11/May/2023

Chapter-2

Structure of atom

* Properties of Cathode Rays

- Cathode Rays travel in a straight lines.
- Cathode Rays consist of material particle.
- Cathode Rays are made up of negatively charged particle
- Cathode Rays produce X-Ray when they strike on heavy metals like copper and Molybdenum

* Properties of Anode Rays

- Anode Rays travel in a straight lines
- Anode Rays consist of material particle.
- Anode Rays are md made up of positively charged partic

* Radioactivity:-

The spontaneous amition of radioactive particle or rays from any radio active element is called Radioactivity.

→ Alpha particles:- It have two units of positive charge and four unit of mass $_2He^4$. This is also called nucleus of helium.

→ Beta particles:- ~~This is also call~~ These are the particles having 1 unit negative charge and their mass is negligible $-1\beta^0$

→ Grama particles :- These particles have approximately 0 charge and negligible mass. $_0\gamma^0$

→ Discovery of neutron:-

When alpha particles strike the lighter atom like Be, B they produce neutron.

Eg:- $_4Be^9 + _2He^4 \longrightarrow {}_6C^{12} + {}_0n^1$

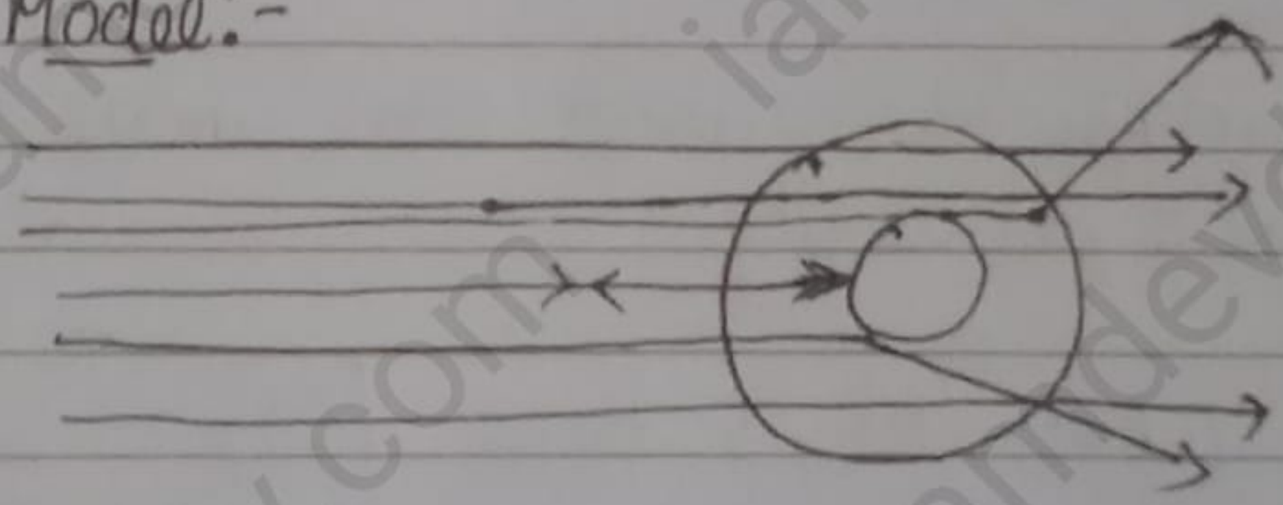
$5B^{11} + 2He^4 \longrightarrow 7N^{14} + on^1$

* Atomic Models

→ Thomson's Models:-

1. Atom is electrically neutral. (proton = electron)
2. This model suggested that electrons are like black seeds and protons are like red edible part so this is also called watermelon model of atom.

→ Rutherford Model:-



1. Most of the α particles passed straight through gold foil without suffering any distraction.
2. Few of them were distracted by some angles
3. A very few α particles 1 in 1lakh was distracted and bounce back

→ Rutherford nuclear concept:-

1. The atom consist of small positively charged nucleus in the centre of the atom which carries almost the entire mass of nucleus
2. The electrons are distributed in the empty space of the atom around the nucleus
3. Number of protons are equal to number of electrons
4. The volume of nucleus is negligible in comparision with the volume of atom
5. Most of the space in atom is empty.

Assertion - The volume of nucleus is very high as compared to volume of atom.

Reason - The nucleus has almost total mass of atom which is propotional to density.

Ans → (A) is false (R) is true [D]

(A) The Extra nuclear part is very dense

(R) Proton and neutron almost carry all the mass.

Ans → (A) is false (R) is true [D]

Name	Symbol	Absolute Charge	Relative Charge	Mass	Relative Mass
Electron	e	-1.6022×10^{-19}	-1	9.1×10^{-31}	Neg
proton	p	$+1.6022 \times 10^{-19}$	$+1$	1.6×10^{-27}	1
Neutron	n	0	0	1.6×10^{-27}	1

* Some important definations

1. Atomic number:- It may be defined as the no. of protons or the no. of electrons in a neutral atom.

Ex:-

Na → P = 11 ≠ e = 11 } P = e (Neutral)

Na^+ → Ion

But Na^+ (11) < P = 11 ; e = 11 − 1 = 10 (equal ✗)

P ≠ e not neutral

2. Atomic mass/mass no.:- It is defined as the sum of all the protons and neutrons in an atom

$_2He^4$ — 4 → Atomic mass, 2 → Atomic no., He → Symbol

Atomic no: P = e, P = 2, e = 2

Atomic mass: P + n, 4 = 2 + n, n = 2

3. Isotopes:- These are the atoms of same element which have same atomic no. but different atomic mass.

Ex:- 1. $_1H^1$, $_1H^2$, $_1H^3$

2. $_6C^{12}$, $_6C^{13}$, $_6C^{14}$

4. Isobar:- These are the atoms of different elements which have same atomic mass but different atomic number.

Ex:- $_{19}K^{40}$, $_{20}Ca^{40}$, $_{18}Ar^{40}$, $_6C^{14}$, $_7N^{14}$

5. Isotones:- These are the atoms in which the no. of neutrons are same.

Ex:- $_6C^{14}$, $_7N^{15}$, $_8O^{16}$

$_6C^{14}$ → $8n$

$_7N^{15}$ → $8n$

$_8O^{16}$ → $8n$ → Isotones

6. Isoelectric species:- These are the atoms/ions in which same number of electrons are present

Ex:- O^{2-}, S^{2-}, Na^+, Ca^{2+}, Mg^{2+}, N^{3-}

Isoelectric ← $10e^-$, $18e^-$

O < $P = 8$, $e = 8 + 2 = 10e^-$

Na^+_{11} < $P = 11$, $e = 11 - 1 = 10e^-$

S^2 (16) < $P = 16$, $e = 16 + 2 = 18e^-$

Mg $\begin{cases} P=12 \\ e=12-2 \\ \quad =10e^- \end{cases}$ Ca^{2+} $\begin{cases} P=20 \\ e^- =20-2=18e^- \end{cases}$

[10e⁻ has more domancy]

Ques- The number of electrons and protons in a given species are 18, 16 and 16 respectively. Write the symbol of this species.

