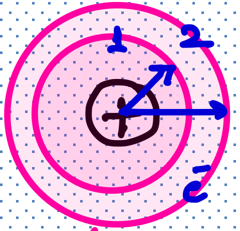
SOME IMPORTANT DEFINITIONS

(Basics of Atomic structure)

Atom →

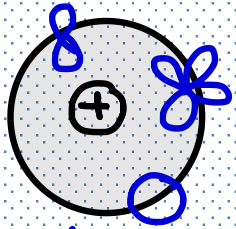


↳ shells | orbits.

- As we go away from Nucleus.
- energy of e^- increases
- velocity decreases.

→ Size of shell increase

→



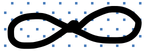
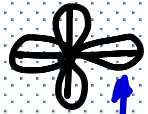
↓ each contains subshell or sub orbit

→ each subshell made of some orbitals.

↓ space where electron resides

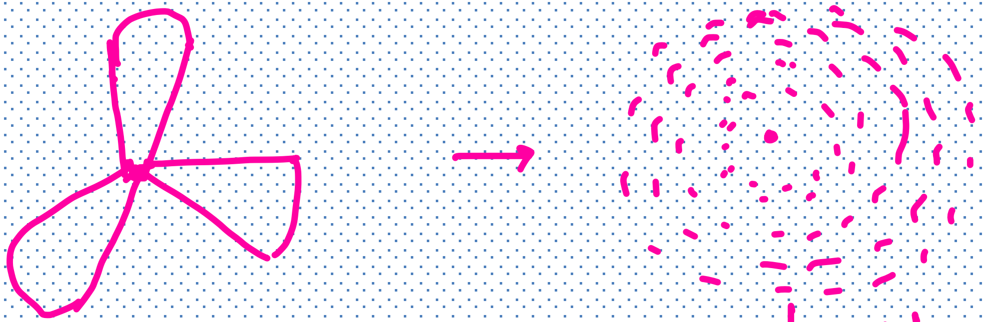
SOME IMPORTANT DEFINITIONS

÷ All shells are circular , K , L , M , N , O . . . .
1 2 3 4 5 . . . . . -

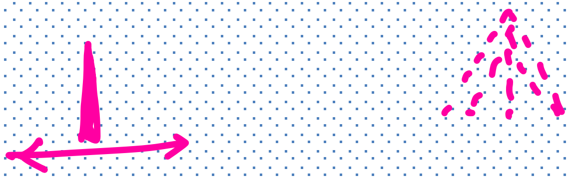
- **Subshells**
  - s- subshell spherical
  - p - subshell  dumb-bell
  - d - subshell  double-dumb-bell
    lobes
  - f → complex.

SOME IMPORTANT DEFINITIONS

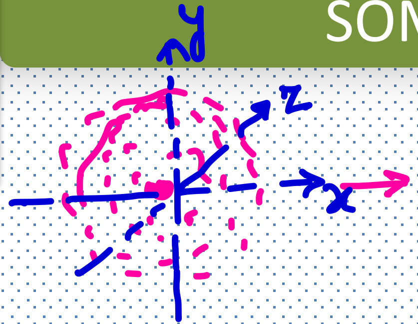
orbital / electron cloud orientation :



Electron cloud.

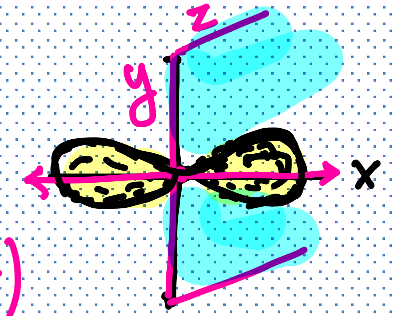


SOME IMPORTANT DEFINITIONS



S- orbital

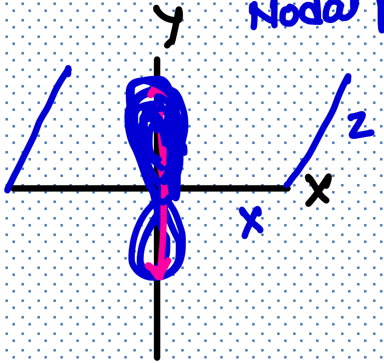
↳ does not have nodal plane



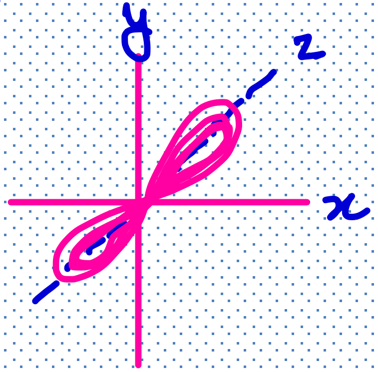
(Nodal plane yz)

