Class:- 8

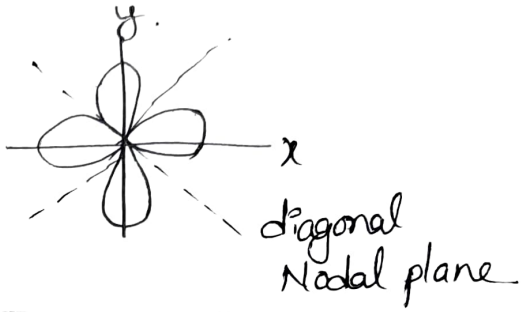
Concept Of Orbital

Teaching Task

JEE Main Level

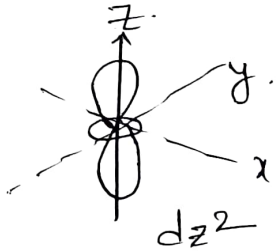
Q1) Ans:- D.

Solution:- $d_{x^2-y^2}$



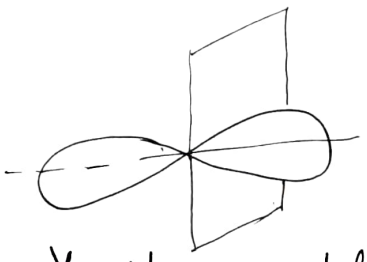
Q2) Ans:- C.

Solution:- dz^2 orbital has a daughnut rolled around the middle of the dumbell. 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 Px, one is Py & one Pz. Px has 1 orbital & its value is zero



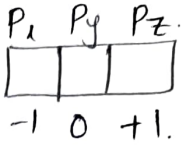
Yz-Plane, a nodal plane.

Q4) Ans:- B

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

Q5) Ans:- B.

Solution:- m_l values for p orbital



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.

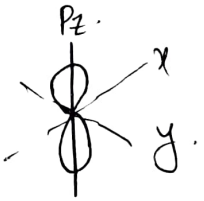
Solution:- P- orbitals are dumb bell shaped orbitals. Therefore, they have a strong directional character.

Q12) Ans:- C.

Solution:- 5f orbitals can accomodate 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 $= n+l-1$

For $3S = 3+0-1 = 2$

No. of spherical nodes $= n+l$

$3S = 3-1 = 2$

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'.

No. of nodal planes $= l$.

$= 0$.

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:- A

Solution:- According to sommerfeld, an electron revolves round a positively charged nucleus in elliptical orbit with nucleus situated at one of focii.

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 azimunthal angle

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

Solution:- The relation blw 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.

$n=1, \longrightarrow 1S$.

$n=2 \longrightarrow 2S, 2P$

$n=3 \longrightarrow 3S, 3P, 3d$

Q6) Ans:- B.

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

Q7) Ans:- C.

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

Q8) Ans:- B.

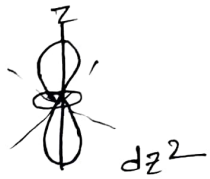
Solution:- 2p orbital in 2nd shell, $n = 2$

Q9) Ans:- C.

Solution:- Shape of p-orbital is dumbell.

Q10) Ans:- A

Solution:- The shape of the $3d_{z^2}$ orbital is daughnut shaped around the z-axis



JEE Main Level

Q1) Ans:- A

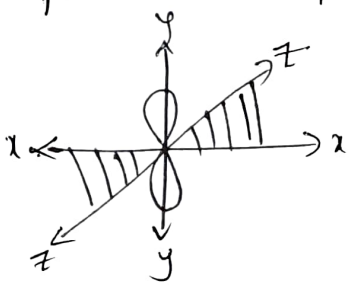
Solution:- Radial node $= n - l - 1$.

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

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

Q2) Ans:-

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



Q3) Ans:- A.

Solution:- For 1s orbital, the distance at which maximum radial probability is 5.2×10^{-2} 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:- D.

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

No. of radial nodes $= n - 2$

For S_1, radial nodes, $n - 2 = 1$, which gives $n = 3$.

$\therefore$ S_1 is described by the quantum number $n = 3$, which corresponds to the 3s orbital.

Q6) Ans:- C

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

$Z = 3,\ n = 2$

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

Q7) Ans:- B.

Solution:- For S_1 (spherically symmetrical)

node = 1.

$\Rightarrow n - 1 = 1.$

$n = 2$

For S_2, radial node = 1

$E_{S_2} = \frac{-13.6 \times Z^2}{n^2} = E_H$ 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 azimuntal 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 could not explain zeeman effect, stark effect and fine spectrum.

→ Bohr's model explains the line spectrum.

Q2) Ans:- A

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

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 nth orbital, 1 - circular.

(n-1) → Elliptical orbits.

Integer

Q5) Ans:- 2.

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

Q6) Ans:- 0.

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

For s, $l = 0$.

Matching

Q7) Ans:- A) D B) C C) B D) A.

Solution:-

A) S-orbital ⟶ D) Spherical.

B) P-orbital ⟶ C) Dumbell.

C). d-orbital ⟶ B) Double dumbbell.

D) f-orbital ⟶ A) Complex.