{2}$

(vi) $n = 4,\ l = 1,\ m_l = 0,\ m_s = +\frac{1}{2}$

92 The bromine atom possesses 35 electrons. It contains 6 electrons in 2*p* orbital, 6 electrons in 3*p* orbital and 5 electrons in 4*p* orbital. Which of these electron experiences the lowest effective nuclear charge? 3

93 According to de Broglie, matter should exhibit dual behaviour, that is both particle and wave like properties. However, a cricket ball of mass 100 g does not move like a wave when it is thrown by a bowler at a speed of 100 km/h. Calculate the wavelength of the ball and explain why it does not show wave nature. 3

94 Chlorophyll present in green leaves of plants absorbs light at 4.620×10^{14} Hz. Calculate the wavelength of radiation in nanometre. Which part of the electromagnetic spectrum does it belong to? 3

95 (i) Write outer electronic configuration of Cr atom. Why are half filled orbitals more stable?
(ii) State Heisenberg's uncertainty principle. An electron has a velocity of 50 m s^{-1}, accurate upto 99.99%. Calculate the uncertainty in locating its position.
(Mass of electron = 9.1×10^{-31} kg, $h = 6.6 \times 10^{-34}$ J s) 5

96 Threshold frequency, v_0 is the minimum frequency which a photon must possess to eject an electron from a metal. It is different for different metals. When a photon of frequency 1.0 × 1015 s^{-1} was allowed to hit a metal surface, an electron having 1.988×10^{-19} J of kinetic energy was emitted. Calculate the threshold frequency of this metal. Show that an electron will not be emitted if a photon with a wavelength equal to 600 nm hits the metal surface. 5

97 The de Broglie wavelengths associated with a ball of mass 1 kg having kinetic energy 0.5 J is

(a) 6.626×10^{-34} m

(b) 13.20×10^{-34} m 1

(c) 10.38×10^{-21} m

(d) 6.626×10^{-34} A.

98 Which of the following pairs of *d*-orbitals have electron density along the axis?

(a) d_{z2}, d_{xz}

(b) d_{xz}, d_{yz} 1

(c) d_{z2}, d_{x^2-y2}

(d) d_{zy}, $d_{x^2\ y^2}$

99 The radius of which of the following orbit is same as that of first orbit of hydrogen atom? 1

(a) $He^{+}(n = 2)$

(b) $Li^{2+}(n = 2)$

(c) $Li^{2+}(n = 3)$

(d) $Be^{3+}(n = 2)$

100 The radius of second Bohr's orbits for hydrogen atoms is [$h = 6.6262 \times 10^{-34}$ Js, $m_e = 9.109 \times 10^{-31}$ kg, $e_{change} = 1.6021 \times 10^{-19C}$]

(a) 1.65 Å

(b) 4.76 Å 1

(c) 0.529 Å

(d) 2.12 Å

----------*The End*----------