1st YEAR CHAPTER 5
ATOMIC STRUCTURE

1. Why the positive rays are also called canal rays?

In 1886, Goldstein discovered canal rays. He used perforated cathode and observe florescence on cathode wall. Because positive rays passed through the holes (canals) in the cathode, so they are called canal rays.

2. Give two defects of Bohr's atomic model.

i. **Orginal of spectrum:**

Bohr's theory failed to successfully explain the origin of spectrum of multi-electron or poly-electron system like He, Li and Be.

ii. Fine structure or multiple structure of spectral lines:

The splitting of spectral lines into component lines while passing through high power resolving spectrometer is called multiple or fine structure. Bohr failed to explain the multiple structure of spectral lines.

iii. Atomic Model is not flat:

Bohr suggested circular orbits of electrons and flat atomic model.

3. State Hund's rule.

If degenerate orbitals are available and more than one electron are to be placed in them, they should be placed in separate orbitalswith same spin rather than putting them in the same orbtal with opposite spin. e.g

4. State Pauli's Exclusion principle.

It is impossible for two electrons residing in the same orbital of a poly-electron atom to have the same value of four quantum numbers.

OR

Two electrons in the same orbital should have opposite spins.

5. How neutrons are used in treatment of cancer?

$$^{65}_{29}Cu + ^{1}_{0}n \longrightarrow ^{66}_{29}Cu + h\nu \qquad (\textbf{a-rays})$$

$$^{66}_{29}Cu \longrightarrow ^{66}_{30}Zn + ^{0}_{-1}e \qquad (\textbf{b-rays})$$

$$^{14}_{7}N + ^{1}_{0}n \rightarrow ^{11}_{5}B + ^{4}_{2}He \qquad (\alpha\textbf{-rays})$$

Because of their intense biological effects, they are being used in cancer treatment.

6. Calculate wave number value of Lyman series when n_1 =1 and n_2 = 3.

Wave number value of Lyman series:

n_1 =1 and n_2 = 3

$$\bar{v} = 1.09678 \times 10^{7}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = 82.26 \times 10^{5}\ m^{-1}$$

$$\bar{v} = 1.09678 \times 10^{7}\left[\frac{1}{1^2} - \frac{1}{3^2}\right] = 97.49 \times 10^{5}\ m^{-1}$$

The value of wave number lies in U.V region of the spectrum. It means that when electron falls from 3rd orbit to 1st orbit , then the photon of radiation emitted lie in the range of U.V region.

7. **Why e/m value of the cathode rays is just equal to that of electron?**

The e/m value of the cathode rays is just equal to that of electron. This shows that they are simply electrons. That's why Stoney named the cathode rays particles as electrons.

$e/m = 1.7588 \times 10^{11}$ C/Kg

8. **Give electronic configuration of La-57 and Cr-24.**

$_{57}$**La =** $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^6, 5s^2, 4d^{10}, 5p^6, 6s^2, 4f^1$

$_{24}$**Cr =** $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^5$

9. **Cathode rays are material particles. Explain with reason.**

Cathode rays can drive a small paddle wheel in their path. This observation shows that cathode rays have momentum. From this observation, it is inferred that cathode rays are not rays but material particles having a definite mass and velocity. Cathode rays are material particles has mass 9.1×10^{-31} Kg. cathode rays cast shadow when a opaque object of placed in their path. This proves that they travel in a straight line perpendicular t the surface of the cathode.

10. **Distribute the electron in orbitals of $_{29}$Cu and $_{26}$Fe.**

$_{29}$**Cu =** $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^{10}$

$_{26}$**Fe =** $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^6$

11. **Write the two drawbacks of Rutherford's model of atoms.**

A revolving electron must emit electron continuously. As a result, electron will move in a spiral path and will fall into the nucleus. However it never happened.

If electron emits energy continuously, then a continuously spectrum should be formed. Actually atom forms line spectrum.

