

Class:- 8 (Foundation Plus)

5. Concept of Orbital

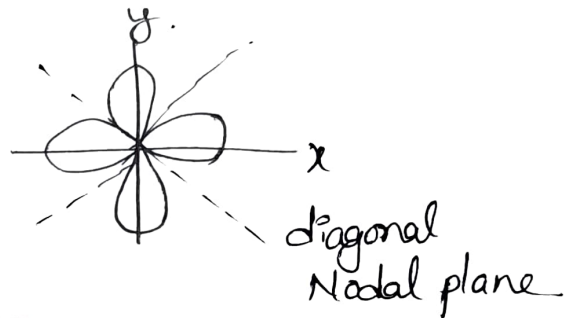
Teaching Task

JEE Main level

Q1)

Ans:- D.

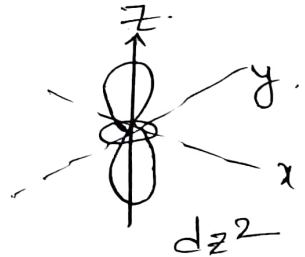
Solution:- $dx^2 - y^2$



Q2)

Ans:- C.

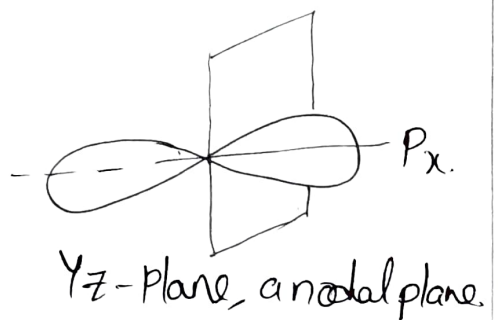
Solution:- dz^2 orbital has a doughnut rolled around the middle of the dumbbell. Hence it has probability density along all three axes



Q3)

Ans:- A.

Solution:- Nodal plane is an imaginary plane on which probability of finding an electron is minimum. P-orbital has 3 nodal planes. One is of P_x , one is P_y & one P_z . P_x has 1 orbital & its value is zero



Q4) Ans:- B.

Solution:- Shape of d-orbital is double dumbbell.

Q5) Ans:- B.

Solution:- m_l values for p orbital

P_x	P_y	P_z
-1	0	+1.

Q6) Ans:- B

Solution:- l value for 's' is zero

Q7) Ans:- B.

Solution:- Arnold Sommerfeld introduced the azimuthal quantum number. It is also known as the angular momentum quantum number ' l '

Q8) Ans:- A

Solution:- The value of the principal quantum number ' n ' represents the main energy level of an electron in an atom. For the 4th shell, $n=4$

Q9) Ans:- B.

Solution:- When the length of major axis becomes equal to the length of minor axis in an orbit, the shape of the orbit becomes a circle

Q10) Ans:- B

Solution:- In every atom, the 1st orbit is always circular according to the Bohr model of the atom.

Q11) Ans:- B

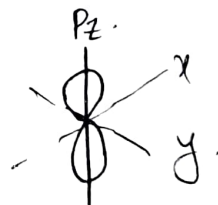
Solution:- P orbitals are dumb bell shaped orbitals. Therefore, they have a strong directional character.

Q12) Ans:- C

Solution:- 5f orbitals can accommodate total of 14 electrons.

Q13) Ans:- D

Solution:- For P_z orbital, the nodal plane lies in xy-plane. Hence the probability of finding electron in xy-plane is zero.



JEE Advanced Level

Q1) Ans:- A, B, C

Solution:- Bohr's theory applicable only for atom containing single electron, like H, He^+ , Li^{2+} etc. It is not applicable for, He, Li, He^{+2} .

Q2) Ans:- A, B, C, D

Solution:- Bohr could not explain Zeeman & Stark effect. He couldn't explain electron with more than 1 electron. He doesn't explain wave nature.

Q3) Ans: A.

Solution: Nodal plane of p_x atomic orbital is yz plane.

In p_x atomic orbital electron density is zero in yz -plane.

Q4) Ans: B.