Ans- 18, 16, 16

$P=16$
(S) $\boxed{S^{2-}}$ Sulbide ion

~~16 ⇒ P=16~~
~~Sulphur~~

* Electromagnetic Wave Theory :-
This theory was proposed by Maxwell and the main features of this theory are:-

- The energy emitted from any source in the form of radiation is called radiant energy.
- The radiation consist of electric and magnetic field oscillating perpendicular to each other and both are perpendicular to the direction of propogation.
- The radiation consist of wave corrector which travel with speed of light 3×10^8 m/s

* ~~Electromagnetic wave theory~~:-

Some Important Points:-

1. Wave length:- Wave length is the distance between corresponding points of two consecutive waves.

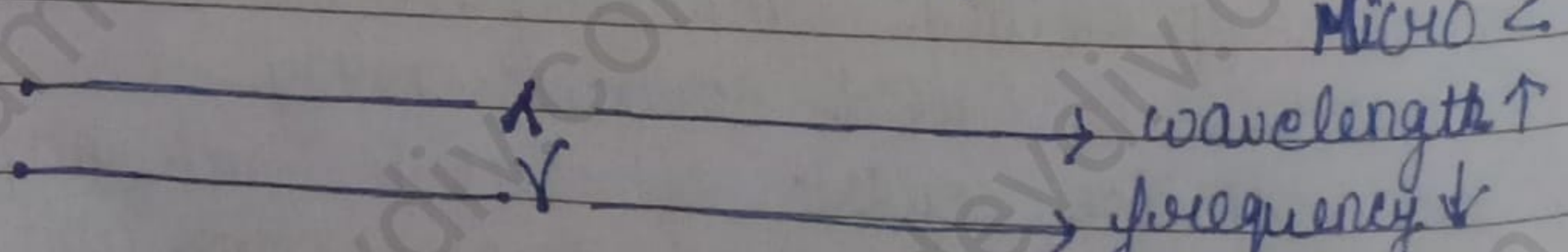
2. Frequency:- Frequency is the number of vibrations that pass through a specific point within a second.

3. Wave no.:- Wave Number is the number of wavelengths in a given distance along the propogation of the wave.

4. Amplitude:- Amplitude is the maximum displacement from its mean position to extreme position of a particle of the medium in which a wave propogates.

→ Electromagnetic Spectrum:-

Cosmic rays < γ- rays < X - rays < UV < Visible < IR < Micro < Radio



- Penitration Power of any wave is inversely proportional to its wave length

Example ① In metro cities we use X-rays to detect the metal object in the back of a person.

② When the bone is broken doctor advice us for X-ray because he knows that X-ray has lower wave length and it can penetrate into human skin.

- Black body radiation

If a substance is been heated it is a black body it should be the perfect absorber and emitter i.e. which can emit the radiation of all the frequencies.

₱

* Photo electric effect

- When the radiation with frequency greater than minimum frequency strike the surface of metals. Electrons are ejected from the surface of the metal. The phenomenon is known as photoelectric effect. The main feature of this effect are:-
- Electrons are ejected as soon as the beam of light strike the surface.
- The no. of electrons ejected is proportional to intensity of light

- For each metal there is a minimum value of frequency that is called threshold frequency (ν_0) below which this effect is not observe
- At a frequency new greater than new not ($\nu > \nu_0$) the electrons come out of the metal surface the with certain amount of Kinetic energy.

$E = h\nu$ — (1) 2CE
$E = h\nu_0$ — (2) 14E

$$h\nu - h\nu_0 = \frac{1}{2} m v^2$$

→ Einstein photoelectric equation

* Planck's Quantum Theory

To explain the phenomenon of black body radiation and photoelectric effect Max, plank put forwards theory in 1900 this is called Planck's Quantum Theory. This theory was further extended by Einstein and the main features of theory are:-

- The energy emitted or absorbed not continuously but discontinuously in the form of small discrete packets of energy
- Each such packet of energy is called 'Quantum' but in case of light it is called 'photon'.
- The energy of each such packet is proportional to frequency $E \propto \nu$

  $E = h\nu$ where h is planck's constant 6.626×10^{-34}
- The total amount of energy emitted or absorb by a body will be whole no. Quanta

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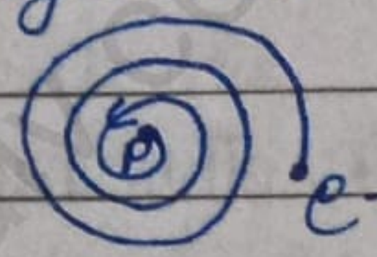
Limitations of Rutherford model

This model cannot explain the stability of atom



This model cannot explain the distribution of electrons as well as the energy of electrons

Bohr's model of atom

- An atom consist of small positively charged nucleus in the centre of the atom and electrons revolve around nucleus in circular orbits
- These orbits are called energy levels or stationary state and they are numbered as 1, 2, 3, 4, and so on OR K, L, M, N - - - - and so on from the nucleus.
- The energy of the orbits is quantized (fixed)
- The angular momentum of the electron is also quantized.

* Angular momentum (ρ) = $m \times v \times r$

$$mvr = n\frac{h}{2\pi}$$

$n = 1$ < $e^- = 1$, $e = 2$

$$e_1(mvr) = 1 \times \frac{h}{2\pi}$$

$$e_2(mvr) = 1 \times \frac{h}{2\pi}$$

$$e_2(A \cdot m) = e_1(A \cdot m)$$

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* Limitations of Bohr's model

- This unable to explain 3D model of atom.
- This model is unable to explain the shapes of the molecule
- This model is unable to explain the structure of ~~atom~~ molecule.
- This model is unable to explain De-Broglie wavelength

* De-Broglie ~~Wavelength~~ Equation

In Bohr's theory electron is treated as particle but De-Broglie suggested that Dual character that is particle as well as wave.