12. **Write the two drawbacks of Bohr's model of atoms.**

i. **Origin of Spectrum**

Bohr's theory fails to successfully explain the origin of spectrum of multiple electron system like He, Li & Be.

ii. **Fine structure of spectral lines**

The splitting of spectral lines into components lines while passing through high power resolving spectrometer is called multiple or fine lines. Bohr failed to explain the multiple structures of spectral lines.

iii. **Atomic model is not flat**

Bohr suggested circular orbits of electrons and flat atomic model.

iv. **Zeeman and Stark's Effect:**

This theory cannot explain the Zeemen's and Stark;s effect.

13. **Define Heisenberg's uncertainty principle and give its mathematical expression.**

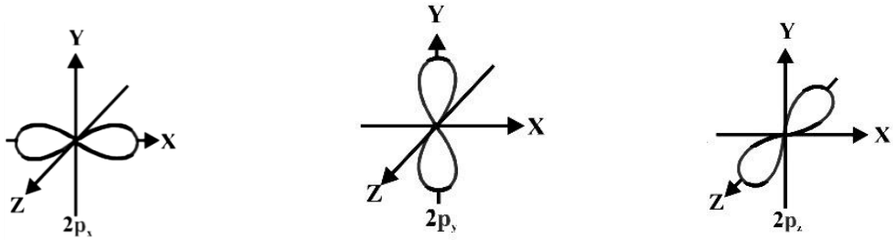
It was gived by Heisenberg in1927

According to this principle, it is **impossible** to measure the **position** as well as **momentum** of electron simultaneously and accurately.

$$\Delta x . \Delta p \geq h/4\pi$$

14. What is orbital? Draw the shape of P orbital.

Orbital: It is the region in space in which probability of finding the electron is maximum.



15. Differentiate between line spectrum and continuous spectrum.

Continuous spectrum	Line spectrum
In this spectrum, colors are diffuse into each other.	It consists of dark and bright lines which are separated by dark and bright bands.
There is no sharp boundary between the colours.	There is distance between the lines.
It is characteristic of a matter in bulk	It is characteristic of atoms.
For example Rainbow	For example spectrum of hydrogen

16. What is Lymen's series?

Lymen's series: When an electron jumps from higher orbit to 1st orbit, the spectrum obtained lies in U.V region. The wavelength of this spectrum forms Lymen's series.

17. Write four properties of cathode rays?

Properties of cathode rays:

i. Cathode rays can ionize the gas.
ii. Cathode rays can cause chemical change because they have reducing effect.
iii. Cathode rays pass through thin metal foil like aluminum or gold foil.
iv. Cathode rays can produce X-rays when they are converged through concave surface on an anode of large atomic number.

18. The radius of first orbit of hydrogen atom is 0.529 A°. Calculate the radius of 3rd orbit of hydrogen atom.

$$r = \frac{\varepsilon_o h^2}{\pi m e^2} \times \frac{n^2}{Z}$$

$Z = 1$

$$r = 0.529\ A^o \times n^2$$

$$r \propto n^2$$

For third orbit $n = 3$

$$r = 0.529\ A^o \times 3^2 = 4.75\ A^o$$

19. Whichever gas is used in the discharge tube the nature of cathode rays remain same? Why?

The cathode rays are the electrons which are fundamental particles of every gas, so nature of cathode rays remains same for every gas.

20. How do you come to know the velocities of electrons in higher orbits are less than those in lower orbitals of hydrogen atom.

$$r = \frac{Ze^2}{4\pi\varepsilon_o m} \times \frac{1}{v^2}$$

Where $\frac{Ze^2}{4\pi\varepsilon_o m}$ is constant

$$r \propto \frac{1}{v^2}$$

Radius is inversely proportional to square of velocity. It means that if radius increased than velocity is decreased and vice versa.

21. Write down the electronic configuration of ^{21}Sc and ^{35}Br.

$_{21}Sc$ = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^1$

$_{35}Br$ = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^{10}, 4p^5$

22. Give any two properties of neutrons.

- Neutrons cannot ionize gas.
- Neutron is highly penetrating particle.
- They can expel high speed proton from paraffin, water, paper and cellulose.
- Free neutrons decays into proton with emission of an electron and neutrino.