Px orbital

Nodal plane



Py orbital

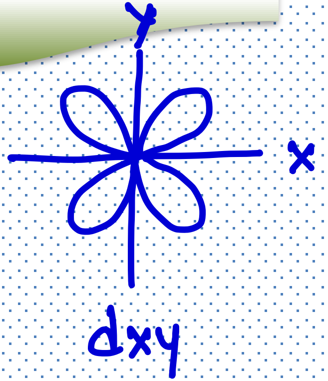


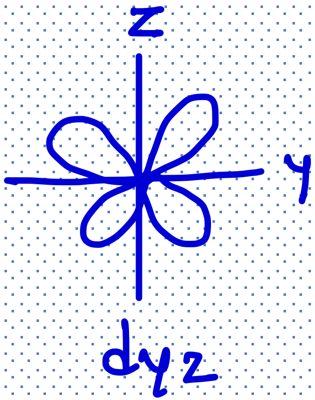
Pz - orbital.

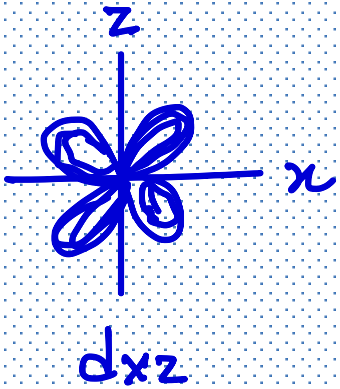
Node → the region where electrons finding probability is zero

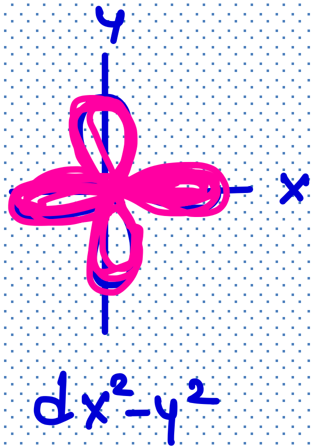
- Radial Node $= n - \ell - 1$
- Angular node / nodal plane $= \ell$

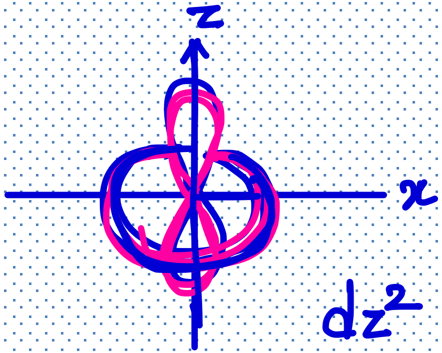
SOME IMPORTANT DEFINITIONS











SOME IMPORTANT DEFINITIONS

Quantum Numbers :

The number which gives complete information of electrons are called quantum Numbers.

(n)	(l)	(m)	s
(Principal Quantum Number)	Azimuthal quantum No	magnetic quantum No	Spin quantum No.
↓	↓	↓	↓
(shell)	Subshell	orbital or orientation	spin of e^- cw/ACW

SOME IMPORTANT DEFINITIONS

- **Principal quantum No (n)** . "Given by Bohr"
- it represent shell · which tells about size of shell
- Energy of $\bar{e}$ in shell , velocity of $\bar{e}$ in shell and angular momentum of $\bar{e}$ shell.
  - $E_1 < E_2 < E_3 < \cdots - E_\infty$
  - $V_1 > V_2 > V_3 \cdots \rightarrow V_\infty$
- Represented by n
- No of possible values of n

** 1, 2, 3, 4, 5, 6 · · — ∞

K L M N O P

SOME IMPORTANT DEFINITIONS

- Each value of n represents 1 shell or orbit

n = 2, 3

→ L shell

→ M shell

) two shell or two orbit

n = 4

→ N-shell – one shell

Ex. n = 1, 2, 5, 7 represents.

