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Answers Key:

IV. ANSWER ANY FOUR QUESTIONS

1. Statement : "No two electrons in an atom can have the same set of values of all four quantum numbers"
   Explanation : It means that, each electron must have unique values for the four quantum numbers (n, l, m and s).
   For the lone electron present in hydrogen atom, the four quantum numbers are: n = 1; l = 0; m = 0 and s = +1/2. For the two electrons present in helium, one electron has the quantum numbers same as the electron of hydrogen atom, n = 1.
   l = 0, m = 0 and s = +1/2. For other electron, the fourth quantum number is different i.e., n = 1, l = 0, m = 0 and s = -1/2.
   As we know that the spin quantum number can have only two values +1/2 and - 1/2, only two electrons can be accommodated in a given orbital in accordance with pauli exclusion principle.

Atom	e^-	n	l	m	s
Helium	First	1	0	0	+1/2
	Second	1	0	0	+1/2

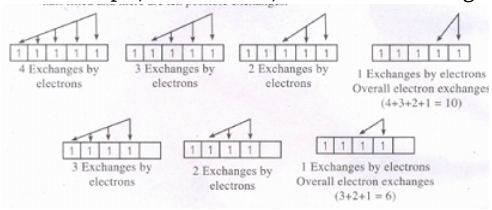
2. m 160 g = 160 x 10^{-3} kg
   $v = 140 kmhr^{-1} = \frac{104\times10^3}{60\times60} ms^{-1}$
   $v = 38.88 ms^{-1}$
   $\lambda = \frac{h}{mv}$
   $= \frac{6.626\times^{-34} Kgm^2s^{-1}}{160\times10^{-3}Kg\times38.88ms^{-1}}$
   $\lambda = 1.065 \times 10^{-34} m$
3. Potential difference = 100V
   = 100 x 1.6 x 10^{-19}J
   $\lambda = \frac{h}{\sqrt{2mev}}$
   $= \frac{6.626\times10^{-34}Kgm^2s^{-1}}{\sqrt{2\times9.1\times10^{-31}Kg\times100\times1.6\times10^{-19}J}}$
   $\lambda = 1.22 \times 10^{-10} m$
4.

n	l	m	Sub energy level
4	2	0	4d
3	1	0	3p
5	1	any one value -1,0,+1	5p
3	2	-2	3d

5. (i) no. of electrons: 35 (given)
   no. of protons : 35
   (ii) Electronic configuration
   $1s^2\ 2S^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^5$
   (iii) Last electron:

↓↑	↑↓	↑

   $4P_x$ $4P_y$ $4p_z$
   last electron present in $4P_y$ orbital y
   n = 4, l = 1 m_l = either + 1 or -1 and s = -1/2
6. 1. If two or more electrons with the same spin are present in degenerate orbitals, there is a possibility for exchanging their positions. During exchange process, the energy is released and the released energy is called exchange energy.
   2. If more number of exchanges are possible, more exchange energy is released. More number of exchanges are possible only in the case of half filled and fully filled configurations.
   3. For example, in chromium, the electronic configuration is $[Ar]3d^5\ 4s^1$. The 3d orbital is half filled and there are ten possible exchanges.



   4. On the other hand only six exchanges are possible for $[Ar]3d^4\ 4s^2$ configuration.
   5. Hence, exchange energy for the half filled configuration is more. This increases the stability of half filled 3d orbitals.
7. Louis de Broglie proposed that all forms of matter showed dual character. To quantify this relation, he Jerived an equation for the wavelength of a matter wave. He combined the following two equations of energy of which one represents wave character (hu) and the other represents the particle nature (mc^2).
   Planck's quantum hypothesis:
   E = hv ....(1)
   Einsteins mass-energy relationship:
   $E = mc^2$ .... (2)

From (1) and (2)

$hv = mc^2$

$hc/\lambda = mc^2$

$\therefore \lambda = \frac{h}{mc}$ ...(3)

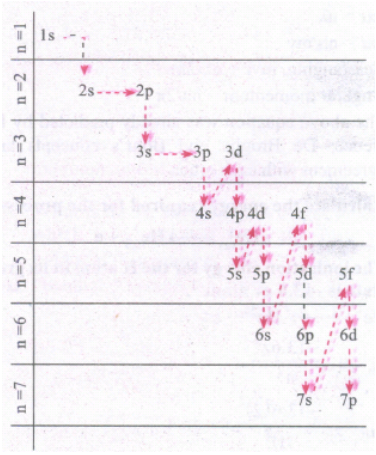
The equation (3) represents the wavelength of photons whose momentum is given by mc. (Photons have zero rest mass).

For a particle of matter with mass m and moving with a velocity v, the equation (3) can be written as

$\lambda = \frac{h}{mv}$ ....(4)

This is valid only when the particle travels at speed much less than the speed of Light.

8. The word Aufbau in German means 'building up'. In the ground state of the atoms, the orbitals are filled in the order of their increasing energies. That is the electrons first occupy the lowest energy orbital available to them.
Once the lower energy orbitals are completely filled, then the electrons enter the next higher energy orbitals. The order of filling of various orbitals as per the Aufbau principle which is in accordance with (n + l) rule.