23. Give reason for the production of positive rays.

Positive rays are produced by the ionization of gas inside the discharge tube. Different gases have different e/m ratio. Highest e/m ratio is obtained by hydrogen gas when high velocity electrons strike with gas molecules it splits up into cations and electrons. Electrons move towards anode and cation move towards cathode.

24. Calculate mass of an electron from its e/m value.

From e/m ratio of electron, mass of electron can be calculated as

$e/m = 1.7588 \times 10^{11}$ C/Kg $\qquad$ 1.7588×10^{11} C/Kg

$m = e/1.7588 \times 10^{11}$ $\qquad$ $m = 9.1095 \times 10^{-31}$Kg

$m = 1.602 \times 10^{-19}$C

25. How the K-series, L-series and M-series of x-rays spectrum are produced?

When X-rays are passed through a slit and then through aluminum window, these rays then thrown on a crystal of $K_4[Fe(CN)_6]$ which analyze the ray. These are diffracted from the crystal and a line spectrum of X-rays is obtained. This is taken on photographic plate. This X-rays spectrum is characteristic of target material. This spectrum has discrete spectral lines. These lines are grouped into K-series, L-series, M-series. Each series has various lines as K_α, K_β, M_α, M_β.

26. What is Plank's quantum theory? OR Give two postulates of Plank's theory.

- Energy is not emitted or absorbed continuously. Rather, it is emitted or absorbed in a discontinuously and in the form of energy packets. These energy packets orquantum are associated with a definite amunt of energy. In case of light the quantum of energy is often called photon.
- The amount f energy associated with a quantum of radiations is proportional to the frequency of the radiations.

$$E \propto v, \qquad E = h\nu$$

27. Write properties of positive rays.

- These rays travel in a straight line towards the cathode.
- They show deflection by electric and magnetic field. It shows that they are positively charged.
- They cause flash upon ZnS plate.
- Their e/m ratio varies with the residual gas.
- Their e/m ratio is smaller than that of cathode rays.
- These rays consist of tiny particles called protons having mass 1860 times to electrons.

28. Write two importance of Moseley law.

Importance of Moseley law:

- Moseley's arranged the elements K and Ar, Ni and Co in a proper way in Mendeleev's periodic table.
- This law has led to the discovery of many new elements like Tc, Pm, Rh.
- The atomic number of rare earths has been determined by this law.

29. Write a nuclear reaction for the decay of free neutron.

Free neutron decays into proton with the emission of an electron and neutrino.

$$^{1}_{0}n \longrightarrow {}^{1}_{+1}P + {}^{0}_{-1}e + {}^{0}_{0}n$$

30. Pressure can affect the production of Cathode Rays.

OR

Why pressure is reduced in discharge tube experiment?

At ordinary pressure, the no. of particles of a gas is greater hence greater chances of collisions of cathode rays with them. These cannot reach the anode and conduction does not take place. When pressure is reduced, the no. of particles becomes smaller collision decreases and conduction take place.

31. Define Auf-bau principle and Pauli's Exclusion principal.

Auf-bau principle:

According to this principle, lower energy level will be filled first. The electrons are first placed in 1s, 2s, 2p and so on.

Pauli's Exclusion principal:

It is impossible for two electrons residing in the same orbital of a poly-electron atom to have the same value of four quantum numbers.

OR

Two electrons in the same orbital should have opposite spins.

