CHAPTER 2: STRUCTURE OF ATOM

NUMBER OF TEACHING HOURS: 10 HOURS

MARKS WEIGHTAGE: 09 (1 M, 2M, and 4M)

QUESTIONS CARRYING ONE MARK:

1. Name the person who first proposed the atomic theory of matter on scientific basis.
2. Mention the sub atomic particles.
3. What is the basic rule, regarding the behaviour of charged particles?
4. Under what conditions of pressure and voltage, the electrical discharge through the gases can be observed?
5. How the pressure of gases in the discharge tube can be adjusted?
6. What are cathode rays(cathode ray particles)?
7. Name the phosphorescent material coated inside the discharge tube behind the anode.
8. Give the conditions under which cathode rays travel in straight line.
9. What is the name given to the particles which constitute the cathode rays?
10. Does the nature of cathode ray depend on the nature of gas in the discharge tube or the electrode material?
11. Name the scientist who was able to determine e/m value of an electron.
12. What is the charge of an electron in coulomb?
13. What is the mass of an electron in terms of kilogram?
14. What are canal rays?
15. Name the fundamental particle of an atom that has highest value for its e/m value.
16. Does the e/m value of canal rays depend on the nature of gas in the discharge tube?
17. Name the gas to be filled in the discharge tube to obtain the smallest and the lightest positive ion.

18. Name the smallest and lightest positive ion obtained when hydrogen gas is subjected to electrical discharge.

19. Who discovered neutron?

20. What is the mass of proton in terms of kilogram?

21. What is the mass of neutron in terms of kilogram?

22. Name the electrically neutral particle obtained by bombarding beryllium with α-particles.

23. Who proposed spherical shape of an atom?

24. Write one name given to the Thomson model of an atom.

25. What is the important feature of Thomson model of an atom?

26. Name the metal foil used in Rutherford's α-particle scattering experiment.

27. What are orbits?

28. What is atomic number?

29. What are nucleons?

30. What is atomic mass number?

31. What are isotopes?

32. What are isobars?

33. Name the three isotopes of hydrogen.

34. ${}^{A}_{Z}X$: what does A and Z represent?

35. How many neutrons are present in ${}^{35}_{17}Cl$?

36. How many protons are present in ${}^{14}_{6}C$?

37. How many electrons are present in ${}^{23}_{11}Na$?

38. Name the fundamental particle of an atom which determines the chemical properties of an element.

39. Write the SI unit of frequency.

40. What is the value of speed of light in vacuum?

41. Define wave number.

42. What is the SI unit of wave number?

43. What is the relation between energy (E) and frequency (ν) of an electromagnetic radiation?

44. What is the name given to the smallest quantity of energy that can be emitted or absorbed in the form of electromagnetic radiation?

45. What is the wave length range of the visible spectrum?

46. What is the value of Planck's constant?

47. What is black body?

48. What is photoelectric effect?

49. Give an example of a metal which exhibits photoelectric effect.

50. What is threshold frequency?

51. What is emission spectrum?

52. What is spectroscopy?

53. Name an element which is identified by spectroscopic method.

54. What is the value of Rydberg's constant in joule?

55. Name the series of spectral line of hydrogen obtained in visible region.

56. Write the mathematical expression for the calculation of angular momentum of an electron in a given stationary state.

57. Write an expression for the calculation of energy associated with an electron in a given stationary state.

58. Write an expression to calculate the wave number of a spectral line in the hydrogen spectrum.

59. What is the value of the radius of the first stationary state (Bohr orbit)?

60. Give an expression to calculate the radii of the stationary states.

61. Write the relationship between wave length (λ), velocity (c) and frequency (ν) of a radiation.

62. What is Zeeman effect?

63. What is Stark effect?

64. Write de Broglie equation.

65. Write the mathematical form of Heisenberg's uncertainty principle.

66. What is the implication of uncertainty principle?

67. What does quantum mechanics deal with?

68. What is Schrödinger equation?

69. What is an atomic orbital?

70. What are quantum numbers?

71. What is the significance of (a) principal quantum number(n); (b) azimuthal quantum number (l); (c) magnetic quantum number (m_l); (d) spin quantum number (m_s)?

