QUANTUM NUMBER

01 UNCERTAINTY PRINCIPLE

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

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

Q. According to Heisenberg's uncertainty principle, $\Delta x.\Delta p \geq \frac{h}{4\pi}$ which of the following is correct ?

a) If $\Delta x = 0$ then $\Delta p = \infty$

b) If $\Delta v = 0$ then $\Delta p = 0$

c) If $\Delta p = 0$ then $\Delta x = \infty$

d) All are correct

Q. Find uncertainty in velocity, if uncertainty position is equal to uncertalnty in momentum.

a) $\frac{h}{2\sqrt{\pi m}}$ b) $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$ c) $\frac{1}{m}\sqrt{\frac{h}{\pi}}$ d) $\frac{1}{2}\sqrt{\frac{h}{m\pi}}$

Q. The uncertainty involved in the measurement of velocity within a distance of 0.1A⁰ is:

a) 5.79×10^6 m/s b) 5.79×10^7 m/s

c) 5.79×10^8 m/s d) 5.79×10^5 m/s

Angular momentum in n^{th} orbital $= mvr = n\hbar$

Orbital angular momentum $= \sqrt{l(l+1)}\,\hbar$

Spin angular momentum $= \sqrt{s(s+1)}\,\hbar$

PRINCIPLE QUANTUM NUMBER

In n^{th} Shell ,

Number of subshells = n

Number of orbitals = n^2

Max. number of electrons $= 2n^2$

1. It describes shell or orbit
   n = 1, 2, 3, 4,........
   K, L, M, N,........
2. It describes size & energy of shell.
   $r \propto n^2$ $E \propto \frac{1}{n^2}$
3. It defines the angular momentum
   $mvr = \frac{nh}{2\pi}$

Q. Find angular momentum of
(i) 2s orbital (ii) 3d orbital
(iii) 4p orbital (iv) e^- in 4^{th} orbit

Q. Find maximum no.of e^- having
(i) $n=4, s=-\frac{1}{2}$ (ii) $n=3, l=1, m=0$
(iii) $n=2, l=0$ (iv) $n=3, l=1$

AZIMUTHAL QUANTUM NUMBER

1. It describes subshell
   value from 0 to n-1
   $l=0 \rightarrow s$ $l=2 \rightarrow d$
   $l=1 \rightarrow p$ $l=3 \rightarrow f$
2. Orbital angular momentum
   $= \sqrt{l(l+1)}\,\hbar, \hbar = \frac{h}{2\pi}$
3. Maximum no. of orbital in a subshell $= 2l + 1$
   Maximum no. of electrons in a subshell $= 4l + 2$

Q. Which of the following set of quantum numbers is correct?

	n	l	m	s
1)	4	0	0	$+\frac{1}{2}$
2)	5	2	3	$-\frac{1}{2}$
3)	2	-1	0	$+\frac{1}{2}$
4)	6	3	0	$-\frac{1}{2}$

If l=2
1) Orbital = d
2) No. of orbitals = 2(2+1)=5
$(d_{xy}, d_{xz}, d_{yz}, d_{x^2-y^2}, d_{z^2})$
3) Total e^-s $= 2(2l+1) = 10$ e^-s
4) Orbital angular momentum $= \sqrt{2(2+1)}\,\hbar = \sqrt{6}\,\hbar$

MAGNETIC QUANTUM NUMBER

Value of m $= -l \leq m \leq l$

Total values of m $= 2l + 1$

n = 4

l = 0 m = 0

l = 1 m = -1, 0, +1

l = 2 m = -2, -1, 0, +1, +2

l = 3 m = -3, -2, -1, 0, +1, +2, +3

SPIN QUANTUM NUMBER

SPIN
- CLOCKWISE (+ 1/2)
- ANTICLOCKWISE (- 1/2)

STRUCTURE OF ATOM

ENERGY OF ORBITALS

1) Mono electronic species

Energy defined upon n

↑E: 1s; 2s, 2p; 3s, 3p, 3d

$\boxed{1s < 2s = 2p < 3s = 3p = 3d}$

2) Multi electronic species

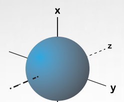
$\boxed{3s < 3p < 4s < 3d}$

(n+l) rule

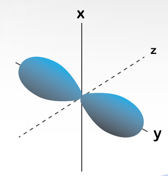
→ As (n + l) ↑, E ↑

→ If (n + l) is same, then n ↑ E ↑

Orbital	2s	3d
(n+l) value	n = 2 l = 0 n+l = 2	n = 3 l = 2 n+l = 5



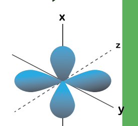
SHAPE OF ORBITALS



1) s orbital - Spherical shape

2) p orbital - dumb bell shape

3) d orbital - double dumb bell shape



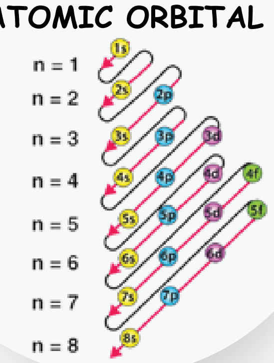
NODES

$\Psi \rightarrow$ e^- wave function

$\Psi^2 \rightarrow$ probability of finding the electrons

* Node → Probability of finding the electron is zero.
* Node plane → Plane; where $\Psi^2 = 0$
* Radial nodes → n-l-1
* Angular nodes = l
* Total nodes = n-1

FILLING OF ATOMIC ORBITAL



1. **Aufbau principle**
   Electrons are filled in the increasing order of energy
   1s < 2s < 2p < 3s < 3p < 4s < 3d ....
2. **Pauli's exclusion principle**
   No two electrons can have same four quantum numbers
   $1s^3$ - against Pauli's exclusion principle
3. **Hund's rule**
   Pairing is only takes place after each orbital is singly occupied.
   ↑↓ | ↑ | ↑ → Against Hund's rule

PHYSICS WALLAH