32. Differentiate between slow and fast neutron.

Slow Neutron	Fast Neutron
1. Slow neutrons travel with energy less than 1 eV.	1. Fast neutrons travel with energy 1.2 MeV.
2. Slow neutrons are more effective in fission reaction.	2. Fast neutrons are less effective in fission reaction.
3. Slow neutrons eject ɤ-rays when they hit Cu. Radioactive $_{29}Cu$ is converted into $_{30}Zn$. $^{65}_{29}Cu + {}^{1}_{0}n \longrightarrow {}^{66}_{29}Cu + h\nu$ (ɤ-rays) $^{66}_{29}Cu \longrightarrow {}^{66}_{30}Zn + {}^{0}_{-1}e$ (β-rays)	**3.** Fast neutrons eject an α-particles and Boron is produced. $^{14}_{7}N + {}^{1}_{0}n \longrightarrow {}^{11}_{5}B + {}^{4}_{2}He$ (α-rays)

33. Justify that the distance gaps between different orbitals go on increasing from the lower to higher orbits.

According to Bohr's model, the radius of an orbit is proportional to the square of number of orbit.

$$r = 0.529\left(\frac{n^2}{Z}\right)A^o$$

For hydrogen atom Z = 1 putting this value in above equation:

$r_1 = 0.529\ A^o$ when n = 1, Z = 1

$r_2 = 2.11\ A^o$ when n = 2, Z = 1

$r_3 = 4.75\ A^o$ when n = 3, Z = 1

$r_4 = 8.46\ A^o$ when n = 4, Z = 1

$r_5 = 13.22\ A^o$ when n = 5, Z = 1

34. When is Zeeman effect and stark effect?

Ans. **Zeeman Effect:** When the excited atoms of hydrogen are placed in a magnetic field, its spectral line are further split up in to closely spaced lines. This type of splitting of spectral lines is called Zeeman effect.

Stark Effect: When the excited hydrogen atom is placed in an electric field, its spectral lines are further split up into closely spaced lines. This type of splitting of spectral lines is called stark effect.

35. Give electronic distribution of

$^{31}_{15}P$ and $^{66}_{29}Cu$

$_{29}$**Cu** = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^{10}$

$_{15}$**P** = $1s^2, 2s^2, 2p^6, 3s^2, 3p^3$

36. **How neutrons were discovered by Chadwick? Give the equation of nuclear reaction involved.**

James Chadwick discovered neutrons in 1932. A stream of α-particles produced from polonium source was directed at beryllium target. Some penetrating radiations were produced called neutrons.

Nuclear reaction:

$$^{9}_{4}Be + {}^{4}_{2}He \longrightarrow {}^{12}_{6}C + {}^{1}_{0}n$$

37. The potential energy of bounded electron is negative.

When electrons are free from the nucleus, their potential energy is considered as zero. When electron is under the force of attraction, the energy of the electron becomes less than zero which is negative and is given by formula

$$E = \frac{Ze^2}{4\pi\varepsilon r}$$

38. Write down electronic configuration of $_{21}$Sc and $_{35}$Br.

$_{21}$**Sc** = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^1$

$_{35}$**Br** = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^5$

39. Discuss magnetic and spin quantum numbers.

Magnetic quantum number (m)

It describes the orientation of the orbital in space. It can have all the integral values between $+\ell$ and $-\ell$ through zero i.e. $+\ell$ …….. 0 …….. $-\ell$. For each value of ℓ, there will be

$(2\ell + 1)$ values of m. actually the values of m gives us the information of degeneracy of orbitals in space.

Spin quantum number (s)

It describes the spin of electron in atom. Since an electron can spin clockwise or anti clockwise, thus two possible values are + and – depending upon the spin of electron.

40. How positive rays are produced in the discharge tube?

In 1886, Goldstein observed that while cathode rays are travelling away from cathode, there are other rays are produced at the same time. These rays after passing through the perforated cathode produce a glow on the wall opposite to the anode. These rays are named as positive rays because they carry positive charge.

41. Why the electrons move faster nearer to the nucleus in an orbit of smaller radius?

According to the equation

$$r = \frac{Ze^2}{4\pi\varepsilon_0 mv^2}$$

The radius of a moving electron is inversely proportional to square of its velocity.

$$r = \frac{1}{v^2}$$

It means that electron should move faster nearer to the nucleus in an orbit of smaller radius.

42. Give products formed due to decay of neutrons.

Free neutron decays into a proton with the emission of an electron and a neutrino.