72. What are the possible values of n (principal quantum number)?

73. What are the possible values of 'l' (azimuthal quantum number) for a given value of 'n'?

74. What are the possible values for m_l (magnetic quantum number) for a given value of 'l'?

75. What are the possible values of m_s (spin quantum number)?

76. What is the total value of m_l (magnetic quantum number) for a given value of 'l'?

77. What is the value of 'l' for:- (a) s- sub shell; (b) p- sub shell; (c) d-sub shell; (d) f-sub shell; (e) g-sub shell; (f) h- sub shell?

78. Write the possible values of magnetic quantum number (m_l) for l= 2.

79. Name the quantum number that specifies the shape of an atomic orbital.

80. Name the quantum number that specifies the size of an atomic orbital.

81. Name the quantum number that designates the orientation of the atomic orbital.

82. What are nodes?

83. Write the total number of nodes for a given value of 'n'.

84. The total number of nodes for 3s orbital is ----------

85. What is the shape of: (a) s-orbital: (b) p- orbital; (c) d-orbital?

86. On the basis of orientation, how the p-orbitals are designated?

87. On the basis of orientation, how the d-orbitals are designated?

88. What is the maximum number of electrons that can be accommodated in: (a) s-orbital: (b) p- orbitals; (c) d-orbitals; (d) f-orbitals?

89. How many number of orbital are possible for f-sub shell?

90. Using s, p, d, notations, write the orbitals having following quantum numbers: (a) n=4, l=0; (b) n=5, l=1; (c) n=3, l= 2.

91. What are degenerate orbitals?

92. What is the ground state of an atom?

93. What is the excited state of an atom?

94. What is effective nuclear charge?

95. How many electrons in an atom may have the following quantum numbers: n=3, l= 0?

96. What is electronic configuration?

97. Write the electronic configuration of the following elements: (a) Cr (Z=24) (b) Cu (Z=29) (c) Ca (Z=20).

98. Write the electronic configuration of the following: (a) Na^{+} (b) Cl^{-} (c) O^{-2}.

99. Between 3d and 4s orbitals which is having higher energy?

100. How many unpaired electrons are present in the following: (a) Na (b) P (c) O?

Two marks Questions

101. State Heisenberg's uncertainty principle.

102. Name the four quantum numbers.

103. Write any two limitations of Bohr's model of an atom.

104. Distinguish between orbit and orbital.

105. Draw the shape of .a) s – orbital. b) p – orbital.

106. State aufbau principle.

107. State Pauli's exclusion principle.

108. State Hund's rule of maximum multiplicity.

109. What is an orbital? Mention different orbitals.

110. Write the schematic diagram to remember sequences of filling atomic orbitals.

111. Name two series of hydrogen spectra which fall in infra red region.

112. Name the series of lines in the emission spectrum of hydrogen.

113. Write de Broglie equation and explain the terms.

114. Write Rydberg's equation and explain the terms.

115. Write two draw backs of Rutherford's model of an atom.

116. State (n+l) rule.

117. Calculate the wave length of the radiation emitted with a frequency of 1,200kHz ($c = 3.0 \times 10^8 m/s$)

118. Calculate the wave number of radiation having wavelength $5800A^0$.

119. Calculate the energy of one mole of photon of radiation whose frequency is 4×10^{12} Hz.

120. The threshold frequency ν_0 for a metal is $6.0 \times 10^{13}\ s^{-1}$. Calculate the kinetic energy of an electron when the radiation of frequency $\nu = 1.0 \times 10^{14}\ s^{-1}$ hits the metal.