(a) 4-shell (b) K, L, O, Q shell (c) Both A & B

(d) None

SOME IMPORTANT DEFINITIONS

- Angular momentum of a n^{th} shell $= n\frac{h}{2\pi}$

$h = 6.64 \times 10^{-34}\ J.sec^{-1}$

- Angular momentum of K shell $= \frac{h}{2\pi} = \hbar$

  for $K \rightarrow n = 1$

- Angular momentum of P-shell $= 6 \cdot \frac{h}{2\pi} = 6\hbar$

  for P-shell

  $\Rightarrow n = 6$

$\frac{h}{2\pi} \Rightarrow \hbar$

SOME IMPORTANT DEFINITIONS

Azimuthal Quantum No "Somerfeld"

- It is also as Angular quantum No / Secoundary Quantum Number / Subsidiary quantum No.
- Represents Shape of subshell
  - s - spherical
  - p - dumb-bell
  - d - double --
- Represented by (ℓ)

** $\boxed{n > \ell}$

No of value of ℓ for given shell (n)

ℓ = 0, 1, 2, 3, 4, 5 .... (n-1)

ℓ	0	1	2	3	4	5
	↓	↓	↓	↓	↓	↓
	s	p	d	f	g	h

4d - subshell

n	ℓ
✗ 3	3
✓ 4	2

No of values = n

SOME IMPORTANT DEFINITIONS

$n > l$

$n = 1$ [K-shell]

$l = 0,$

$l = 0 \longrightarrow$ 1s subshell

$n = 2$ [L-shell]

$l = 0, 1$

$l = 0 \longrightarrow$ 2s subshell

$l = 1 \longrightarrow$ 2p-subshell

why 1f does not exist

$n = 1$

$l = 3$

n always greater than l

so not possible

Ex → which of following subshell do not significance

(a) 3p (b) 4f (c) 2d (d) 3f

SOME IMPORTANT DEFINITIONS

$n = 3$ [M-shell]

$l = 0, 1, 2$

3s

3p

3d

$n = 4$ [N-shell]

$l = 0, 1, 2, 3$

4s

4p

4d

4f

- nth shell contains n no of values of l / subshell

SOME IMPORTANT DEFINITIONS

Orbital Angular momentum $= \sqrt{l(l+1)}\,\frac{h}{2\pi}$

Subshell	l	orbital angular momentum
s	0	0
p	1	$\sqrt{2}\frac{h}{2\pi} \Rightarrow \frac{h}{\sqrt{2}\pi}$
d	2	$\sqrt{6}\frac{h}{2\pi}$
f	3	$\sqrt{12}\frac{h}{2\pi} \Rightarrow \sqrt{3}\frac{h}{\pi}$

SOME IMPORTANT DEFINITIONS

- Radial Node = $n - \ell - 1$
- Angular Node / Nodal plane = ℓ

- total Node = $n - 1$

Node → Space where probability of finding e^- is 0

Q = Find the angular and Radial Node for 4P subshell

$n = 4, \ell = 1$

Sol^n - Radial Node = $4 - 1 - 1 = 2$

Angular Nodal / Nodal plane = 1

	Nodal plane
P_x →	yz
P_y →	xz
P_z →	xy.

SOME IMPORTANT DEFINITIONS

Ex. Find orbital angular momentum for 4s, 5p, 6d subshell.

Orbital Angular moment $= \sqrt{l(l+1)}\,\dfrac{h}{2\pi}$

for 4s $\longrightarrow$ $l = 0$, OAM $= 0$

for 5p $\longrightarrow$ $l = 1$ $\quad \sqrt{2}\,\dfrac{h}{2\pi} \Rightarrow \dfrac{h}{\sqrt{2}\,\pi}$

for 6d $\longrightarrow$ $l = 2$ $\quad \sqrt{6}\,\dfrac{h}{2\pi}$

SOME IMPORTANT DEFINITIONS

Magnetic Quantum No "J. Linde"

- Represents orientation of Electron cloud | orbital
- represented by m
- For a given value of l or subshell m may have:

$$-l, \ldots 0 \ldots +l$$

- Each value represents 1 orbital.