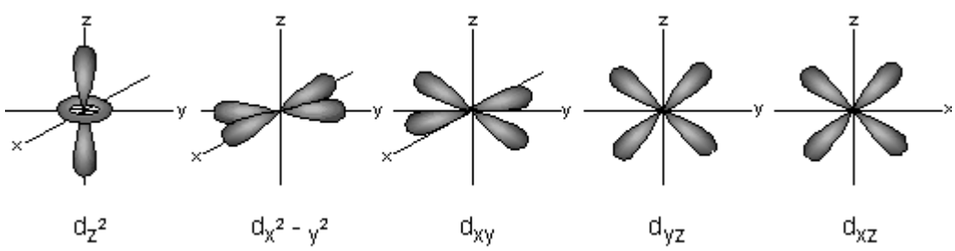
$$^{1}_{0}n \longrightarrow {}^{1}_{+1}P + {}^{0}_{-1}e + {}^{0}_{0}n$$

43. Describe $(n + \ell)$ rule for distribution of electrons.

This rule gives us arrangement of electrons on subshell. It has two parts

- Electrons are filled in subshells in increasing order of their $n+\ell$ value.
- If two subshells have same $n+\ell$ value, then subshell with low 'n' value filed first. This rule gives us arrangement of subshells in increasing order of their energy.

44. Draw the shapes of d orbitals?



45. What is Mosley's law? Also give its importance.

The frequency of x-rays is directly proportional to square of atomic number of metal emitting it.

$$V \propto Z^2$$

$$\sqrt{v} = a(Z-b)$$

52. How Devison and Germar proved dual nature of matter.

In 1927, Davison and Germer proved that the accelerated electrons undergo diffraction just like waves when they fall on nickel crystal. In this way, wave nature of moving electron is

verified.For this, they produced electrons from heated filament and accelerated by applying the potential difference through charged plates. They proved that accelerated electrons undergo diffraction when they fall on nickel crystal. This diffraction is similar to wave. Davisson and Germer got Noble prize from inventing an apparatus to prove the wave nature of matter.

53. Why the Rutherford atomic model was unsatisfactory?

OR

What are the defects of Rutherford's atomic model?

i. The electron revolving around the nucleus should be accelerated towards nucleus and ultimately fall in it but it never happens.

ii. The electron continuously revolves around the nucleus. It should radiate energy continuously and should give continuous spectrum. Opposite of that atom actually gives line spectrum.

54. Differentiate between atomic emission and atomic absorption spectrum?

Atomic Emission Spectrum	Atomic Absorption Spectrum
In this spectrum, bright lines are separated by dark bands	In this spectrum, dark lines are separated by bright lines
It is formed when the substance is in excited state	It is formed when the substance is in unexcited state
It is formed when the substance is excited to vapor state	It is frmed by the transparent gases, transparent liquids and solids.
For its formation, electron jumps from higher energy level to lower energy level and emit energy as light. The emitted rays are indicated as coloured lines.	For its formation, electron jumps from lower energy level to higher energy level and absorb energy. The absorbed rays are indicated as dark lines.
Emission spectrum of sodium has two yellow lines separated by dark bands	Absorption spectrum of sodium has two dark lines separated by bright bands.

55. What is Hα line in hydrogen spectrum?

Hα line in hydrogen spectrum is the spectral line which is formed when electron jumps from 3rd orbit to 2nd orbit in Balmer series

56. Why it is necessary to decrease the pressure in the discharge tube to get the cathode rays?

Ans. The current does not flow through the gas at ordinary pressure even at high voltage about 500 volts. However when the pressure inside the tube is decreased, the gas in the tube begins to conduct electricity at low pressure. Therefore it is necessary to decrease the pressure in the discharge tube to get the cathode rays.

57. Whichever gas is used in the discharge tube the nature of the cathode rays remains the same why?

Ans. A cathode ray consists of beam of electrons and electrons are constituents of all matter so, cathode rays do not depend upon the nature of the gas. Therefore, whichever gas is used in the discharge tube, the nature of cathode rays remains the same.

58. Why e/m value of cathode rays is just equal to that of electrons?

Ans. A cathode ray consists of beam of electrons, so cathode rays are actually electrons. Therefore e/m value of cathode ray is just equal to that of electron.

