INDEX

CHEMISTRY

Synopsis - 1

(Orbit and Orbital Concept)

Orbital :

i) Orbital is the region where there is maximum probability of electrons

ii) Orbitals are denoted by the letters s,p,d,f.....

iii) The shape of the orbitals is determined by the azimuthal quantum number *'l'*

	Orbit		Orbital
1.	Orbit is a well-defined circular path around the nucleus in which an electron revolves.	1.	It represents the region in space around the nucleus in which the probability of finding the electron is maximum.
2.	It represents the planar motion of an electron.	2.	It represents the three- dimensional motion of an electron around the nucleus.
3.	Orbit gives a definite path of an electron and this concept is not in accordance with the uncertainty principle.	3.	Orbital does not specify definite path and according to this concept, electron may be anywhere in this region. This concept is in accordance with the uncertainty principle.
4.	All orbits are circular.	4.	Orbitals have different shapes. For example, s-orbital is spherical, while p-orbital is dumb bell shaped.
5.	Orbits do not have directional characteristics.	5.	Except s-orbitals, all other orbitals have directional characteristics.
6.	An orbit can accommodate electrons equal to $2n^2$ where n represents the principal quantum number.	6.	An orbital cannot accommodate more than two electrons.

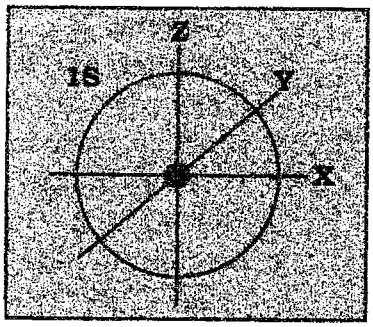
Shape of s - orbital

i) s- orbital do not vary with angles i.e. they do not have directional dependence. thus all s-orbital are called spherically symmetrical.

ii) Their size increases with increase in the value of n.

iii) 1s orbital has no nodal plane (the plane at which zero electron density is noticed). 2s orbital has one nodal plane; 3s orbital has two nodal planes.

iv) It is thus evident that number of nodal planes increases with increasing value of principal quantum number n.



Shape of p - orbitals:

i) Each p- orbitals consist of two lobes to form dumb bell shaped structure.

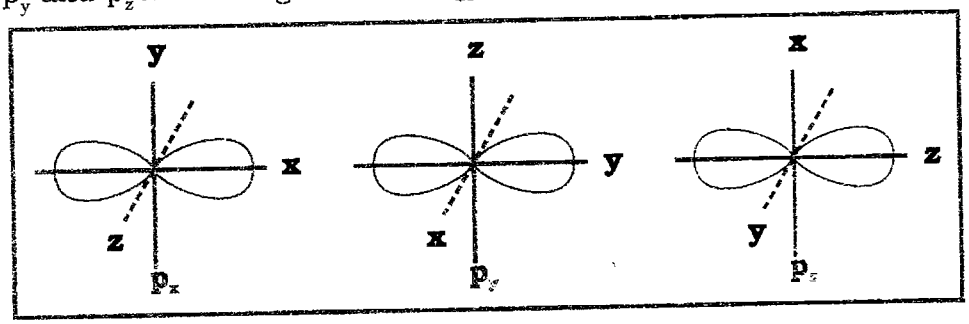
ii) The three p -orbitals along x,y,z axis named as p_x, p_y and p_z orbitals, they are perpendicular to each other respectively.

iii) All the three p-orbitals of a sub shell have the same size and shape but differ from each other in orientation.

iv) The subscripts x,y and z indicate the axis along which orbitals are oriented and possess maximum electron density.

v) The orbitals of a sub shell having same energy are referred as degenerate orbitals.

vi) p_x, p_y and p_z are having same energy, so they are referred as degenerate orbitals.