$E = mc^2$ — (1)

$E = h\nu$ — (2)

$mc^2 = h\nu$

$mc^2 = h \times \frac{c}{\lambda}$

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

$\nu = \frac{c}{\lambda}$

wave $\lambda = \frac{h}{mv}$ — De Broglie eqn.

$\nu = \frac{c}{\lambda}$

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Heisenberg Uncertainity principle

⇒ According to this principle it is not possible to determine precisely both the position and the momentum (velocity) at a moving microscopic particle.

⇒ This principle is ~~a~~ mathematically expressed as.

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi} = \frac{6.626 \times 10^{-34} \times 7}{4 \times 22}$$

Change in position — Chang in momentum

$$\Delta x \cdot \Delta (mv) \geq \frac{h}{4\pi}$$

$$\boxed{\Delta x \cdot m \cdot \Delta v \geq \frac{h}{4\pi}}$$

modified form

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

⇒ This principle is not useful in our daily life.

⇒ This principle is very useful to determine the definant path of a moving object

- Atomic orbitals:- An atomic orbitals is the region around the nucleus where the probability of finding the electron is maximum.

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• Quantum No:- Quantum No.'s ~~no~~ may be defined as a set of 4 no.'s with the help of which we can get complete information about all the electrons in an atom i.e. location, energy, types of orbital occupied etc.

⇒ The various quantum no.'s are discussed as :-

(i) Principal quantum no.(n)

a. It is the most important quantum no. since it tells about principal energy level or the shell to which the electrons belongs.

b. It gives the average distance of the electron from the nucleus.

c. The maximum no. of electrons present in principal shell are $2n^2$, where n is the no. of that shell.

d. It complete determines the energy of electron in Hydrogen or Hydrogen like particles.

$$E_n = \frac{2\pi^2 m e^4}{n^2 h^2}$$

Mass & charge constant

Variable

Angular momentum quantum no (l):- It gives the following information:-

a. The no. of subshells present in a shell.
b. It gives the info about angular momentum of the electron.
c. The quantum no. for any value of n it can have any integer value ranging from 0 to n(-1).

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d. For any value of l will be = 0 1 2 3
Subshell = s p d f

Ques- For a orbital the value of n is 2 & the value of l is 0 designate that sub shell.
→ 2s

Ques- Write the designation for the sub shell when the following data is given

(i) n=2, l=0 → 2s
(ii) n=3, l=1 → 3p
(iii) n=4, l=2 → 4d
(iv) n=3, l=0 → 3s

Ques- Designate which of the following sub shell is possible when n=4 l=3

(i) 1p (ii) 2s (iii) 2p (iv) 4f

Ques- How many neutrons, protons are there in the following nucleus:-

(i) $_6C^{14}$
p=6
n=8

(ii) $_7N^{14}$
p=7
n=7

Ques - Explain the orbitals or subshells using s, p, d notation

n=1 l=0 → 1s
n=3 l=1 → 3p
n=4 l=2 → 4d
n=4 l=3 → 4f

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(iii) Magnetic quantum no. (m) → It is denoted by (m)
→ It determines the no. of orbitals present in any subshell.
→ For any value of (l) the value of (m) is -l to +l including zero.
~~→ For any value of (l) the value of (m) is -l to +l including~~
→ Ex:- S, l = 0 & value of m = 0 □
For p l = 1 m = -1, +1, 0 □□□
For d l = 2 m = -2 -1, 0, 1, 2 □□□□□
For f l = 3 m = -3, -2, -1, 0, 1, 2, 3 □□□□□□□

(iv) Spin Quantum no:- It is denoted by (s)
→ It gives the information about the direction of spinning of electrons in any orbital
→ If the electron is spinning clockwise value will be +1 & in case of anticlockwise spin it is $-\frac{1}{2}$

Ques- Determine the four set of Quantum no. in the following

(i) $5f^9$
n = 5
l = 3
m = -2
$s = -\frac{1}{2}$

(ii) $3p^5$
n = 3
l = 1
m = 0
$s = -\frac{1}{2}$

(iii) $4f^{11}$
n = 4
l = 3
m = 0
$s = -\frac{1}{2}$

Ques- How many electron are possible in the following :-
(i) n = 4
l = 2
4d = 10 electrons

Ques Calculate possible set of quantum no.
(i) n = 3 l = 3 m = -3 $s = +\frac{1}{2}$ ⇒ 3f¹ not possible

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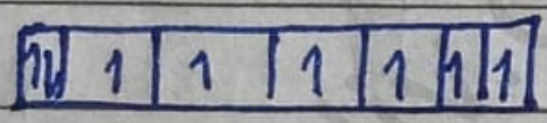
Ques- Calculate four set of quantum numbers for each of the following.

5f⁸

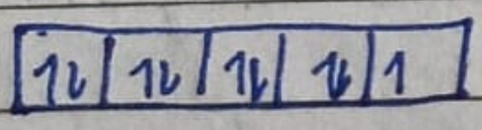
n = 5
l = 3



m = -3
s = $-\frac{1}{2}$

4d⁹

n = 4
l = 2



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

☆ Rules for filling electrons

→ Pauli's Exclusion principle :-
No two electron in an atom can have the same set of all the four quantum numbers

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Ex:- $4d^9$ $4d^4$

$n=4$ $n=4$
$l=2$ $l=2$
$m=-3$ $m=+1$
$S=-\frac{1}{2}$ $S=+\frac{1}{2}$

Rules for filling electrons:-

(i) ~~Aufl~~ Aufbau's principle:- a.) Electron first occupy the lowest energy orbital available and after enter into a higher energy orbital only then the the lower energy orbitals are filled

b.) Alternatively this is called $(n+l)$ rule also because the energy of various orbitals depends upon value of n & l.

c.) In natural state first orbital will be filled having $(n+l)$ value smaller and after that chigher value orbital are filled.

d.) In case of those orbitals in which $(n+l)$ values are same according to small value of n orbital will be preffered (will be filled first).