121. What will be the wavelength of a ball of mass 0.2 kg moving with velocity of 10 ms^{-1}?

122. Calculate the wave number of the spectral line of shortest wavelength appearing in the Balmer series of hydrogen spectrum (Given $R_H = 1.09 \times 10^7\ m^{-1}$)

Four Mark Question

123. What are the results drawn from the Cathode ray discharge experiment?

124. What are the Characteristics of Canal Rays?

125. What are the observations made out of Ruther ford's α-ray scattering experiment?

126. What are the conclusions drawn regarding the structure of the atom on the basis of observations in the α-ray scattering experiment?

127. Describe Rutherford's nuclear model of the atom.

128. What are the properties of electromagnetic waves (electromagnetic radiation)?

129. What are the factors that cannot be explained by electromagnetic theory?

130. What are the observations made by Hertz after conducting the photo electric effect experiment?

131. What are the postulates of Bohr's model of hydrogen atom?

132. Write the significance of the four quantum numbers.

Answers

Chapter 2: Structure of atom

1. John Dalton
2. Protons, Neutrons and electrons
3. 'Like charges repel each other and unlike charges attract each other'.
4. At very low pressure and at very high voltage
5. By using vacuum pump
6. The particles moving in the discharge tube from cathode to anode.
7. Zinc sulphide
8. In the absence of electrical or magnetic field.
9. Electrons
10. No. Neither nature of the gas nor electrode material
11. J.J. Thomson.
12. -1.6×10^{-19}C.
13. 9.1094×10^{-31}Kg.
14. The particles carrying positive charge in a discharge tube.
15. Electron.
16. Yes.
17. Hydrogen.
18. Proton.
19. James Chad Wick.
20. 1.672×10^{-27} Kg.
21. 1.675×10^{-27} Kg.
22. Neutron.
23. J. J. Thomson.
24. Plum pudding or raisin pudding or watermelon.

25. Mass of the atom is uniformly distributed over the atom.
26. Gold.
27. The circular path of an electron moving around the nucleus of an atom.
28. No. of Protons present in the nucleus or No. of electrons in a neutral atom.
29. Protons and neutrons present in the Nucleus of an atom.
30. Total No. of Protons and neutrons present in the nucleus of an atom.
31. Atoms of the same element having identical atomic Number but different mass No.
32. Atoms of different elements having same mass No. but different atomic No.
33. Protium, deuterium and Tritium.
34. A= Mass No, Z= Atomic No.
35. 18.
36. 6.
37. 11.
38. Electron
39. Hertz2
40. 3.0×10^8 m/s.
41. Number of wave lengths per unit length is called wave number ($\bar{\nu}$).
42. m^{-1} or per meter
43. $E = h\nu$
44. Proton.
45. 400 nm to 750 nm
46. 6.626×10^{-34} Js.
47. The ideal body which emits and absorbs radiations of all frequency.
48. The ejection of electrons from metal surface when radiation strikes it.
49. Potassium or Caesium or Rubidium.
50. The minimum frequency below which photoelectric effect is not observed.

51. The spectrum of radiation emitted by a substance that has absorbed energy is called an emission spectrum.

52. The study of emission or absorption spectra is known as spectroscopy.

53. Rubidium or Caesium, or Thallium or Indium, or Gallium or Scandium or Helium.

54. 2.18×10^{-18} J.

55. Balmer series

56. $m_e\, vr = n \frac{h}{2\pi}$

57. $E_n = -R_H \left(\frac{1}{n^2}\right)$

58. $\bar{\nu} = R_H \left(\frac{1}{n1^2} - \frac{1}{n2^2}\right)$ cm^{-1}

59. $a_0 = 52.9$ Pm.