Shape of d - orbitals

i) The 'd' sub level consist of five orbitals. They are $d_{xy}, d_{yz}, d_{zx}, d_{x^2-y^2}$ and d_{z^2} orbitals.

ii) Each of the d orbitals possesses same energy but differ in their orientation in space (degenerate orbitals).

iii) Four of the d-orbitals $\left(d_{xy}, d_{yz}, d_{xz} \text{ and } d_{x^2-y^2}\right)$ contain four lobes each, while fifth i.e d_{z^2} consists of only two lobes along z-axis a doughnut in the xy - plane.

Energies of orbitals:

iv) In any given sub-shell all the orbitals have equal energy. Hence they are called degenerate orbitals.

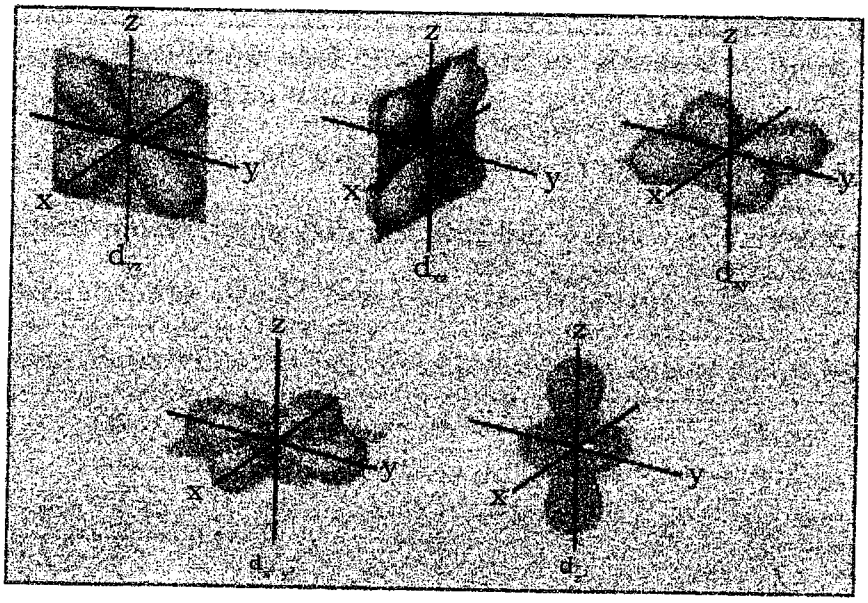
v) In general the energy of an orbital can be known from its (n + *l*) value in absence of any external magnetic field.

vi) As the number of nodal planes increases, the energy of that orbital increases.

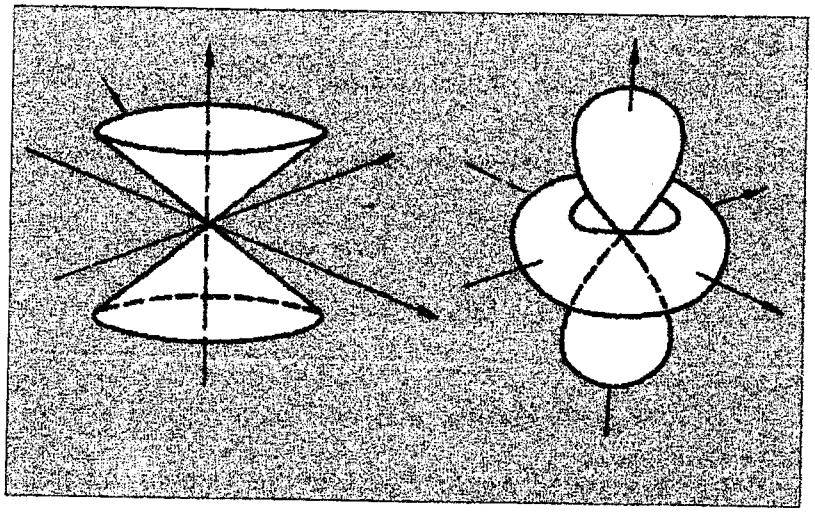
vii) In any main energy level the order of increasing energy of orbitals is s < p < d < f < g .....