Ques- 4f, 5d, 6s, 7p, 2p
Arrange the following in increasing order of their energy.
4f : $(n+l) = 7$ $7p = 8$
$5d = 7$ $2p = 3$
$6s = 6$
$\therefore 2p < 6s < 4f < 5d < 7p$

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Ques- Arrange the following into decreasing order of their energy levels.
5f, 7p, 6d, 4f, 3d

7p > 6d > 5f > 4f > 3d

(ii) Pauli's Exclusion principle:- a.) According to this principle four any two electrons in a same atom the values four 4 set of quantum no.'s can never be same.

b) If we take example of two electrons which are nearest to each other i.e. $5p^1$ & $5p^4$

$n=5$	$n=5$
$l=1$	$l=1$
$m=-1$	$m=-1$
$s=+\frac{1}{2}$	$s=-\frac{1}{2}$

3 are same but 1 is different

Ques- Calculate the 4 set of QN for $6d^1$ & $6d^6$ & prove that this verifies Pauli's exclusive ~~this~~ principle

→ $6d^1$

$n=6$
$l=2$
$m=-2$
$s=+\frac{1}{2}$

$6d^6$

$n=6$
$l=2$
$m=2$
$s=-\frac{1}{2}$

3 are same but 1 is different, therefore it verifies pauli's exclusion principle.

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Ques $5d^5$, $2p^2$

$n=5$	$n=2$
$l=2$	$l=1$
$m=+2$	$m=0$
$S=+\frac{1}{2}$	$S=+\frac{1}{2}$

∴ this verifies Pauli's exclusive principle

Ans – For the following data prove that this follows aufbau acc. to (i) Aufbau principle put them in the increasing order of their energy

(ii) Follows Pauli's Exclusion Principle

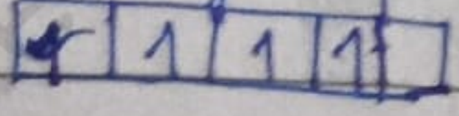
$n=5$	$n=4$	$n=2$	$n=7$
$l=1$	$l=1$	$l=0$	$l=1$
$m=0$	$m=+1$	$m=0$	$m=0$
$S=+1/2$	$S=+1/2$	$S=-1/2$	$S=-\frac{1}{2}$
$5p^2$	$4p^3$	$2s^2$	$7p^5$

$2s^2 < 4p^3 < 5p^2 < 7p^5$

It follows Pauli's exclusion principle as all 4 are diff.

(iii) Hund's Rule of maximum multiplicity:- a.) Electron pairing in p, d, f orbitals can't occur unit each orbital of a given subshell contain 1 electron each or it is singly occupied.

b. Unpairing is always preffered over pairing

Ex:- $5d^4$ → 

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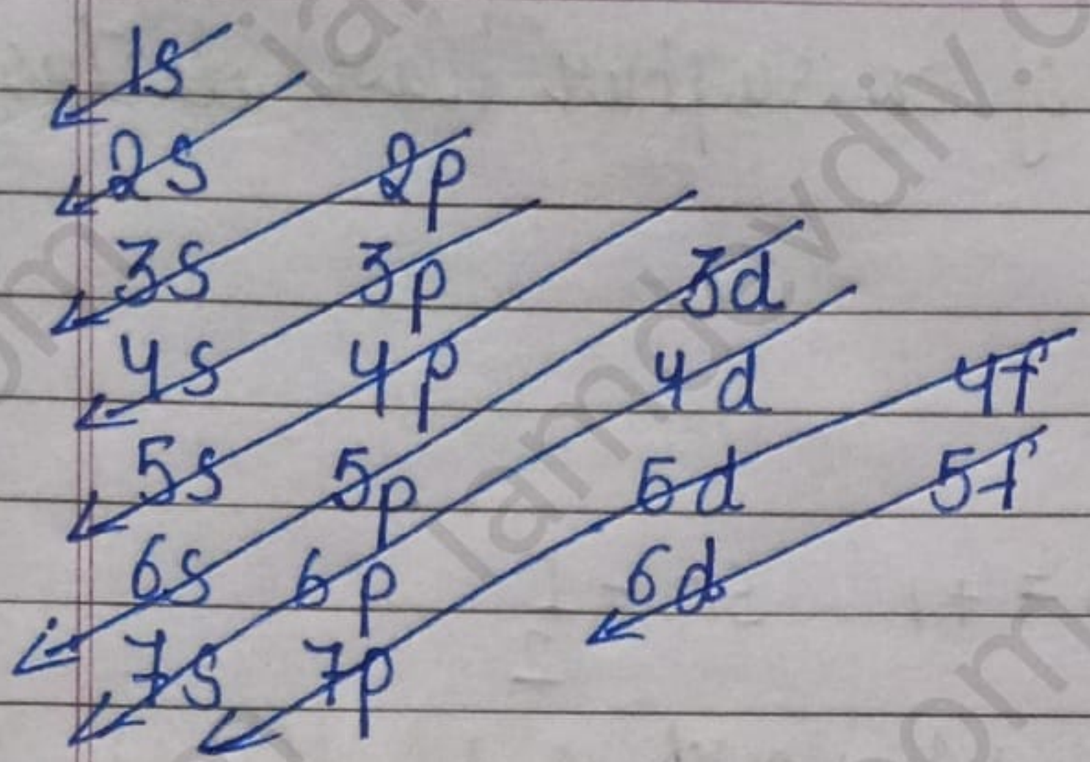


1. H → $1s^1$
2. He → $1s^2$
3. Li → $1s^2 2s^1$
4. Be → $1s^2 2s^2$
5. B → $1s^2 2s^2 2p^1$
6. C → $1s^2 2s^2 2p^2$
7. N → $1s^2 2s^2 2p^3$
8. O → $1s^2 2s^2 2p^4$
9. F → $1s^2 2s^2 2p^5$
10. Ne → $1s^2 2s^2 2p^6$
11. Na → $1s^2 2s^2 2p^6 3s^1$
12. Mg → $1s^2 2s^2 2p^6 3s^2$
13. Al → $1s^2 2s^2 2p^6 3s^2 3p^1$
14. Si → $1s^2 2s^2 2p^6 3s^2 3p^2$
15. P → $1s^2 2s^2 2p^6 3s^2 3p^3$
16. S → $1s^2 2s^2 2p^6 3s^2 3p^4$
17. Cl → $1s^2 2s^2 2p^6 3s^2 3p^5$
18. Ar → $1s^2 2s^2 2p^6 3s^2 3p^6$
19. K → $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
20 Ca → $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Q Calculate the 4 set of Q.N. of ion sulphur (last electron).