Solution: No. of nodes $= n + l - 1$

$$\text{For } 3s = 3 + 0 - 1 = 2$$

No. of spherical nodes $= n - 1$

$$3s = 3 - 1 = 2$$

No. of planar nodes $= l$, $\therefore$ for $3s = 0$.

Q5) Ans: A.

Solution: p -orbital can accommodate 6 electrons because a p -subshell has 3 orbitals & each orbital can hold a maximum of 2 electrons with opposite spins.

Q6) Ans: D.

Solution: Electron density in the xy -plane in $3d_{x^2-y^2}$ orbital is non zero.

→ Electron density in the xy -plane in $3d_{z^2}$ orbital is non zero.

→ $2s$ -orbital has one nodal surface

→ For $2p_x$ -orbital, yz is the nodal plane, for $2p_z$ nodal plane is xy

Integer Type

Q7) Ans:- 3.

Solution:- P-Subshell have 3 orbitals. They are P_x, P_y, P_z

Q8) Ans:- 0.

Solution:- For an s-orbital, the azimuthal quantum number (l) is '0'.

$$\begin{aligned}\text{No. of nodal planes} &= l \\ &= 0.\end{aligned}$$

Matching Type

Q9) Ans:- A) C B) B c) A D). D.

Solution:-

A) s-orbital	c) $2e^-$
B) p-orbital	B). $6e^-$
c) d-orbital	A). $10e^-$
D) f-orbital	D) $14e^-$

Learner's Task

Q1) Ans:- A

Solution:- The splitting of spectral lines under the influence of magnetic field is called Zeeman effect.

Q2) Ans:- C

Solution:- According to Sommerfeld, an electron revolves round a positively charged nucleus in elliptical orbit with nucleus situated at one of foci. (Elliptical orbit along with Circular)

Q3) Ans:- A

Solution:- The angle of revolution refers to the angle through which an object moves as it revolves around a central point. The angle is azimuthal angle.

Q4) Ans:- $l = 0$ to $n-1$.

Solution:- The relation b/w n and l is

$$l = 0 \text{ to } (n-1)$$

$$\frac{n}{k} = \frac{\text{length of major axis}}{\text{length of minor axis.}}$$

Q5) Ans:- B.

Solution:- According to Sommerfeld n^{th} shell of Bohr has ' n ' subshells.

$$n=1, \rightarrow 1s$$

$$n=2 \rightarrow 2s, 2p$$

$$n=3 \rightarrow 3s, 3p, 3d$$

Q6) Ans:- B.

Solution:- The Sommerfeld's model, which extended Bohr's model, introduced the idea of elliptical orbits.

Q7) Ans:- C.

Solution:- For d-orbital, $l=2$

Q8) Ans:- B.

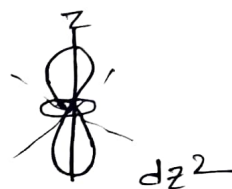
Solution:- 2p orbital in 2nd shell, $n=2$

Q9) Ans:- C.

Solution:- Shape of p-orbital is dumbbell.

Q10) Ans:- C

Solution:- The shape of the $3d_{z^2}$ orbital is doughnut shaped around the z-axis. It looks like baby soother shape.



JEE Main Level.

Q1) Ans:- A

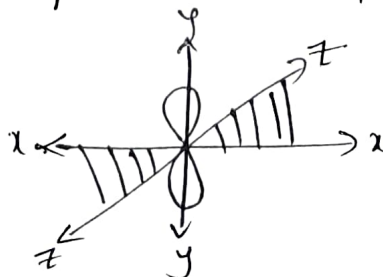
Solution:- Radial node $= n - l - 1$.

For 2s, $n=2$, $l=0$.

Radial nodes $= 2 - 0 - 1 = 1$.

Q2) Ans:- C

Solution:- For $3p_y$, the nodal plane is xz-plane.



Q3) Ans:- A.

Solution:- For $1s$ orbital, the distance at which maximum radial probability is $5.2 \times 10^{-2} \text{ nm}$ from the nucleus. This distance is exactly same as the radius of the innermost orbit of Bohr model and this distance is called Bohr's radius.
 $r = r_0.$

Q4) Ans:- C.