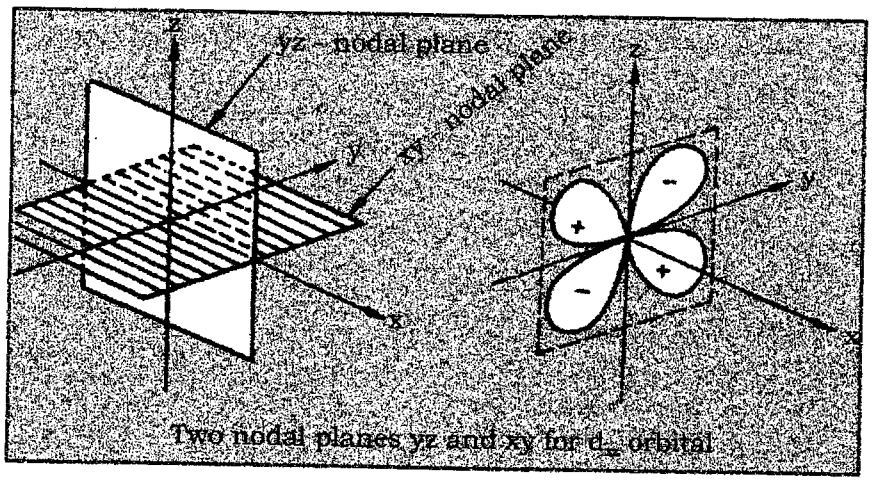
IMPORTANT

- *ELECTRONIC CONFIGURATIONS ARE WRITTEN IN nl^x METHOD.*
  n = principal quantum number (1,2,3,4,.....)
- *l = Azimuthal quantum number, here it denotes about name of sub level (s, p, d, f, ...).*
  x is number of electrons
- *If l is s-sub level then $x \leq 2$.*
- *If l is p-sub level then $x \leq 6$.*
- *If l is d-sub level then $x \leq 10$.*
- *If l is f-sub level then $x \leq 14$.*