Ans- $S \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

$S^{-2} \rightarrow 16^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

$3p^6 \rightarrow n=3,\ l=1\ \ m=+1\ \ s=-\frac{1}{2}$

Ques- Calculate the 4 set of Q.N. of last 3rd electron (Al)

Ans- $Al \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

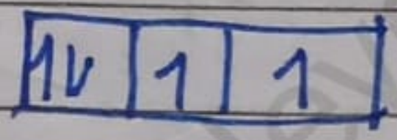
$\rightarrow 1s^2\ 2s^2\ 2p6$

$2p^4 \rightarrow n=2\ \ l=1\ \ m=-1\ \ s=-\frac{1}{2}$

Ques- Write down the electronic configuration

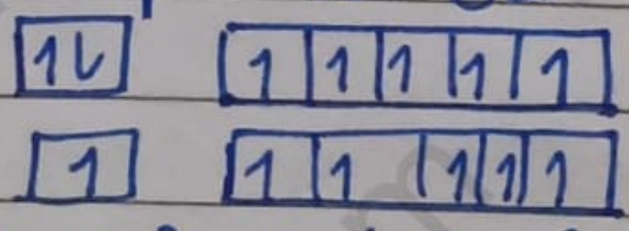
→ Exception's of Electronic configuration :-

(i) Half filled & fully filled electronic configuration are always stable.

Partially filled is not stable 

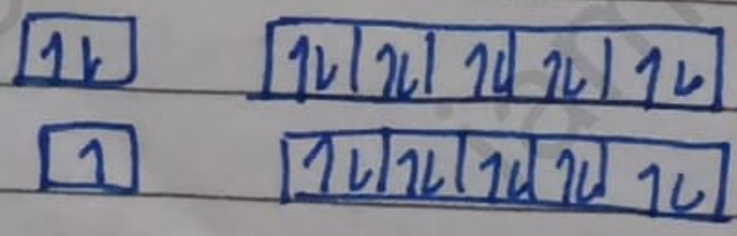
Electronic configuration of Cr (24):-

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



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

Cu (29):- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^9$



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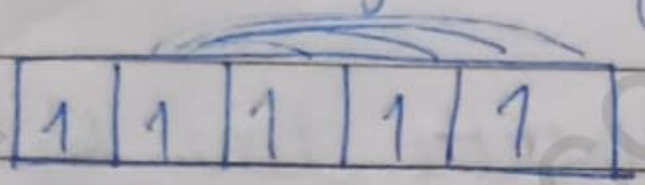
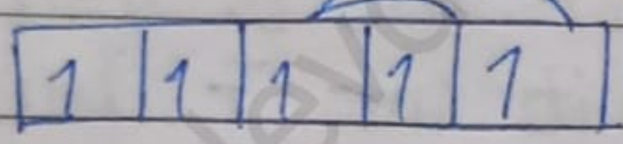
Concept of exchange energy:-

The electrons present in the diff. orbitals of same subshell can exchange their positions mutually & exchange energy is released.

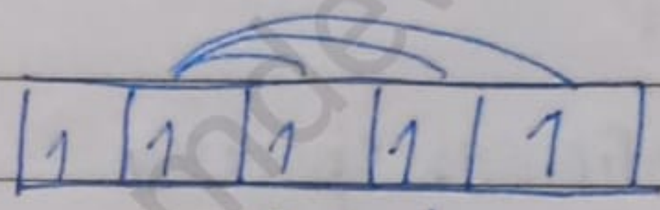
More the no. of exchanges more will be the stability.



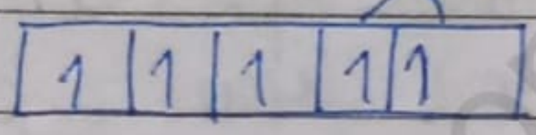
4 exchange by one -



2 exchanges



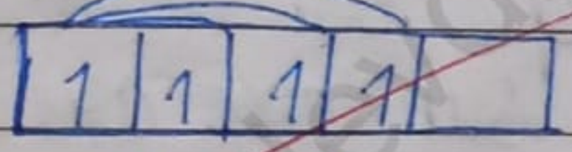
3 exchange



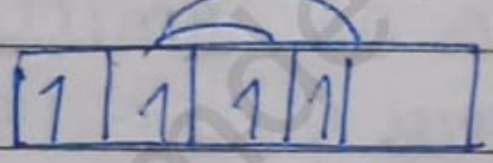
1 exchange

Total no. of exchanges = 4+3+2+1
= 10 Ans

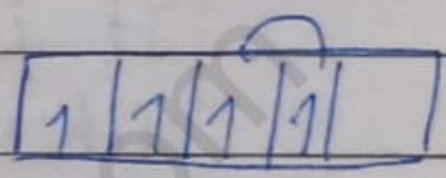
d^4



3 exchange



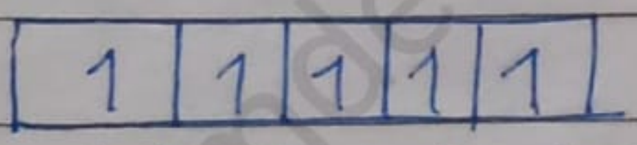
2 exchange



1 exchange

Total no. of exchanges = 3+2+1 = 6 Ans

Symmetry:- d^5 and d^{10} configuration are symmetrical as compared to d^4 and d^9 configuration hence d^5 and d^{10} are stable



Ques - Calculate the 4 set of Qu. N. for 23rd electron of Cr.
b.) last electron of Cr+3

a.) $Cr \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6 4s^1, 3d^5$

$3d^4 \rightarrow n=3 \quad l=2 \quad m=+1 \quad S=+\frac{1}{2}$

b.) $3d^2 \quad n=3 \quad l=2 \quad m=-1 \quad S=+\frac{1}{2}$

$3d^3 \rightarrow n=3 \quad l=2 \quad m=0 \quad S=+\frac{1}{2}$

~~Cr^{+3}~~ Cr^{13} (21)

☆ Study of Atomic Spectra

→ Emission spectra is noticed when the radiation emitted from a source are passed through a prism & then received on the photographic plate. The emission spectra is of two type.

(i) Continuous spectra (ii) Discrete line spectra

* Continuous spectra:- When sunlight or a white light emitted from a person it splits into 7 bands ranging from violet to Red. [VIBGIYOR].

* Line Spectra or discontinuous spectra
It is also an emission spectra & it is noticed when vapour of some volatile substance are allowed to fall on the flame of a burner & analyzed with the help of spectroscope some specific colours appear on the photographic plate which are different for different elements.

Ex:- As Na^+, K^+, Ca^{2+} are often detected with the help of flame test.