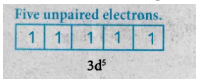


III.ANSWER ANY FOUR QUESTIONS

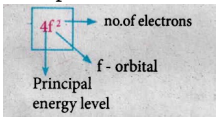
9. i) $_{25}Mn$ - $1s^2, 2S^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^5$
$_{23}Mn^{2+}$ - $1s^2, 2S^2, 2p^6, 3s^2, 3p^6, 3d^5$
ii) $_{24}Cr$ - $1s^2, 2S^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^3$
$_{21}Cr^{3+}$ - $1s^2, 2S^2, 2p^6, 3s^2, 3p^6, 3d^3$

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10. It states that electron pairing in the degenerate orbitals does not take place until all the available orbitals contains one electron each.
11. If a substance which gives a line emission spectrum, is placed in a magnetic field, the lines of the spectrum get split up into a number of closely spaced lines. This phenomenon is known as Zeeman effect.
12. It is impossible to accurately determine both the position as well as the momentum of a microscopic particle simultaneously.
$\Delta x . \Delta p \geq h/4\pi$
where, Δx and Δp are uncertainties in determining the position and momentum, respectively
13. Electronic configuration of Fe^{3+} $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$



Electronic configuration of mn^{2+} is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^5$
Five unpaired electrons
Electronic configuration of Ar is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
no unpaired electrons.



14.
n = 4; f orbital l = 3 $\Rightarrow$ m_l= - 3, -2,-1, 0, +1, +2, +3
out of two electrons, one electron occupies 4f orbital with m_l = -3 and another electron occupies 4f orbital with m_l = -2.
All the four quantum numbers for the two electrons are

Electron	n	l	m_l	m
$1e^-$	4	3	-3	+1/2
$2e^-$	4	3	-2	+1/2

15.

Orbital	n	l	Radial node n - l -1	Angular node l	Total node n - 1
3d	3	2	0	2	2
4f	4	3	0	3	3

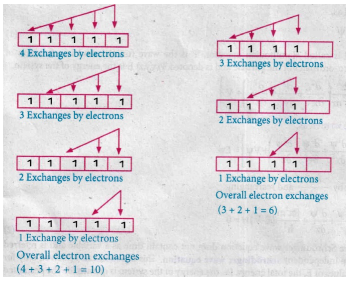
II.ANSWER ANY FOUR QUESTIONS

16. Energy electrons symmetry
This is due to the symmetrical distribution and exchange energy of given d- electrons. Symmetry leads to stability.

Exchange energy:

If two or more electrons with the same spin are present in degenerate orbitals, there is a possibility for exchanging their positions. During exchange process, the energy is released and the released energy is called exchange energy. If more number of exchanges are possible, more exchange energy in released. More number of exchanges are possible only in case of half filled and fully filled configurations.

For example, in chromium the electronic configuration is [Ar]$3d^5$ $4s^1$. The 3d orbital is half filled and there are ten possible exchanges as shown in figure. On the other hand only six exchanges are possible for [Ar]$3d^4$ $4s^2$ configuration. Hence, exchange energy for the half filled configuration is more. This increases the stability of half filled 3d orbitals.



The exchange energy is the basis for Hund's rule, which allows maximum multiplicity, that is electron pairing is possible only when all the degenerate orbitals contain one electron each.

17.

n	l	m	orbitals	Total no of orbitals
	0	0	1	(1- 4s +3 - 4P orbital +5 - 4d orbital +7 - 4f orbital) =16
4	1	-1 0 +1	3	
	2	-2 -1 0 +1 +2	5	
	3	-3 -2 -1 0 +1 +2 +3	7	

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18.

Orbital	n	l	Radial node n-l-1	Angular node l
2s	2	0	1	0
4p	4	1	2	1
5d	5	2	2	2
4f	4	3	0	3

19. a) Principal quantum number defines energy and size of an orbital.
b) Azimuthal quantum number defines shape of an orbital
c) Magnetic quantum number defines spatial orientation (direction) of an orbital.

20. Given $\triangle v = 5.7 \times 10^5\ ms^{-1}$. $\triangle x$ = ?
According to Heisenbergs uncertainty principle $\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$
$\frac{h}{4\pi} = \frac{6.626\times10^{-34}}{4\times3.14} kgm^2\ s^{-1} = 5.28 \times 10^{-35}$
$\Delta x \cdot \Delta p \geq 5.28 \times 10^{-35}$
$\Delta x . m\Delta v \geq 5.28 \times 10^{-35}$
$\Rightarrow \Delta x \geq \frac{5.28\times10^{-35} kgm^2\ s^{-1}}{9.1\times10^{-31} kg \times 5.7\times10^5\ ms^{-1}} \Rightarrow \Delta x \geq 1.017 \times 10^{-10}\ m$

21. n = 4 l = 0,1,2,3
4 sub shells s, p, d & f.
I = 0 m_l = 0 + one 4s orbital.
I = 1 m_l = -1, 0, + 1 $\Rightarrow$ three 4p orbitals.
I = 2 m_l = -2,:1, 0, +1, +2 $\Rightarrow$ five 4d orbitals.
I = 3 m_l = -3, -2, -1,0, +1, +2, +3 $\Rightarrow$ seven 4f orbitals.
Over all 16 orbitals are possible.

22. Electronic configuration of Fe^{3+} : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^5$
Electronic configuration of Ni^{2+} : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^8$
Fe^{3+} has stable $3d^5$ half filled configuration.

I. ANSWER ALL THE QUESTIONS

23. (d) n = 6 to n = 5

24. (b) spin quantum number

25. (c) 4l + 2

26. (c) 2
27. (a) 9
28. (a) ns $\rightarrow$ (n-2)f $\rightarrow$ (n - 1)d $\rightarrow$ np
29. (b) 17
30. (c) $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$
31. (d) -9E
32. (a) If both assertion and reason are true and reason is the correct explanation of assertion.

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