59. The bending of the cathode rays in the electric and magnetic field show that they are negatively charged.

Ans. The cathode ray beam travels in a straight line from the cathode to anode. The beam bends toward the south pole of the magnet when it passes through the magnetic field, which shows the cathode rays are negatively charged.

60. Why positive rays are also called canal rays?

Ans. Since positive rays produced in the discharge tube passed through the canals or holes of cathode, therefore positive rays are also called canal rays.

61. The e/m values of positive rays for different gases are different but those for cathode rays, the e/m value is the same.

Ans. The e/m value of positive rays depends upon the nature of gas used in the discharge tube. The characteristic of the gas varies from gas to gas, but for cathode rays e/m value is independent of the nature of the gas. Therefore, e/m values of positive rays for different gases are different but those for cathode rays the e/m value is the same.

62. The e/m value for positive rays obtained from hydrogen gas 1836 times more than that of an electron?

Ans. The mass of hydrogen gas is 1836 times more than that of an electron. Cathode rays consist of beam of electrons. The e/m value for positive rays depends upon the gas used in the tube, and e/m value for cathode rays is independent of the nature of the gas. Therefore e/m value for positive rays obtained from H_2 gas is 1836 times less than that of cathode rays. Heavier the gas, the smaller the e/m value for positive rays.

63. Justify that cathode rays are material particles.

Ans. Cathode rays drive a small paddle, wheel which shows that these rays posses momentum. From this observation, it is inferred that cathode rays are not rays but particles having a definite mass and velocity. Therefore cathode rays are material particles.

64. How neutrons are produced?

Ans. When a stream of α–particles from a polonium source is directed at beryllium target, penetrating radiations are produced, which are called neutrons.

$$^{4}_{2}He + {}^{9}_{4}Be \longrightarrow {}^{12}_{6}C + {}^{1}_{0}n$$

65. Why the neutrons are used as projectile?

Ans: The particles, which hit the nucleus and can change its nature are called projectile. A projectile must be chargeless otherwise it will be captured or repelled by the nucleus. The slow moving neutrons cause nuclear reactions like fission and are used in artificial radioactivity. They are chargeless; therefore they can be used as projectile in nuclear research.

$$^{65}_{29}Cu + {}^{1}_{0}n \longrightarrow {}^{66}_{29}Cu + h\nu \quad \textbf{(a-rays)}$$

$$^{66}_{29}Cu \longrightarrow {}^{66}_{30}Zn + {}^{0}_{-1}e \quad \textbf{(b-rays)}$$

66. Explain the energy difference between adjacent levels goes on decreasing sharply in Bohr's model.

Ans. The energy difference between adjacent levels goes on decreasing, because the distance between the adjacent orbits increases.

67. Why does cathode rays produce shadow of an opaque object placed in their path.

Ans. Any object which is material in nature, produces its shadow. Since cathode rays are material in nature, therefore, they produce shadow of an opaque object placed in their path.

68. Give the main points of quantum theory of radiation.

Ans. 1. Energy is emitted or absorbed by atoms only in the form of packets called quantum.

2. The amount of energy associated with a quantum of radiation is proportional to the frequency (υ) of the radiation.

$E \propto \upsilon$ or $E = h\upsilon$

3. A body can emit or absorb energy only in terms of integral multiples of quantum.

$E = nh\upsilon$ (where $n = 1, 2, 3, 4, 5, \ldots\ldots$)

69. Define frequency, wavelength and wave number.

Ans. Frequency (υ):

The number of waves passing through a point per second is called frequency (υ). Its units are cycles/sec.

Wavelength (λ):

The distance between two successive crests or troughs is called wavelength "λ" and is expressed in A^o or nm.

Wave number:

The number of waves per unit length is called wave number and is reciprocal of wave length.

The wave number is expressed (m^{-1}) or per meter.

70. Describe briefly Rutherford's atomic model.

Ans. According to Rutherford's model most of the mass of the atom (99.95%) is concentrated in a positively charged centre, called nucleus around which the negatively charged electrons move.

