Kishore XI

XI - ... CHEMISTRY

1. Basic Concepts of Chemistry and Chemical Calculations

26. 1) **Define relative atomic mass** yes

The relative atomic mass is defined as the ratio of the average atomic mass factor to the unified atomic mass unit.

(OR)

$$\text{Relative atomic mass (Ar)} = \frac{\text{Average mass of the atom}}{\text{unified atomic mass}}$$

Relative atomic mass of hydrogen $(A_r)_H = 1.008$

2. **Define molecular mass**

Molecular mass is defined as the ratio of the mass of a molecule to the unified atomic mass unit.

Relative molecular mass of hydrogen molecule $(H_2) = 2.016$

27. 3) **What do you understand by the term mole.** NO

Mole is the SI unit to represent a *specific amount* of a substance.

Mole = weight / molar mass

The amount of substance of a system contain many elementary particle 12g C 12 isotope.

28. 4) **Define equivalent mass.** yes

Gram equivalent mass of an element, compound or ion is the mass that combines or displaces 1.008 g hydrogen or 8 g oxygen or 35.5 g chlorine.

29. 5) **What do you understand by the term oxidation number.** NO

It is defined as the imaginary charge left on the atom when all other atoms of the compound have been removed in their usual oxidation states that are assigned according to set of rules.

30. 6) **Distinguish between oxidation and reduction.** yes

Oxidation	Reduction
1. Removal of electron	1. Addition of electron
2. Positive charge increases	2. Negative charge increases
3. Addition of oxygen or Removal of Hydrogen	3. Addition of hydrogen or removal of Oxygen

31. 7) **Calculate the molar mass of the following compounds.** yes

i) Urea $[CO(NH_2)_2]$

C ⇒ 1 x 12 = 12
O ⇒ 1 x 16 = 16
N ⇒ 2 x 14 = 28
H ⇒ 4 x 1 = 4
Molar mass = 60

ii) Acetone $[CH_3COCH_3]$

C ⇒ 3 x 12 = 36
H ⇒ 6x 1 = 6
O ⇒ 1 x 16 = 16
Molar mass = 58

iii, Boric acid $[H_3BO_3]$

H ⇒ 1 x 3 = 3
B ⇒ 1 x 11 = 11
O ⇒ 3 x 16 = 48
Molar mass = 62

iv) Sulphuric acid $[H_2SO_4]$

H ⇒ 2x 1 = 2
S ⇒ 1 x 32 = 32
O ⇒ 4 x 16 = 64
Molar mass = 98

Define Avagadro number.
The total number of entities present in one mole of any substance is equal to 6.022×10^{23}

Define Molar volume.
The volume occupied by one mole of substance in the gaseous state at a given T and P.

Define limiting reagent
When a reaction is carried out using non-stoichiometric quantities of the reactants, the product yield will be determined by the reactant that is completely consumed. It limits the reaction from taking place and is called as the limiting reagent.

Define Relative molecular mass
$$= \frac{\text{Average molecular mass of the atom}}{\text{Unified atomic mass}}$$

N - 14, S - 32, H - 1
C - 12, O - 16, B - 11

28. $$\text{Gram equivalent mass} = \frac{\text{Molar mass } (g\,mol^{-1})}{\text{Equivalence factor } (eq\,mol^{-1})}$$

32. **8.** The density of carbon dioxide is equal to 1.965 kgm^{-3} at 273 K and 1 atm pressure. Calculate the molar mass of CO_2.

Molecular mass = Density x Molar volume

Molar Volume of CO_2 at 273K and 1 atm pressure = $2.24 \times 10^{-2} m^3$

Density of CO_2 = $1.965\ kgm^{-3} = 1.965 \times 10^3 gm^{-3}$

Molecular mass = $2.24 \times 10^{-2} m^3 \times 1.965 \times 10^3 gm^{-3}$

= $1.965 \times 10^1 \times 2.24$

= 44 g

33. **9.** Which contains the greatest number of moles of oxygen atoms

i) 1 mole of ethanol ii) 1 mole of formic acid iii) 1 mole of H_2O

Compounds	No.of moles	No.of Oxygen atoms
Ethanol C_2H_5OH	1	$1 \times 6.023 \times 10^{23}$
Formic acid HCOOH	1	$2 \times 6.023 \times 10^{23}$
Water H_2O	1	$1 \times 6.023 \times 10^{23}$

1 mole of **Formic acid** contains the greatest number of Oxgygen atoms

35. **10.** In a reaction $X + Y + Z_2 \rightarrow XYZ_2$ identify the Limiting reagent if any, in the following reaction mixtures.