Solution:- The lobes of d_{xy} orbital are in b/w the axes at an angle 45° . So the finding electron in a d_{xy} orbital is maximum at an angle of 45° from x and y axis.

Q5) Ans:- B.

Solution:- For a hydrogen-like atom, the radial nodes are related to quantum number n .

$$\text{No. of radial nodes} = n - l - 1$$

For $5s$ orbital, radial nodes, $n - 0 - 1 = 4$, which gives $n = 5$.

$\therefore$ $5s$ is described by the quantum number $n = 5$ which corresponds to the $5s$ orbital.

Q6) Ans:- C.

Solution:- $E_{S_1} = \frac{-13.6 \times Z^2}{n^2}$ or $E_{S_1} = E_H \times \frac{Z^2}{n^2}$

$$Z=3, n=2$$

$$E_{S_1} = \frac{E_H \times 3^2}{2^2} = 2.25 E_H$$

Q7) Ans:- B.

Solution:- For S_1 (spherically symmetrical)

$$\text{node} = 1.$$

$$\Rightarrow n-1 = 1.$$

$$n = 2$$

For S_2 , radial node = 1

$$E_{S_2} = \frac{-13.6 \times Z^2}{n^2} = E_H \text{ in ground state} = -13.6.$$

Q8) Ans:- A

Solution:- The angular wave function of the S orbital will not be disturbed by the variation with the azimuthal angle.

Q9) Ans:- A

Solution:- For d_{z^2} , two lobes along Z -axis & a ring along xy -plane.

Q10) Ans:- C

Solution:- In case of $d_{x^2-y^2}$ orbital probability of finding electron is maximum along x and y -axis.

JEE Advanced Level.

Q1) Ans:- A, B, D.

Solution:- Bohr's model couldn't explain Zeeman effect, Stark effect and fine spectrum.

→ Bohr's model explains the line spectrum.

Q2) Ans:- A, B.

Solution:- An orbital cannot accommodate more than 2 electrons. Orbital Capacity = 2 electrons.

Orbitals are probability clouds → Heisenberg's principle.

Q3) Ans:- B.

Solution:- Shape of p-orbital is dumb-bell.

m_l values for orbitals in p is $-1, 0, +1$.

Q4) Ans:- B.

Solution:- p_x orbital maximum density along x-axis & its nodal plane is yz plane.

→ As n increases, size of shell increases, due to which the size of orbitals also increases.

Q5) Ans:- A.

Solution:- For n th orbital, 1 - circular.

$(n-1)$ → Elliptical orbits.

Integer

Q6) Ans: 2.

Solution: No. of lobes present in d_{z^2} orbital is '2'.

Q7) Ans: 0.

Solution: Orbital angular momentum of $s = 0$.

For s , $l = 0$.

Matching

Q8) Ans: A) D B) C c) B D) A

Solution:

A) s -orbital $\rightarrow$ D) Spherical.

B) p -orbital $\rightarrow$ c) Dumbell.

c). d -orbital $\rightarrow$ B) Double dumbbell.

D) f -orbital $\rightarrow$ A) Complex.

5. CONCEPT OF ORBITAL KEY

TEACHING TASK									
JEE MAINS LEVEL QUESTIONS									
1	2	3	4	5	6	7	8	9	10
D	C	A	B	B	B	B	A	B	B
11	12	13							
B	C	D	JEE ADVANCED LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	
A,B,C	A,B,C,D	A	B	A	D	3	0	A-C,B-B,C-A,D-D	
LEARNERS TASK									
CUQ'S									
1	2	3	4	5	6	7	8	9	10
A	C	A	$l=0$ to $n-1$	B	B	C	B	C	C
JEE MAINS LEVEL QUESTIONS									
1	2	3	4	5	6	7	8	9	10
A	C	A	C	B	C	B	A	A	C
JEE ADVANCED LEVEL QUESTIONS									
1	2	3	4	5	6	7	8		
A,B,D	A,B	B	B	A	2	0 A-D,B-C,C-B,D-A			