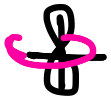
BEGINNER'S BOX-4

Quantum Numbers

1. Which d -orbital does not have four lobes?

(A) $d_{x^2-y^2}$ (B) d_{xy} (C) d_{yz} (D) d_{z^2}

$d_{z^2} \rightarrow$  $\rightarrow$ It contains two lobe & ring

2 The total number of subshells in n^{th} main energy level are :

(A) n^2 (B) $2n^2$ (C) $(n-1)$ (D) n.

No of subshell for given shell (n) = n

3. Which of the following orbital does not make sense?

(A) 3d (B) 3f (C) 5p (D) 7s.

(A) 3d	(B) 3f		(C) 5p	(D) 7s
✓	✓	$n > l$	✓	✓
$n = 3$	$n = 3$	but	$n = 5$	$n = 7$
$l = 2$	$l = 3$	here $(n = l)$	$l = 1$	$l = 0$

4. The maximum number of electrons in s, p and d-subshells are :

(A) 2 in each (B) 2, 6 and 6 (C) 2, 6 and 10 (D) 2, 6 and 12.

no of electrons = $(4l+2)$

$s \Rightarrow l=0$, $e^- = 2$

$p \Rightarrow l=1$, $e^- = 6$

$d \Rightarrow l=2$, $e^- = 10$

5*. Any p-orbital can accommodate up to :

(A) four electrons (B) two electrons with parallel spin

(C) six electrons (D) two electrons with opposite spin.

One orbital means 1 $\square$ that contains $2e^-$

6. Which of the following sets of quantum numbers represent an impossible arrangement

	n	l	m	m_s
(A)	3	2	–2	$\frac{1}{2}$
(B)	4	0	0	$\frac{1}{2}$
(C)	3	2	–3	$\frac{1}{2}$
(D)	5	3	0	$\frac{1}{2}$

$|m| \le l$

7*. Which quantum number will determine the shape of the subshell

(A) Principal quantum number
(B) Azimuthal quantum number
(C) Magnetic quantum number
(D) Spin quantum number

shape of subshell determined by Azimuthal

8. A d-block element has total spin value of +3 or –3, then the magnetic moment of the element is approximately:

(A) 2.83 B.M. (B) 3.87 B.M. (C) 5.9 B.M. (D) 6.93 B.M.

total spin $= n\left(\pm\frac{1}{2}\right) = \pm 3 \Rightarrow n = 6$, $\mu = \sqrt{6(6+2)}$
$= 6.93$ BM

9*. Magnetic moment of $_{25}Mn^{x+}$ is $\sqrt{15}$ B.M then the value of x is :

(A) 1 (B) 2 (C) 3 (D) 4

$Mn(25) = [Ar], 3d^5, 4s^2$

for n unpaired $\bar{e} = 3$

$Mn^{+4} = [Ar], 3d^3, 4s^0$

$\mu = \sqrt{15}$

$\sqrt{n(n+2)} = \sqrt{15}$

$n = 3$

10. Magnetic moment of $_{26}Fe^{2+}$ ion is same as

(A) $_{26}Fe$ (B) $_{24}Cr^{2+}$ (C) $_{28}Ni^{4+}$ (D) All of these

$Fe = [Ar]\ 3d^6, 4s^2,$ $\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$ $\boxed{\uparrow\downarrow}$ $n = 4$

$Fe^{+2} = [Ar], 3d^6$ $\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$ $n = 4$

$Cr(24) \Rightarrow [Ar], 3d^5, 4s^1$

$Cr^{+2} \Rightarrow [Ar], 3d^4, 4s^0$ $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\ }$ $n = 4$

$Ni(28) = [Ar], 3d^8, 4s^2$

$Ni^{+4} = [Ar], 3d^6, 4s^0$ $\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$ $n = 4$

11. Orbital angular momentum of an electron is $\sqrt{3}\dfrac{h}{\pi}$, then the number of orientations of this orbital in space are

(A) 3 (B) 5 ✓(C) 7 (D) 9

$$\sqrt{3}\frac{h}{\pi} = \sqrt{\ell(\ell+1)}\frac{h}{2\pi}$$

$\ell = 3$

No of orientation = orbitals

$= 2\ell + 1$

$= 2 \times 3 + 1 = 7$

12. The correct order of the magnetic moment of $[_{25}Mn, {}_{24}Cr, {}_{26}Fe]$ is :

✓(A) $Fe^{3+} > Cr^{+3} = Mn^{+4}$ (B) $Fe^{3+} > Cr^{3+} > Mn^{4+}$ (C) $Cr^{3+} = Mn^{4+} > Fe^{3+}$ (D) $Fe^{3+} > Mn^{+4} > Cr^{3+}$