* Formula:-

Rydberg Formula:-

$$= \frac{1}{\lambda} = \bar{v} = RZ^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

λ = wavelength
$\bar{v}$ = wave no.
R = Rydberg constant
Z = Atomic no. n_2 & n_1 = No of shells ($n_2 > n_1$)

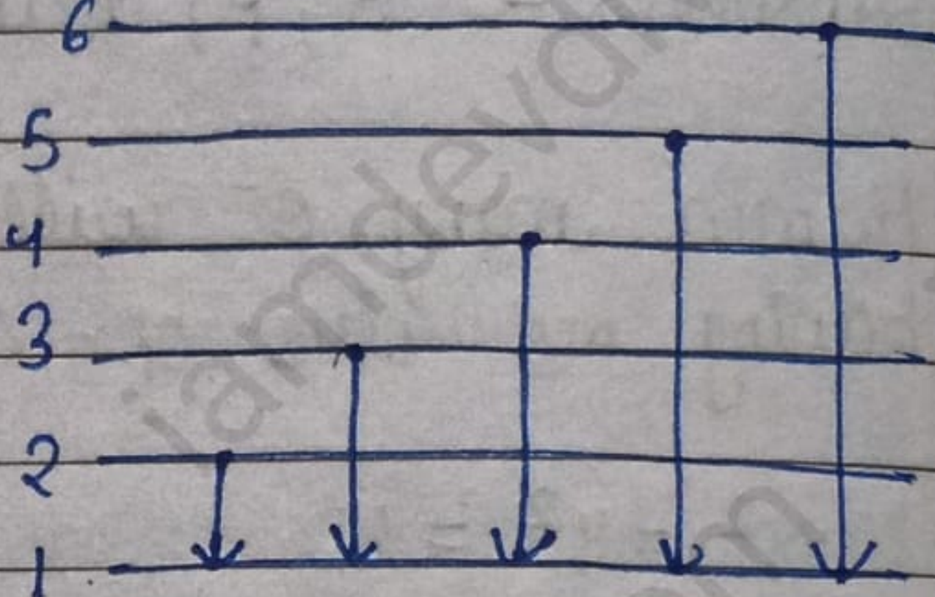
Chapter - 2

Structure of an atom

* Lyman Series

For n_2 to n_1

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



$$\frac{1}{\lambda} = R\left[\frac{3}{4}\right]$$

$$\lambda = \frac{4}{3} \times 912$$

$$\lambda = 4 \times 304 = 1216 A^\circ \text{ Any}$$

For n_4 to n_1

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

$$\frac{1}{\lambda} = R\left[\frac{16-1}{16}\right]$$

$$= \frac{15}{16} \times R \Rightarrow \frac{16}{15} \times \frac{1}{R} = \frac{16}{15} \times 915$$

$$= 16 \times 61$$

$$= 976 A^\circ$$

For ∞ to n_1

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$$

$$= R\left[\frac{1}{1} - 0\right]$$

$$= 1 \times \frac{1}{R} \Rightarrow 1 \times 911 \Rightarrow 911 A^\circ \text{ (Any)}$$

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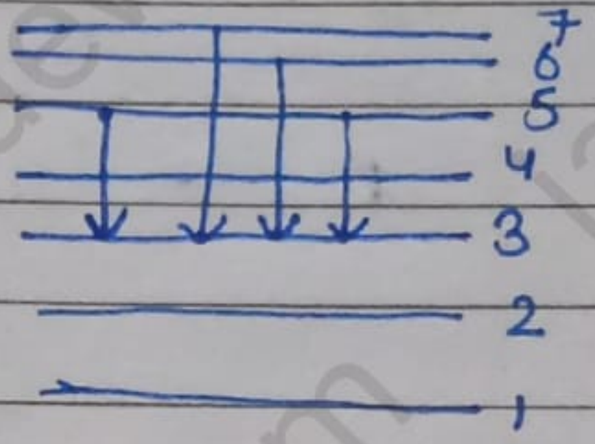
* Balmer series:- It is only series we can see visible vision = 3800 A° - 7000 A°

Here, $n=2$ always & n_2 may vary from 3 to ∞

* Paschen series

$n_1 = 3$

$n_2 = 4$ to ∞



* Brackett Series

$n_1 = 4$

$n_2 = 5$ to ∞

* Pfund series

$n_1 = 5$

$n_2 = 6$ to ∞

* Quick Recap of Series

Series	n_1	n_2	Region
Lyman	1	2,3,4 - ∞	Ultra violet
Balmar	2	3,4,5 - ∞	Visible
~~Balmar~~ Paschen	3	4,5,6 - ∞	IR
Brackett	4	5,6,7 - ∞	IR
Pfund	5	6,7,8 - ∞	IR
Humphrey	6	7,8,9 - ∞	IR

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- No. of transitions in any series:-

$$= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$$

Q- $n_2 = 4 \quad n_1 = 1$ no. of transitions?

$$= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$$

$$= \frac{(4-1)(4-1+1)}{2}$$

$$= \frac{3 \times 4^2}{2} = 6 \text{ (Ans)}$$

Ques - What is the maximum no. of emission ~~is~~ when the excited electron of hydrogen atom drop from $n_2 = 6$ to $n_1 = 4$

$$= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$$

$$= \frac{(5)(6)3}{2}$$

$$= 15 \text{ (Ans)}$$

Ques - Emission transitions in Paschen series at orbit, $n = 3$ and starts from the orbit n and can be represented as $\nu = 3.28 \times 10^{15}$ Hz. Find the value of n of transitions is observed at 1285 nm Find the ~~the~~ region of spectrum

$n_1 = 3$, $n_2 = 4, 5, 6 - - - - \infty$

$\lambda = 1285 \text{ nm} = 1285 \times 10^{-9} \text{ m}$

$= 1.285 \times 10^3 \times 10^{-9} \Rightarrow 1.285 \times 10^{-6} \text{ m}$

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$$\nu = \frac{c}{\lambda} = \frac{3\times10^8}{1\cdot285\times10^{-6}} = 2\cdot33\times10^{14}\,s^{-1}$$