(a) 200 atoms of x + 200 atoms of y + 50 molecules of Z_2

(b) 1mole of x + 1 mole of y+3 moles of Z_2

(c) 50 atoms of x + 25 atoms of y + 50 molecules of Z_2

d) 2.5 moles of x + 5 moles of y+5 moles of Z_2

Question	Number of moles of reactants allowed to react			Number of moles of reactants consumed during reaction			Limiting Reagent
	X	Y	Z_2	X	Y	Z_2	
a	200 atoms	200 atoms	50 molecules	50 atoms	50 atoms	50 molecules	Z_2
b	1mole	1mole	3moles	1mole	1mole	1mole	X & Y
c	50 atoms	25 atoms	50 molecules	25 atoms	25 atoms	25 molecules	Y
d	2.5 moles	5 moles	5 moles	2.5 moles	2.5 moles	2.5 moles	X

34. **11.** Calculate the average atomic mass of naturally occurring magnesium using the following data

Isotope	Isotopic atomic mass	Abundance (%)
Mg-24	23.99	78.99
Mg-25	24.99	10.00
Mg-26	25.98	11.01

$$\text{Average atomic mass} = \frac{(78.99 \times 23.99) + (10 \times 24.99) + (11.01 \times 25.98)}{100}$$

$$= \frac{2430.9}{100} = 24.31$$

Average atomic mass of Mg = 24.31

36. **12.** Mass of one atom of an element is 6.645×10^{-23} g. How many moles of element are there in 0.320 kg.

Given: mass of one atom = 6.645×10^{-23} g

∴ Mass of 1 mole of atom = $6.645 \times 10^{-23} \times 6.023 \times 10^{23}$

= 40 g

∴ Number of moles of element in 0.320 kg = $= \frac{1\ mole}{40\ g} \times 0.320 Kg = \frac{1}{40} \times 320 g$

= 8moles

$$n = \frac{\text{Molar mass} = 322}{\text{calculated empirical formula mass}}$$

$$n = \frac{322}{322} = 1$$

Molecular formula = $(Na_2SH_{20}O_{14})_n = (Na_2SH_{20}O_{14})_1$
$= Na_2SH_{20}O_{14}$

Since all the hydrogen in the compound present as water

Molecular formula	$= Na_2SO_4.10H_2O$

Equivalent mass of Acid = molar mass of the acid / Basicity

Equivalent mass of Base = molar mass of the Base / Acidity

Equivalent mass of oxidising (or) Reducing agent = Molar mass of the reagent / No. of e⁻ lost (or) gain

Balance the following equations by oxidation number method.

(i) $K_2Cr_2O_7 + 6KI + 7H_2SO_4 \rightarrow 4K_2SO_4 + Cr_2(SO_4)_3 + 3I_2 + 7H_2O$

(ii) $2KMnO_4 + 3Na_2SO_3 + H_2O \rightarrow 2MnO_2 + 3Na_2SO_4 + 2KOH$

(iii) $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

(iv) $2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$

Calculate the equivalent mass of zinc, $KMnO_4$, $K_2Cr_2O_7$, H_2SO_4.

Zn · Equ. mass = Molar mass / valency
$= \frac{65.38}{2}$; 32.69 g equ^{-1}

$KMnO_4$; Molar mass / No. of electrons
$= \frac{158}{5}$; 31.6 g equ^{-1}

$K_2Cr_2O_7$; Molar mass / No. of electrons
$= \frac{294}{6}$; 49 g equ^{-1}

H_2SO_4 ; Molar mass / Basicity
$= \frac{98}{2}$; 49 g equ^{-1}

Calculate the number of moles in 9g of Ethane.

No. of moles = mass / molar mass
$= \frac{9}{30}$; 0.3 mole

What are the different types of Redox reactions.