71. On which experiment Rutherford's atomic model is based on, describe it briefly?

Ans. Rutherford's atomic model is based on the scattering of α–particles emitted from radioactive substances pass through the metal atoms of the foil undeflected by the light weight electrons. When an α–particle does happen to hit a metal–atom nucleus. However, it is scattered at a wide angle because it is repelled by the massive positively charged nucleus.

72. Define orbit and orbital.

Ans. Orbit: A definite circular path at a definite distance from the nucleus in which the electrons revolve around the nucleus is called an orbit.

K, L, M, N are orbits.

Orbital:

A three dimensional region or space around the nucleus, within which the probability of finding an electron is maximum called an orbital, s, p, d and f are atomic orbitals.

73. What do you understand by wave particle duality and what is the de Broglei relation?

Ans. According to de Broglei, all matter particles in motion have a dual character. It means that electrons, protons, neutrons, atoms, and molecules, possess the characteristics of both the material particle and a wave. This is called wave particle duality in matter.

De Broglei derived a mathematical equation which relates the wavelength (λ) of the electron to the momentum of electron (mv)

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

Where λ = wavelength v = velocity of electron

m = mass of electron h = Planck's constant.

This equation $\lambda = \frac{h}{mv}$ is called De Broglie equation.

74. What is Heisenberg's uncertainty principles?

Ans. Heisenberg showed that it is impossible to determine simultaneously both the position and momentum of an electron. Suppose that Δx is the uncertainty in the measurement of the position and Δp is the uncertainty in the measurement of momentum of an electron.

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$

This relationship is called uncertainty principle.

75. What are quantum numbers?

Ans. The dimensionless numbers, rise naturally when the Schrodinger wave equation is solved for electron wave patterns and their energies are called quantum numbers.

These numbers describe the behaviour of electron in an atom completely.

There are four quantum numbers.

1. **Principal quantum number "n"**

It describes the energy of an electron in an atom. The value of n represents the shell or energy level in which the electron revolves around the nucleus. These shells are named as K, L, M, N, O, P, having the values of n, 1, 2, 3, 4, 5 and 6 respectively. The greater the value of n, the greater will be the distance from the nucleus and greater will be the energy of electron in the shell.

2. Azimuthal quantum number "*l*"

It determines the shape of orbital, it can have any integer value from 0 to n–*l*. this quantum number is used to represent the sub–shells, and these value are $l = 0, 1, 2, 3$. These values represent different sub–shells which are designated as s, p, d, and f, with values of $l = 0, 1, 2, 3$ respectively.

3. Magnetic quantum number (m)

It describes the orientation of the orbital in space. It can have all the integral values between $+l$ and $-l$ through zero i.e. $+l$ …….. 0 …….. $-l$. For each value of l, there will be $(2l + 1)$ values of m. actually the values of m gives us the information of degeneracy of orbitals in space.

4. Spin quantum number (s)

It describes the spin of electron in atom. Since an electron can spin clockwise or anti clockwise, thus two possible values are + and – depending upon the spin of electron.

76. What is $n + l$ rule?

Ans. This rule says that sub–shells are arranged in the increasing order of $(n + l)$ values and if any two sub–shells have the same $(n + l)$ values, then the sub–shell is filled first whose n values is smaller.

77. What is the origin of line spectrum?

Ans. According to Bohr's theory each bright line in a line spectrum results from the downward jump of electron from a higher energy E2 to lower energy E1. This difference in energy (E2 – E1) is emitted as radiation of definite frequency in the form of spectral line.

According to the quantum theory of radiation,

$$E1 - E2 = h\upsilon$$

78. Describe Summerfield's modification of Bohr's model atom.

Ans. Summerfield suggested that the moving electron revolves in elliptical orbits in addition to circular orbit, with the nucleus situated at one of the foci of the ellipse. The elliptical paths of the

moving electron go on changing their position in space, and the nucleus is buried by the electronic cloud from all the sides.