$\boxed{1Hz = s^{-1}}$ Given that,

$$\nu = 3\cdot28\times10^{15}\,s^{-1}\left[\frac{1}{3^2} - \frac{1}{n^2}\right]$$

$$= 2\cdot33\times10^{14}\,s^{-1} = 3\cdot29\times10^{15}\left[\frac{1}{9} - \frac{1}{n^2}\right]s^{-1}$$

$$\Rightarrow \frac{1}{9} - \frac{1}{n^2} = \frac{2\cdot33\times10^{14}}{3\cdot29\times10^{15}}$$

$$\frac{1}{9} - \frac{1}{n^2} = 0\cdot708\times10^{-1}$$

$$\frac{1}{9} - \frac{1}{n^2} = \frac{0\cdot708\times1}{10}$$

$$\frac{1}{9} - \frac{1}{n^2} = 0\cdot0708 \Rightarrow \frac{-1}{n^2} = 0\cdot0708 - \frac{1}{9}$$

$$\Rightarrow \frac{-1}{n^2} = -0\cdot3628$$

$$\frac{1}{n^2} = 0\cdot0403 \Rightarrow n^2 = \frac{100000}{0\cdot04031} \Rightarrow n^2 = 24\cdot80$$

$$n = \sqrt{24\cdot80} \Rightarrow n = 4\cdot98 \Rightarrow \boxed{n=5}$$ Ans

$\therefore$ Given that, $\nu = 2\cdot33\times10^{14}s^{-1}$
Transition is obtained in IR region (Ans)

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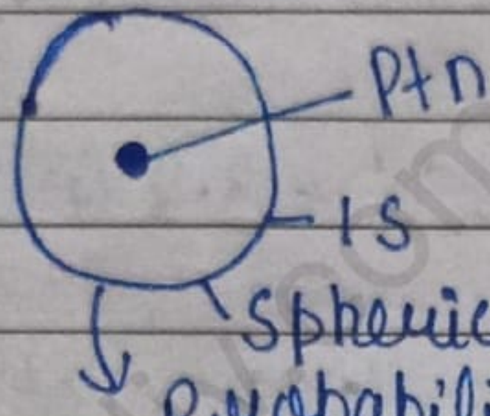
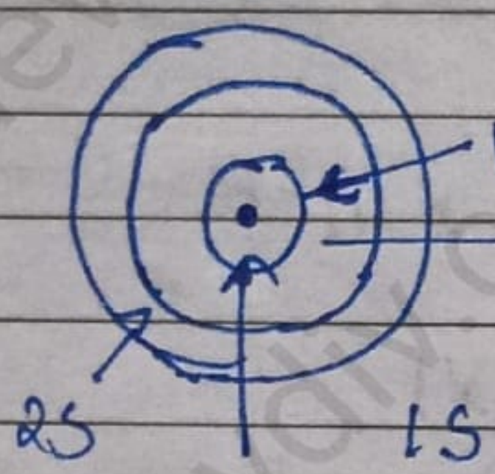
* Shapes of atomic orbital:-

1. S-orbital:- For s orbital the value of $l=0$, $m=0$ thus orbital has only 1 orientation that is spherical shape with uniform e- distribution along all 3 axis.



probability of bonding e- is maximum here



S has no agular node

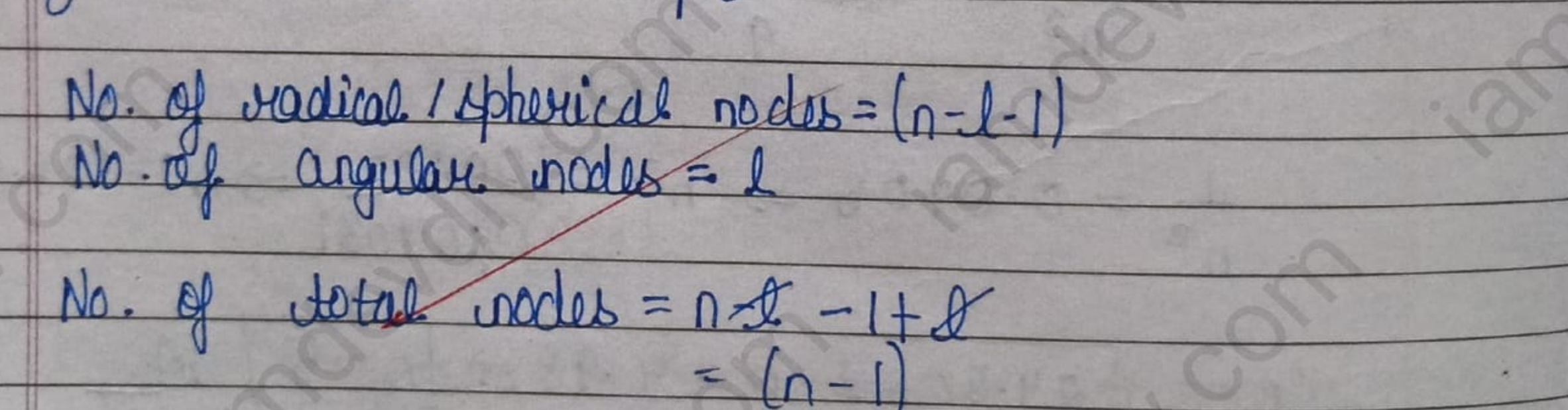
- The region where the probability of finding the e- is zero is called nodal plane.

* No. of radical / spherical nodes = $(n-l-1)$
No. of angular nodes = l

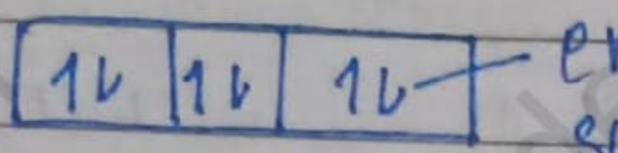
No. of total nodes = $n-l-1+l$
$= (n-1)$

2. Shape of p orbital - ~~ϕ orbital~~ ϕ orbital $l=1$, $m=-1,0,1$

Shape of p is dumbell



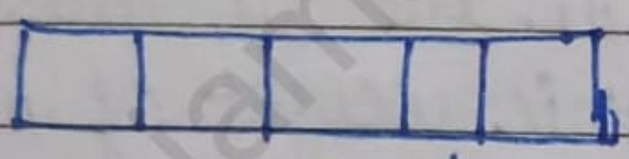
- Angular nodes independent of the shell present