(1) Combination reaction
When two substance combine to give a single compound.
$C + O_2 \rightarrow CO_2$

(2) Decomposition reaction
When a compound break into two or more compounds.
$CaCO_3 \rightarrow CaO + CO_2$

(3) Displacement reaction
When an atom in a compound is replaced by another atom.
$CuSO_{4(aq)} + Zn_{(s)} \rightarrow Cu_{(s)} + ZnSO_{4(aq)}$

(4) Disproportionation reaction (or) Auto redox reaction
When a same compound undergoes both oxidation and reduction
$2H_2O_2 \rightarrow 2H_2O + O_2$

(5) Competitive electron transfer reaction.
$Cu_{(s)} + 2AgNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$

What are the rules for assigning for the oxidation number

(1) Oxidation state of a free element is zero
(2) H = +1 ; except metal hydrides = −1
(3) oxygen = −2 ; except peroxide = −1
(4) Fluorine = −1
(5) Alkali metal = +1
Alkaline Earth metal = +2

Example − 1,2 − Pg. No − (11)
Evaluate − 5 − Pg. No − (11)

[redacted]

Example − 1, 2, 3, 4 − Pg. No − (15)

2 . Quantum Mechanical Model of Atom

1. Which quantum number reveal information about the shape, energy, orientation and size of orbitals?

Principle quantum number : Reveal information about Energy and Size
Azimuthal quantum number :Reveal information about Shape
Magnetic quantum number : Orientation

2. How many orbitals are possible for n =4?

If n= 4 l values are 0,1,2,3 (s,p,d,f)
If l =0 4s orbital = 1 orbital
If l =1 m = -1, 0,1 = 3 orbitals
If l = 2 m = -2, -1, 0, 1, 2 = 5 orbitals
If l = 3 m = -3, -2, -1, 0, 1, 2, 3 = 7 orbitals
Total number of orbitals are possible = 16 orbtals

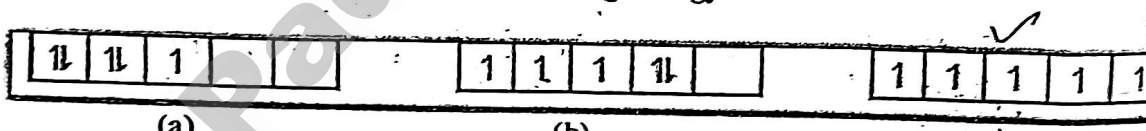
3. How many radial nodes for 2s, 4p, 5d and 4f orbitals exhibit? How many angular nodes?

Orbital	n	l	Radial nodes (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

4. The stabilisation of a half filled d - orbital is more pronounced than that of the p-orbital why?

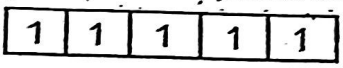
In d- orbital *10 exchanges* are possible but in p-orbital *3 exchanges* are possible
Greater the number exchanges, greater the stability.

5. Consider the following electronic arrangements for the d^5 configuration.
(i) which of these represents the ground state
(ii) which configuration has the maximum exchange energy.

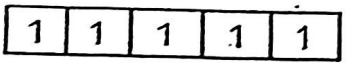


(a) (b) (c)

(i) which of these represents the ground state



(ii) which configuration has the maximum exchange energy.



6. State and explain Pauli's exclusion principle.

"No two electrons in an atom can have the same set of values of all four quantum numbers."

Eg. For the electron in Helium $[He]^2$

Valus of Quantum number	Ist electron	IInd electron
n	1	1
l	0	0
m	0	0
s	+½	-½

7. Define orbital? what are the n and l values for $3p_x$ and $4d_{x^2-y^2}$ electron?

Orbital is a three dimensional space which the probability of finding the electron is maximum

$3p_x$ orbital $\Rightarrow$ $n = 3$ & $l = -1$

$4d_{x^2-y^2}$ orbital $\Rightarrow$ $n = 4$ & $l = -2$

8. Explain briefly the time independent schrodinger wave equation?

The time independent Schrodinger equation can be expressed as,

$\hat{H}\Psi = E\Psi$

$\hat{H}$ is called Hamiltonian operator

ψ is the wave function

E is the energy of the system

$\hat{H} = \left[\frac{-h^2}{8\pi^2 m}\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)+V\right]$

$\hat{H} = \left[\frac{-h^2}{8\pi^2 m}\left(\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}\right)+V\psi\right] = E\psi$

multiple by $-\frac{8\pi^2 m}{h^2}$

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}+\frac{8\pi^2 m}{h^2}(E-V)\psi = 0$$

The above *schrodinger wave equation* does not contain time as a variable and is referred to as time independent Schrodinger wave equation.