SOME IMPORTANT DEFINITIONS

$n = 1$

$l = 0$ [s- subshell]

$\boxed{}$) 1 orbital

$m = 0$

s-orbital

orbitals = 1

$n = 2$

$l = 0$ (s-subshell)

→ $m = 0$ 1 orbital [2s]

$\boxed{}$

$l = 1$ [p-subshell]

→ $\boxed{}\boxed{}\boxed{}$ | → 3 orbitals → $2p_x$, $2p_y$, $2p_z$ → $m = 0$

$m = -1, 0, +1$

orbitals = 4

SOME IMPORTANT DEFINITIONS

$n = 3$

$l = 0 \longrightarrow m = 0$ | 3s orbital

$l = 1 \longrightarrow m = -1, 0, +1$ | 3 orbitals → $3p_x$, $3p_y$, $3p_z$

$l = 2 \longrightarrow m = -2, -1, 0, +1, +2$ 5 orbitals → $3d_{xy}$, $3d_{yz}$, $3d_{xz}$, $3d_{x^2-y^2}$, $3d_{z^2}$

orbitals $= 9$

Mole Concept

SOME IMPORTANT DEFINITIONS

$n = 4$

(i) $l = 0,$ → $m = 0$ [4s]

(ii) $l = 1$ → $m = -1, 0, +1$ → $4p_x$, $4p_y$, $4p_z$

(iii) $l = 2$ → $m = -2, -1, 0, +1, +2$ → $4d_{xy}$, $4d_{yz}$, $4d_{xz}$, $4d_{x^2-y^2}$, $4d_{z^2}$

(iv) $l = 3$ → $m = -3, -2, -1, 0, +1, +2, +3$ → 7 orbitals.

= 16 orbitals

⇒ • No of orbital for given subshell (l)

$(2l+1)$ = orbitals

⇒ • No of orbital for given shell (n)

$= n^2$

Spin Quantum No

$$\boxed{\uparrow\downarrow}$$

CW $\longleftrightarrow$ ACW

$s = , m_s \quad +\frac{1}{2} \longleftrightarrow -\frac{1}{2}$

→ total spin $= n\left(\pm\frac{1}{2}\right)$ where n is no of unpaired electrons.

SOME IMPORTANT DEFINITIONS

Ex. find value of total spin for p^3

1	1	1

Unpaired electrons = 3

total spin (S) = $3\left(\pm\frac{1}{2}\right) = \pm\frac{3}{2}$

- Spin multiplicity = $2|S|+1$
- Magnetic moment (μ) = $\sqrt{n(n+2)}$ B.M.

$n \rightarrow$ No of unpaired electrons.

SOME IMPORTANT DEFINITIONS

magnetic moment.
μ

$\mu = 0$
Diamagnetic
Species are Called diamagnetic

$\Rightarrow$ No of unpaired electron $= 0$

$\mu \neq 0$ → no of unpaired electron $\neq 0$
Paramagnetic
Species are paramagnetic

→ Feromagnetic
→ Fe, Co, Ni

• Higher the value unpaired electron higher the magnetic moment.

SOME IMPORTANT DEFINITIONS

Note :

- $n > l$
- $|m| \leq l$
- for given value of n (shell) the No of values subshell (l) $= n$
- For a given value of n no of orbital (values of m) $= n^2$
- For a given value n (shell) max. no of electron possible $= 2n^2$
- For a given subshell (l) No of orbitals or values of (m) $= 2l+1$
- For a given subshell (l) the max. No of electron $= 4l+2$

SOME IMPORTANT DEFINITIONS

Ex. Find the no of electrons in 4d subshell

sol^n → 4d ↓ $l = 2$

No of orbitals $= 2l+1$
$= 5$

max. No of electrons $= 2 \times 5 = 10$

Ex. Find the no of max. e^- in M-shell

$n = 3$ ⟶ $l = 0,\ 1,\ 2$

↓ 3s, 3p, 3d

orbital 1, 3, 5

total orbitals $= 9$

No of $e^- = 9 \times 2 = 18$

max. No of $e^- = 2n^2$
$= 2 \times 9 = 18$