60. $r_n = n^2 a_0$

61. $C = \nu\lambda$

62. The splitting of spectral lines in the presence of magnetic field.

63. The splitting of spectral lines in an electric field.

64. $\lambda = \frac{h}{mv} = \frac{h}{p}$

65. $\Delta x \times \Delta P_x \geq \frac{h}{4\pi}$

66. It rules out existence of definite paths of electrons.

67. It deals with dual behavior of matter.

68. $\hat{H}\psi = E\psi$

69. It is the region around the nucleus where electron will most probably be found.

70. Quantum Numbers specify the energy, size, shape and orientation of an orbital.

71. a) It determines the size and energy of the orbital.

    b) It determines the three dimensional shape of the orbital.

    c) It gives the spatial orientation of the orbital.

d) It refers to orientation of the spin of the electron.

72. n=1,2,3 - - - - - ∞.

73. l=0,1,2,3 - - - - (n-1).

74. m=-l, -(l-1), -(l-2)- - - - 0,1 - - - (l-2), (l-1),l

75. + $\frac{1}{2}$ and - $\frac{1}{2}$

76. (2l+1) values.

77. a) l=0, b) l=1, c) l=2, d) l=3, e) l=4, f) l=5

78. m_l = -2, -1, 0, + 1, + 2.

79. Azimuthal Q.no(l)

80. Principal Q. no (n)

81. Magnetic Q.no (m_l)

82. The region where probability density function reduces to zero.

83. Total no. of nodes = (n-1).

84. No. of nodes = 2

85. a) Spherical b) dumb bell c) double dumb – bell.

86. p_x , p_y and p_z

87. d_{xy}, d_{yz}, d_{zx}, $d_{x^2-y^2}$ and d_{z^2}

88. a) 2 b) 6 c) 10 d) 14

89. 7

90. a) 4s b) 5p c) 3d

91. Orbital's having the same energy.

92. Atom having electrons occupying lowest energy level.

93. The state of an atom having its electron in higher energy level.

94. The net positive charge experienced by the outer electrons.

95. 2 electrons.

96. The distribution of electrons into orbitals of an atom.

97. a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6 3d^5\ 4s^1$ b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6 3d^{10}\ 4s^1$

c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

98. a) $1s^2\ 2s^2\ 2p^6$ b) $1s^2\ 2s^2\ 2p^6\ 3s^2 3p^6$ c) $1s^2\ 2s^2\ 2p^6$

99. 3d

100. a) 1 b) 3 c) 2

Answers to two marks questions

101. It is impossible to determine simultaneously the exact position and exact momentum of an electron."

102. a. Principal Q. Number (n)

b. Azimuthal Q. Number (l)

c. Magnetic Q. Number (ml)

d. Spin Q. Number (ms)

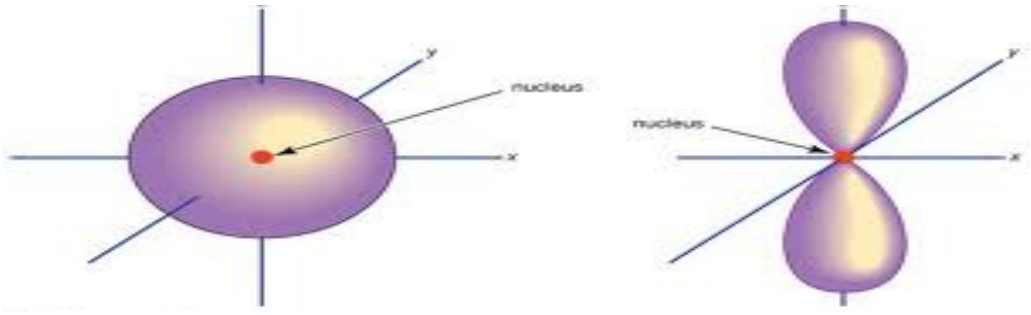
103. It fails to accounts for the finer details of the hydrogen atom spectrum. It could not explain the ability of atom to form molecules by chemical bonds

104.

	Orbit		Orbital
1	It is a circular path around the nucleus in which an electron moves.	1	It is the three dimensional region of space where the probability of finding the electron is maximum
2	Maximum number of electrons that can be accommodated is equal to $2n^2$	2	Maximum number of electrons in an orbital is 2.