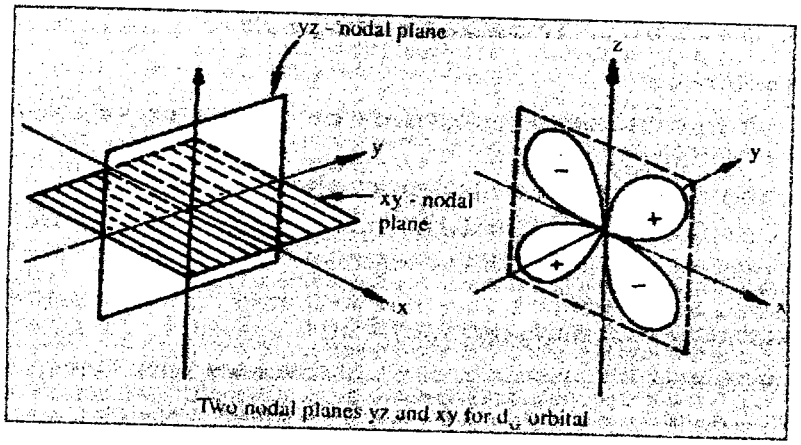


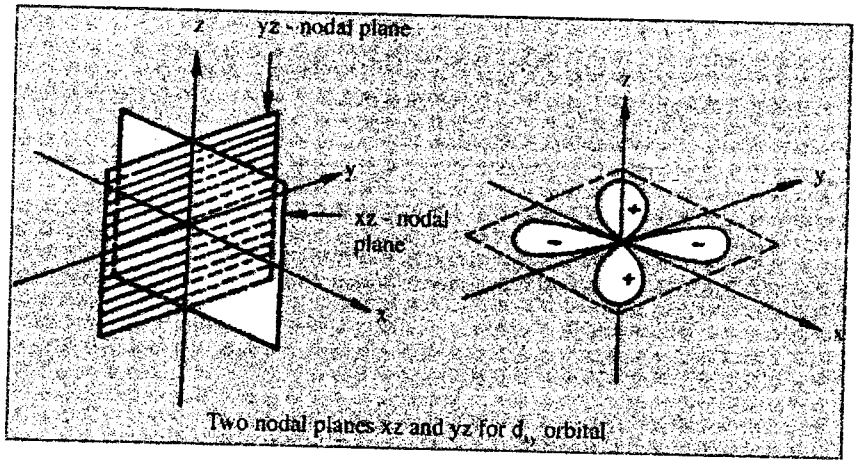
Nodes and Nodal planes for d - orbitals

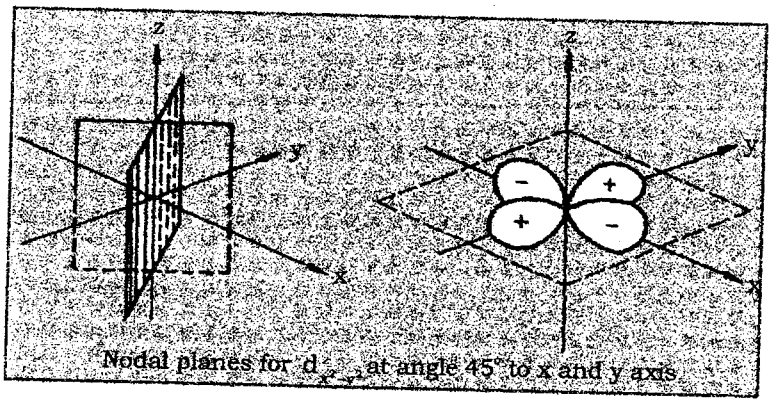




Two nodal planes yz and xy for $d_{x^2-y^2}$ orbital







➢ Number of nodal planes

Orbitals	***Number of nodal planes***	***Nodal***
s	0	Nil
p_x	1	YZ
p_y	1	ZX
p_z	1	XY
d_{xy}	2	YZ, ZX
d_{yz}	2	ZX, XY
d_{zx}	2	XY, YZ
$d_{x^2-y^2}$	2	YZ, ZX

WORKSHEET - 1

1. An orbit is :
   1) A region in space defined by the properties of the wave equation
   2) A rectangular space
   3) Another name for electronic shell
   4) Circular path around the nucleus in which an electron revolve.
2. An orbit can accommodate electrons equal to :
   1) n^2 2) $2l+1$ 3) $n-l-1$ 4) $2n^2$
3. The size of the orbit increases as
   1) n value decreases 2) l values decreases
   3) n value increases 4) n value constant
4. Which orbital is spherically symmetrical?
   1) 5f 2) 4p 3) 3d 4) 3s
5. Which of the subshell has double dumb bell shape ?
   1) s 2) p 3) d 4) f
6. An example for non directional orbital is
   1) 2s 2) $2p_x$ 3) 3d 4) $2p_y$
7. Electrons in an s orbital are free to occupy any position with in a
   1) Square 2) Cube 3) Sphere 4) Dum - bell volume
8. The $2p_x$, $2p_y$ and $2p_z$ orbitals of an atom have identical shapes but differ in their
   1) Size 2) Shape 3) Orientation 4) All of these
9. The d-orbital with the orientation along x and y-axis is called as :
   1) d_{xy} 2) d_{yz} 3) d_{xz} 4) $d_{x^2-y^2}$
10. Which orbital does not possess radial node?
    1) s 2) p 3) d 4) f
11. The number of nodal planes in each p – orbital
    1) Zero 2) One 3) Two 4) Three

JEE MAINS

Single Correct Choice Type:

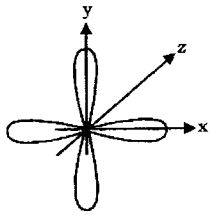
LEVEL-1 1. The space within an atom, where there is maximum probability of finding an electron at any instant is:
   1) An orbit 2) An orbital 3) A stationary orbit 4) Shell
2. Maximum number of electrons that d orbitals can accomodate is:
   1) 6 2) 10 3) 2 4) 18
3. The first energy level that can have f orbitals is:
   1) K 2) L 3) M 4) N
4. An example of non directional orbital is:
   1) 3s 2) 2p 3) 3d 4) 4f
5. Energy of atomic orbitals in a particular shell is in order of:
   1) s < p < d < f 2) s > p > d > f 3) p < d < f < s 4) f > d > s > p
6. The number of radial nodes, nodel planes for an orbital with n = 4 ; l = 1 is
   1) 3, 1 2) 2, 1 3) 2, 0 4) 4, 0
7. The electron density of $3d_{xy}$ orbital in YZ plane is
   1) 50 % 2) 95 % 3) 33.33 % 4) Zero

8. Orbital having most of its orientation along the axis is
1) dx^2-y^2 2) s 3) d_{xy} 4) d_{yz}

9. In a main energy level the orbital with more number of nodal planes will have .....
1) higher energy 2) lower energy
3) either 1 or 2 4) neither 1 nor 2

10. The probability of finding an electron in an orbital is approximately? (M-2000)
1) 95% 2) 50% 3) 60% 4) 25%

LEVEL-2 11. The figure given below is a representation of the shape of:



1) $3d_{xy}$ orbital 2) $3d_{z^2}$ orbital 3) $2p_z$ orbital 4) $3d_{x^2-y^2}$ orbital

12. Which of the following orbitals has appearance like a baby soother?
1) d_{xy} 2) d_{yz} 3) $d_{x^2-y^2}$ 4) d_{z^2}

13. The $2p_x$, $2p_y$ and $2p_z$ orbitals of an atom have identical shapes but differ in their
1) size 2) shape 3) orientation 4) spin

14. Which one of the following atomic orbitals is not directed along the axis? (M-99)
1) P_x 2) $d_{x^2-y^2}$ 3) d_{xy} 4) d_{z^2}

LEVEL-3 15. Which of the following orbitals does not exist?
1) $d_{x^2-y^2}$ 2) $d_{x^2-z^2}$ 3) d_{xy} 4) d_{xz}

16. The d-orbitals whose four lobes lie along the axes is
1) d_{z^2} 2) d_{xz} 3) d_{yz} 4) $d_{x^2-y^2}$

17. Which of the following 3d orbitals has electron density in all three axes ?
1) $3d_{xy}$ 2) $3d_{yz}$ 3) $3d_{z^2}$ 4) $3d_{zx}$

18. Which is not an atomic orbital?
1) $2d$ 2) $5p$ 3) $3p$ 4) $4d$

19. The number of radial nodes for 3p orbital is/are _____.
1) 4 2) 3 3) 2 4) 1

20. Number of angular nodes for 4d orbital is/are _____
1) 4 2) 3 3) 2 4) 1

LEVEL-4 21. Which of the following statements is wrong about the probability of finding an electron in the p_x orbital is :
1) Zero along the X axis 2) Zero along the Y axis
3) Zero along the Z axis 4) Both 2 and 3

22. Which of the following is correct with respect to p orbitals?
1) Spherical 2) Strong directional character
3) Five fold degenerate 4) No directional character

23. The zero probability of finding the electron in p_x orbital is:
1) Maximum on two opposite sides of the nucleus along the x-axis.
2) In the nucleus.
3) Same on all sides around the nucleus.
4) None.