79. Which of these orbitals, 3d or 4s has higher energy level?

Ans. For 3d, $n + l = 3 + 2 = 5$

For 4s, $n + l = 4 + 0 = 4$.

Therefore 3d orbital has higher energy, than 4s orbital.

80. How many maximum number of electron can have an orbital and a shell?

Ans. An orbital can have maximum two electrons with opposite spins. A shell can have maximum of $2n^2$ electrons, where "n" is the principal quantum number. First shell can have maximum 2 electrons, 2nd shell have 8 electrons 3rd shell have 18 electrons etc.

81. Distribute electrons in orbitals of ^{19}K, ^{29}Cu, ^{24}Cr, ^{53}I.

Ans.

$^{19}K \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$

$^{29}Cu \rightarrow 1s^2, 2s^2, 2p^6, 3s^2\ 3p^6, 4s^1, 3d^{10}$

$^{24}Cr \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^5$

$^{53}I \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^2, 4p^6, 4d^{10}, 5s^2, 5p^5$

82. What does it mean, when we say energy is quantized?

Ans. Quantization means that energy can only be absorbed or emitted in specific amounts or multiples of these amounts. This minimum amount of energy is equal to a constant times the frequency of the radiation absorbed or emitted $E = hv$.

83. Why do not we notice the quantization of energy in every day activities?

Ans. In everyday activities, macroscopic objects such as our bodies gain or lose total amounts of energy much larger than a single quantum, hv. The gain or loss of the relatively minuscule quantum of energy in unnoticed.

84. Explain the existence of line spectra is consistent with Bohr's theory of quantized energies for the electron in the hydrogen atom.

Ans. When applied to atoms, the notion of quantized energies means that only certain values of ΔE are allowed. These are represented by the lines in the emission spectra of excited atoms.

85. In what ways does de Broglie's hypothesis require revision of our picture of the H–atom based on Bohr's model?

Ans. De Broglie's hypothesis not electrons have a characteristic wavelength requires, revision of Bohr's particle only model. For example the idea of a fixed orbit for the electron in hydrogen is hard, to reconcile with the wave properties of electron.

86. (a) For $n = 4$ what are possible values of 'l'?

(b) For $l = 2$ what are the possible values of m.

Ans. (a) $n = 4$ $l = 3, 2, 1, 0$

(b) $l = 2$ $m = -2, -1, 0, 1, 2$

87. What are the possible values of the electron spin quantum numbers?

(a) Positive (+) Negative (–)

(b) What piece of experimental equipment can be used to distinguish electrons that have different values of the electron spin quantum number?

(b) A magnet with a strong homogeneous magnetic field.

(c) Two electrons in an atom both occupy the Is orbital. What quantity must be different for the two electrons? What principle governs the answer to this question?

(c) They must have different spin quantum number values. The Pauli exclusion principle.

88. Give region of different spectral lines.

Ans.1. Lyman series (U. V. region)

2. Balmer series (visible region)

3. Paschen series (I. R. region)

4. Bracket series (I. R. region)

5. Pfund series (I. R. region)

89. How are x–rays produced?

Ans. X–rays are produced when fast moving electrons collide with heavy metal anode in the discharge tube.

LONG QUESTION

1. Describe determination of atomic number of element by X-rays.

2. How charge to mass (e/m) ratio of electron is measured?

3. Explain Rutherford's model of atom.

4. Define quantum numbers. Discuss briefly Azimuthal quantum number.

5. What is spectrum? Explain atomic emission and atomic absorption spectrum?

6. Give postulates of Bohr's atomic model

7. Write down the properties of cathode rays.

8. Write down Millikan's oil drop method for the measurement of charge of an electron.

9. Write J.J. Thomson method to measure the e/m value of electron.

10. How are positive rays produced in discharge tube? Give properties of these rays.

11. What are quantum numbers? Explain principal and magnetic quantum numbers.

12. What is Rutherford's atomic model? How he proposed this model?

13. Derive an expression to calculate the radius of revolving electron in nth orbit by Bohr's model of atom.