105.

S – orbital p – Orbital



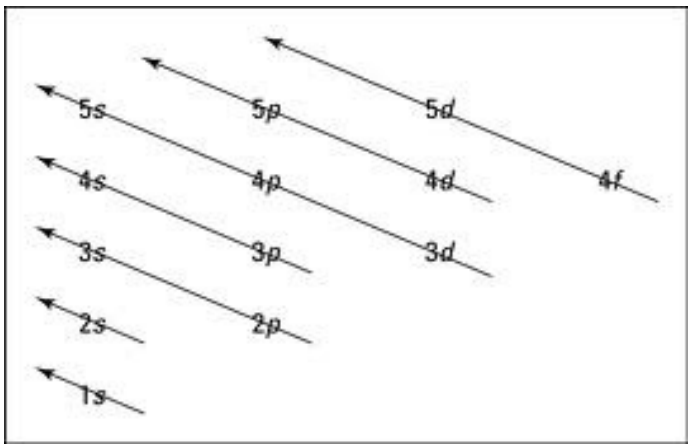
106. " In the ground state of the atom orbitals are filled in the order of their increasing energies".

107. " No two electrons in an atom can have the same set of four quantum numbers".

108. " Pairing of electrons in the orbital's belonging to the same sub shell does not takes place until each orbital belonging to that sub shell has got one electron each."

109. " It is the three dimensional region of space where the probability of finding the electron is maximum."

110. The different orbitals are s, p, d, and f



111. Bracket series

Paschen series

Pfund series (any two)

112. Lyman series

Balmer Series

Bracket series

Paschen series

Pfund series

113. De Broglie Equation $\lambda = \frac{h}{Mv}$

Where m is the mass of the particle?

v is the velocity of the particle

114. $\bar{\nu} = R_H \left[\frac{1}{n1^2} - \frac{1}{n2^2}\right] cm^{-1}$

$\bar{\nu}$ - wave number

R_H – Rydberg constant

115. a. This model fails to account for the stability of an atom.

b. This model does not explain the line spectrum of an atom.

Or

This model does not have any specific radius for radius electron orbit.

116. " Lower the value of (n+l) for an orbital , the lower is its energy . If two orbital's have the same value of (n + l) , the orbital with lower value of n will have the lower energy."

117. $\lambda = \frac{C}{\nu}$

$\lambda \quad \frac{3 \text{ X } 10\ 8\ ms\text{-}1}{1200 \text{ X } 10^3\ s^{-1}}$

$\lambda = 0.0025 \text{ X } 10^5 \text{ m}$

$\lambda = 250 \text{ m}$

118. Calculation of wave number

$\lambda = 5800\ A^0 = 5800 \text{ X } 10^{-8} \text{ cm} = 5800 \text{ x } 10^{-10} \text{ m}$

$\bar{\nu} = \frac{1}{\lambda} = 1/\ 580 \text{ X } 10^{-10} \text{ m}$

$= 1.724 \text{ X } 10^6 \text{ m-1}$

119. Energy of photon $E = h \nu$

$h = 6.626 \times 10^{-34}$ JS

$\nu = 4 \times 10\ 12$ Hz (s^{-1})

$E = 6.626 \times 10^{-34}$ Js $\times 4 \times 10^{12}$ S^{-1}

$= 26.504 \times 10^{-22}$

$= 2.65 \times 10^{-21}$ J

120. Kinetic Energy $= h (\nu - \nu_o)$

$= (6.626 \times 10^{-34}$ Js) $(1.0 \times 10^{14}$ $s^{-1} - 6.0 \times 10^{13}$ $s^{-1})$

$= (6.626 \times 10^{-34}$ Js) $(4.0 \times 10^{13}$ $s^{-1})$

$= 2.65 \times 10^{-20}$J

121. $\lambda = \frac{h}{m\nu}$

$= (6.626 \times 10^{-34}$ Js)/ (0.2 Kg X 10 ms^{-1})