$Mn (24) = [Ar], 3d^5, 4s^2$

$Mn^{+4} = [Ar], 3d^3$ $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\ }\boxed{\ }$ $n = 3$

$Fe(26) = [Ar], 3d^6, 4s^2$

$Fe^{+3} = [Ar], 3d^5$ $\boxed{\uparrow \mid \uparrow \mid \uparrow \mid \uparrow \mid \uparrow}$ $n = 5$

$Cr(24) = [Ar], 3d^5, 4s^1$

$Cr^{+3} = [Ar], 3d^3$ $\boxed{\uparrow \mid \uparrow \mid \uparrow \mid \mid }$ $n = 3$

then magnetic moment order

$Fe^{+3} > Mn^{+4} = Cr^{+3}$

13. Magnetic moment of X^{n+} ($Z = 26$) is $\sqrt{24}$ B.M. Hence number of unpaired electrons and value of n respectively are -

(A) 4, 2 ✓ (B) 2, 4 (C) 3, 1 (D) 0, 2

$\mu = \sqrt{n(n+2)} = \sqrt{24} \Rightarrow n = 4$ unpaired electrons

$X(26) = [Ar], 3d^6, 4s^2$ $\boxed{\uparrow\downarrow \mid \uparrow \mid \uparrow \mid \uparrow \mid \uparrow}$ $\boxed{\uparrow\downarrow}$ $n = 4$, X^0

$X^{+2} = [Ar], 3d^6, 4s^0$ $\boxed{\uparrow\downarrow \mid \uparrow \mid \uparrow \mid \uparrow \mid \uparrow}$ $n = 4$ X^{+2}

$X^{+4} = [Ar], 3d^4, 4s^0$ $\boxed{\uparrow \mid \uparrow \mid \uparrow \mid \uparrow \mid \ }$ $n = 4$ X^{+4}

14. Magnetic moments of V ($Z = 23$), Cr ($Z = 24$), Mn ($Z = 25$) are x, y, z respectively. Hence :

(A) $x = y = z$ (B) $x < y < z$ (C) $x < z < y$ (D) $z < y < x$

$V(23) = [Ar], 3d^3, 4s^2$ $\boxed{\uparrow \mid \uparrow \mid \uparrow \mid \ \mid \ }$ $\boxed{\uparrow\downarrow}$ $n = 3$

$Cr(24) = [Ar], 3d^5, 4s^1$ $\boxed{\uparrow \mid \uparrow \mid \uparrow \mid \uparrow \mid \uparrow}$ $\boxed{\uparrow}$ $n = 6$

$Mn(25) = [Ar], 3d^5, 4s^2$ $\boxed{\uparrow \mid \uparrow \mid \uparrow \mid \uparrow \mid \uparrow}$ $\boxed{\uparrow\downarrow}$ $n = 5$

magnetic moment order $\Rightarrow y > z > x$

15. Predict total spin for each configuration.

(a) $1s^2$ (b) $1s^2, 2s^2\,2p^6$ (c) $1s^2, 2s^2\,2p^5$ (d) $1s^2, 2s^2\,2p^3$ (e) $1s^2\,2s^2\,2p^6, 3s^2\,3p^6\,3d^5, 4s^2$.

total spin $= n(\pm\frac{1}{2})$ where n are unpaired electrons

(a) $1s^2$, $n=0$, total spin $=0$, (b) $1s^2, 2s^2, 2p^6$, $n=0$, $TS=0$

(c) $1s^2, 2s^2, 2p^5$ $\boxed{\uparrow\downarrow \,|\, \uparrow\downarrow \,|\, \uparrow}$ $n=1$, total spin $= \pm 1 \times \frac{1}{2} = \pm\frac{1}{2}$

(d) $1s^2, 2s^2, 2p^3$,

$\boxed{\uparrow \,|\, \uparrow \,|\, \uparrow}$ $n=3$, total spin $= 3 \times \pm\frac{1}{2} = \pm 3/2$

(e) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^2$

$\boxed{\uparrow \,|\, \uparrow \,|\, \uparrow \,|\, \uparrow \,|\, \uparrow}$ $n=5$, total spin $= +\frac{5}{2}$

16*. The electronic configuration of a carbon atom is $1s^2, 2s^2, 2p^2$ and consider the following four arrangements of the 2p electrons. Which arrangement have lowest energy ?

(A) $\boxed{\uparrow\downarrow}\boxed{}\boxed{}$ (B) $\boxed{\uparrow}\boxed{\downarrow}\boxed{}$ (C) $\boxed{\uparrow}\boxed{\uparrow}\boxed{}$ (D) $\boxed{\uparrow}\boxed{}\boxed{\downarrow}$

According to hunds maximum multiplicity rule.