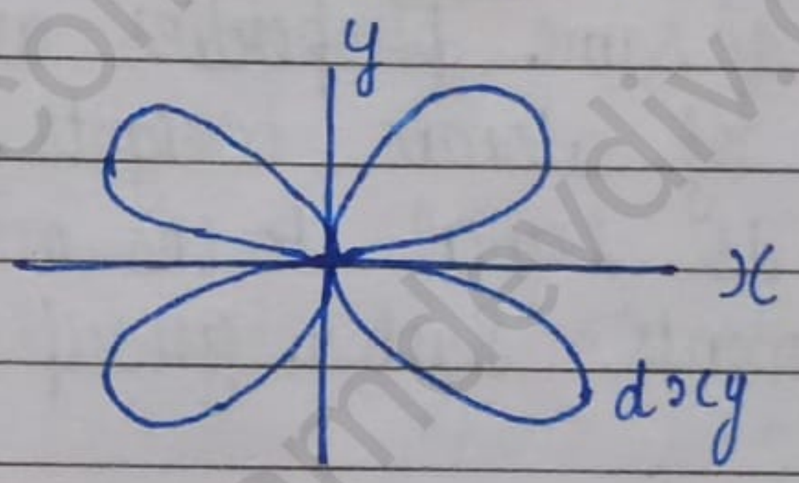


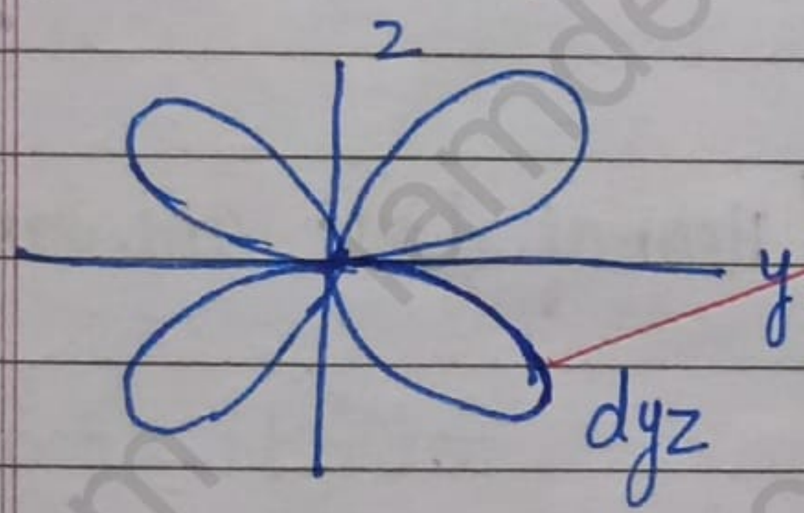
The orbital having same energy or belonging to same energy shell are called degenerate orbitals.

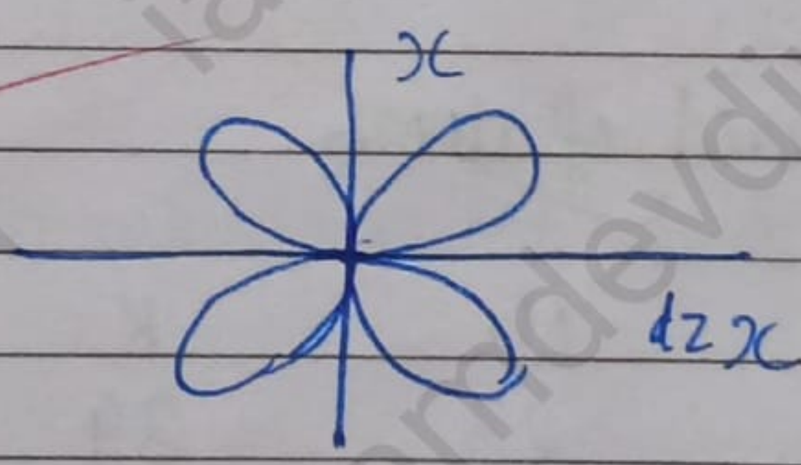
3. Shape of d orbital

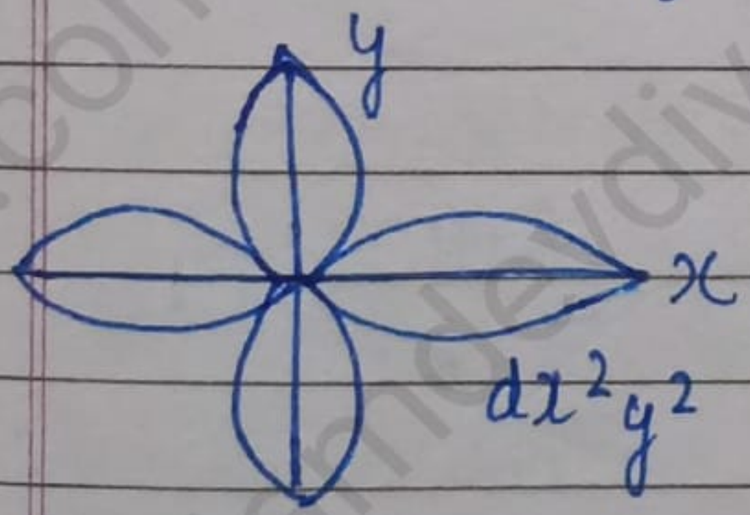
For d orbital → $l=2$, $m=-2, -1, 0, 1, 2$

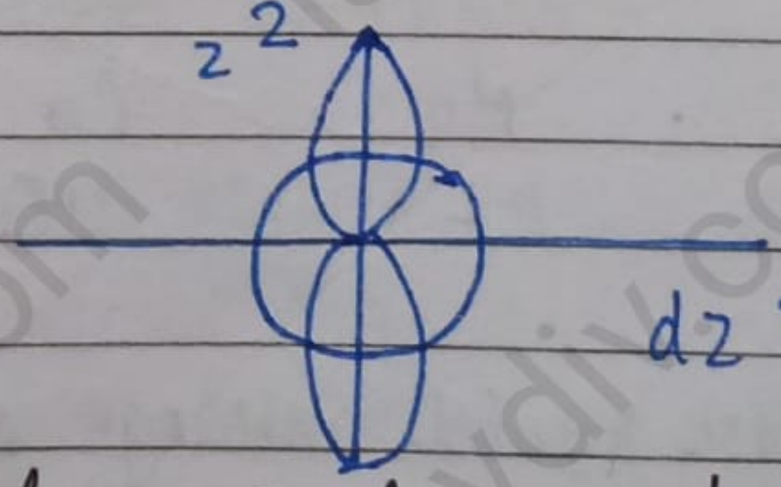












Ques- Calculate the radical node, angular node & total nodes present on 4d

Radical node - 1

Angular node - 2

Total node - 3