$= 3.313 \times 10^{-34}$ m

122. $\overline{\nu} = R_H \ (1/n_1^2 - 1/n_2^2)$

For Balmer series with shortest wavelength

$n_1 = 2 \qquad n_2 = \infty$

$R_H = 1.09 \times 10^7$ m^{-1}

$\overline{\nu} = 1.09 \times 10^7 \ (1/2^2 - 1/\infty^2)$

$= 1.09 \times 10^7 \ (¼ - 0)$

$\overline{\nu} = 2.725 \times 10^6$ m^{-1}

123. .

i. The Cathode rays start form cathode and move towards anode.

ii. Cathode rays are not visible.

iii. In the absence of electrical or Magnetic field, Cathode rays travel in straight lines.

iv. In the presence of electrical or magnetic field, the direction of deflection of cathode rays shows that they contain negatively charged particles.

v. The characteristics of cathode rays do not depend on the material of electrodes and nature of the gas present in the cathode ray tube.

(Any Four Points)

124.

i. Positively charged particles (Canal Rays) depend upon the nature of the gas present in the cathode-ray tube.

ii. The charge to mass ratio of the particles depend on the gas from which they originate.

iii. Some of the positively charged particles carry a multiple of the fundamental unit of electrical charge.

iv. In the presence of electrical or magnetic field, the behavior of positively charged particles is opposite to that observed for cathode rays.

125.

i. Most of the α–particles passed through the gold foil undeflected.

ii. A small fraction of the α–Particles was deflected by small angles.

iii. A very few α-particles bounced back, that is were defected nearly 180^0

126.

i. Most of the space in the atom is empty

ii. The Positive charge of the atom is not spread through out the atom, but concentrated in a very small volume

iii. The volume occupied by the nucleus is negligibly small as compared to the total volume of the atom

127.

i. The positive charge and most of the mass of the atom is concentrated in a small region called nucleus

ii. The nucleus is surrounded by Electrons

iii. The Electrons move around the nucleus in circular paths called orbits.

iv. The Electrons and the nucleus are held together by Electrostatic force of attraction

128.

i. Electrical and Magnetic waves are perpendicular to each other and both are perpendicular to the direction of the propagation of the wave.

ii. Electromagnetic waves do not require medium and they can move in vacuum

iii. There are many types of electromagnetic radiations. They differ from one another in wavelength or frequency

iv. Different kinds of units are used to represent Electromagnetic

v. radiation.

129.

i. The nature of emission of radiation from hot bodies (black body radiation)

ii. Ejection of electrons from metal surface when radiation strikes it (Photo electric effect)

iii. Variation of heat capacity of solids as a function of temperature

iv. Line spectra of atoms with special reference to hydrogen

130.

i. The electrons are ejected from the metal surface as soon as the beam of light strikes the surface

ii. The number of electrons ejected is proportional to the intensity of light

iii. For each metal there is a characteristic minimum frequency called threshold frequency below which photo electric effect is not observed.

iv. The kinetic energies of ejected electrons increase with increase of frequency of light used.

131.

i. The electron in the hydrogen atom can move around the nucleus in a circular path of fixed radius and energy and the paths are called orbits

ii. The energy of an electron in the orbit does not change with time

iii. The frequency of radiation absorbed or emitted when transition occurs between two stationary states that differ in energy by ΔE is given by

$$\nu = \frac{\Delta E}{h}$$

$$\nu = \frac{E_2 - E_1}{h}$$

iv. The angular momentum of an electron in a given stationary state is integral multiple of $\frac{h}{2\pi}$

$$\text{i.e., } m_e V_r = n \frac{h}{2\pi}$$

132.

i. Principal quantum number determines energy and size of the orbital

ii. Azimuthal quantum number defines three dimensional shape of the orbital.

iii. Magnetic quantum number gives the information about the spatial orientation of the orbital.

iv. Spin quantum number refers to orientation of the spin of the electron.