24. During ionisation of copper atom, the quantum numbers of electron removed maybe

1) $n=4\ l=1 \quad s=+\frac{1}{2}$ 2) $n=3\ l=0 \quad s=-\frac{1}{2}$

3) $n=4\ l=0 \quad s=+\frac{1}{2}$ 4) $n=4\ l=2 \quad s=-\frac{1}{2}$

LEVEL-5

25. The spin magnetic momentum of electrons in an ion is 4.84 BM. Its total spin will be

1) ± 1 2) ± 2 3) $\geq \sqrt{\frac{h}{4\pi}}$ 4) ± 2.5

JEE ADVANCED

LEVEL-1 Multi Correct Choice Type

26. Which of the following are true about p-orbital?
1) These are spherical.
2) These are dumbbell in shape.
3) These are double dumbbell in shape.
4) They posses directional character.

Statement Type

27. *Statement I* : p_x, p_y, p_z are degenerate orbitals.
Statement II : p_x, p_y, p_z have same energy in the absence of electric field.
1) Both statement I and II are correct.
2) Both statement I and II are incorrect.
3) Statement I is correct and statement II is incorrect.
4) Statement I is incorrect and statement II is correct.

Comprehension Type

In an atom, a large number of orbitals are possible. These orbitals differ in their size, shape and orientation in space around the nucleus. The state of an electron in any atom is described by its location with respect to the nucleus and by its energy.

28. Number of electrons in p, d subshells respectively are:
1) 2, 6 2) 6, 10 3) 10, 14 4) 3, 5

29. A neutral atom of an element has two 'K', eight 'L', nine 'M' and two 'N' electrons. The total number of electrons present in the subshell having l value 1 is:
1) 6 2) 8 3) 10 4) 12

Matrix Match Type

30.

Column-I Orbital	Column-II Number of nodes
a) 1s	1) 1 node
b) 2s	2) 2 nodes
c) 3s	3) 3 nodes
d) 4s	4) no nodes
	5) 4 nodaes

LEVEL-2 & 3 Multi Correct Choice Type

31. Which of the following statements is/are incorrect?
    1) An orbital describes the path of an electron in an atom.
    2) An orbital is a region where the electron is not located.
    3) An orbital is a function which gives the probability of finding the electron in a given region
    4) All orbitals have directional characteristics.

32. The probability of finding the electron in p_x-orbital is
    (1) maximum on two opposite sides of the nucleus along x-axis
    (2) zero at the nucleus
    (3) same on all the sides around the nucleus
    (4) zero on the z-axis

33. 'g' orbital is possible if
    (1) n = 5, $l = 4$
    (2) It will have 18 electrons
    (3) It will have 9 types of orbitals
    (4) It will have 22 electrons

LEVEL-4 & 5

34.

Column I	Column II
a) 2p orbital	(p) Number of spherical nodes =0
b) 3d orbital	(q) Number of nodal plane =0
c) 2s orbital	(r) Orbital angularmomentum number =0
d) 4f orbital	(s) Azimuthal quantum number=0

Synopsis - 2

(Quantum Numbers)

Quantum Numbers

Any of a set of real numbers assigned to a physical system that individually characterize the properties and collectively specify the state of a particle of the system.

i) The term quantum number is used to identify the various energy levels available with the atom.

ii) Quantum numbers are used to describe identify of an electron in atom, sub orbits and sub-sub orbits (orbitals) in which electrons are residing.

For this four quantum numbers are proposed :

PRINCIPAL, AZIMUTHAL, MAGNETIC and SPIN QUANTUM NUMBERS.

A. Principal Quantum Number:

i) It was proposed by Bohr.

ii) Principal quantum number (n) can have values of 1,2,3,4,....., ∞.

iii) Principal quantum number determines the size of the orbit as well as energy of the electron.

iv) As n value increases, the radius (size) of the orbit, the distance of the electron from the nucleus and its energy increases.

v) Principal quantum number tells us about the main energy level to which an electron belongs.

vi) The number of 'sub energy levels' sub stationary states in a given shell is equal to n^2.

vii) The maximum No.of electrons that can be accomodated in a shell is given by $2n^2$(Bohr).

viii) The maximum No.of electrons that can be accomodated in M shell are 18 ($2 \cdot 3^2$).