9. Calculate the uncertainty in position of an electron, if $\Delta v = 0.1\%$ and $v = 2.2 \times 10^6 ms^{-1}$

$$\Delta x.\Delta p \geq \frac{h}{4\pi}$$

$$\Delta x.\Delta p \geq 5.28\times10^{-35} Kgm^2s^{-1}$$

$$\Delta x.(m\Delta v) \geq 5.28\times10^{-35} Kgm^2s^{-1}$$

Data $\Delta v = 0.1\%$, $v = 2.2\times10^6 ms^{-1}$ and $m = 9.1\times10^{-31} Kg$

$$\Delta v = \frac{0.1}{100}\times2.2\times10^6 ms^{-1}$$

$$= 2.2\times10^3 ms^{-1}$$

$$\therefore \Delta x \geq \frac{5.28\times10^{-35} Kgm^2s^{-1}}{9.1\times10^{-31} Kg\times2.2\times10^3 ms^{-1}}$$

$$\boxed{\Delta x \geq 2.64\times10^{-8} m}$$

10. The quantum mechanical treatment of the hydrogen atom gives the energy value:

$E_n = \frac{-13.6}{n2} ev\ atom^{-1}$

i) use this expression to find ΔE between $n = 3$ and $n = 4$

ii) Calculate the wavelength corresponding to the above transition.

$$E_n = \frac{-13.6}{n^2} eV\ atom^{-1}$$

$n = 3$ $E_3 = \frac{-13.6}{3^2} = \frac{-13.6}{9} = -1.51\ eV\ atom^{-1}$

$n = 4$ $E_4 = \frac{-13.6}{4^2} = \frac{-13.6}{16} = -0.85\ eV\ atom^{-1}$

$\Delta E = (E_4 - E_3) = (-0.85) - (-1.51)\ eV\ atom^{-1}$

$= (-0.85 + 1.51)$

$\boxed{= 0.66\ eV\ atom^{-1}}$

* oxidation state of free electron is zero

* H = +1 Except metal hydrides

* oxygen = -1

* Alkali metal = +1

$(1eV = 1.6 \times 10^{-19}\ J)$

$\Delta E = 0.66 \times 1.6 \times 10^{-19}\ J$

$\Delta E = 1.06 \times 10^{-19}\ J$

$h\nu = 1.06 \times 10^{-19}\ J$

$$\frac{hc}{\lambda} = 1.06 \times 10^{-19} J$$

$$\therefore \lambda = \frac{hc}{1.06 \times 10^{-19} J}$$

$$= \frac{6.626 \times 10^{-34} JS \times 3 \times 10^{8} ms^{-1}}{1.06 \times 10^{-19} J}$$

$$\lambda = 1.875 \times 10^{-6} m$$ 18.75 x 10⁻⁷m.

11) How fast must a 54g tennis ball travel in order to have a de Broglie wavelength that is equal to that of a photon of green light $5400A^0$?

Wave length of photon of green light $= 5400A^0$

Mass (m) $= 54\ g$

Planck'sconstant (h) $= 6.626 \times 10^{-34}\ JS$

$$\lambda = \frac{h}{mV}$$

$$V = \frac{h}{m\lambda}$$

$$V = \frac{6.626 \times 10^{-34} JS}{54 \times 10^{-3} Kg \times 5400 \times 10^{-10} m}$$

$$\boxed{V = 2.27 \times 10^{-26} ms^{-1}}$$

12) For each of the following, give the sub level designation, the allowable m values and the number of orbitals

i) $n = 4, l = 2$, ii) $n = 5, l = 3$ iii) $n = 7, l = 0$

n	l	sub level designation	m values	Number of orbitals
4	2	4d	+2, +1, 0, -1, -2	5 – d orbitals
5	3	5f	+3, +2, +1, 0, -1, -2, -3	7 – 4f Orbitals
7	0	7s	0	1– 7s orbital

13. Determine the values of all the four quantum numbers of the 8th electron in O- atom and 15th electron in Cl atom and ~~the last electron in chromium~~

Atom	Electron	n	l	m	s
O	8th	2	1	-1	~~-½~~ -½
Cl	15	3	1	+1	+½ ✓
Cr	~~Last electron (24th)~~	~~4~~	2	+2	+½

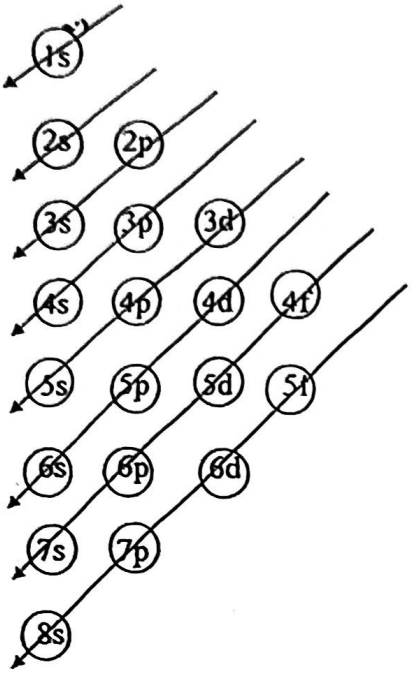
14. Give the electronic configuration of Mn^{2+} and Cr^{3+}.

Electronic configuration of Mn^{2+} is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$

Electronic configuration of Cr^{3+} is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$

15) Describe the Aufbau principle

In the ground state of the atoms, the orbitals are filled in the order of their increasing energies which is in accordance with (n+l) rule.



1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d < 6p < 7s < 5f < 6d < 7p < 8s

16. An atom of an element contains 35 electrons and 45 neutrons. Deduce

i) The number of protons

The number of protons = The number of electrons = 35

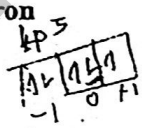
ii) The electronic configuration for the element

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^5$

iii) All the four quantum numbers for the last electron

Last electron present in $4P_y$ orbital

n	l	m	s
4	1	0	-½



17. Show that the circumference of the Bohr orbit for the hydrogen atom is an integral multiple of the de Broglie wave length associated with the electron revolving around the nucleus.

According to the de Broglie concept, the electron that revolves around the nucleus exhibits both particle and wave character. In order for the electron wave to exist in phase, the circumference of the orbit should be an integral multiple of the wavelength of the electron wave. Otherwise, the electron wave is out of phase.

Circumference of the orbit $= n\lambda$

$2\pi r = n\lambda$

$2\pi r = nh/mv$

Rearranging, $mvr = nh/2\pi$

Angular momentum $= nh/2\pi$

18. Calculate the energy required for the process. $He^+_{(g)} \rightarrow He^{2+}_{(g)} + e^-$

The ionisation energy for the H atom in its ground state is - 13.6 ev $atom^{-1}$.

$$He^+ \longrightarrow He^{2+} + e^-$$

$$E_n = \frac{-13.6z^2}{n^2}$$

$$E_1 = \frac{-13.6\,(2)^2}{(1)^2} = -54.4$$

$$E_\infty = \frac{-13.6(2)^2}{(\infty)^2} = 0$$

Required Energy = $E_\infty - E_1 = 0 - (-54.4) = 54.4$ ev

16. An ion with mass number 37 possesses unit negative charge. If the ion contains 11.1% more neutrons than electrons. Find the symbol of the ion.

Numbers	Atom	Uni-negative ion
Number of electron	x – 1	x
Number of protons	x – 1	x – 1
Number of neutrons	y	y

Given that $y = x + 11.1\%$ of x

$$y = x + \frac{11.1}{100}x$$

$$y = 1.11x$$

mass number = 37

mass number = number of protons + number of neutrons = $(x - 1) + 1.11x = 37$

$$= x + 1.11x = 38$$

$$= 2.11x = 38$$

$$x = \frac{38}{2.11} = 18$$

number of electron (or) number of protons = $(x - 1) = 18 - 1 = 17$

symbol of the ion is $^{37}_{17}Cl^-$

20. The Li^{2+} ion is a hydrogen like ion that can be described by the Bohr model. Calculate the Bohr radius of the third orbit and calculate the energy of an electron in 4th orbit.

Bohr radius of the third orbit

$$r_n = \frac{(0.529)n^2}{Z}$$

$n = 3$ and Z value of Li^{2+} ion is 3

$$r_n = \frac{(0.529)3^2}{3} = 1.587A^0$$

The energy of an electron in 4th orbit.

$$E_n = \frac{-13.6Z^2}{n^2}$$

$n = 4$ and Z value of Li^{2+} ion is 3

$$E_n = \frac{-13.6 \times 3^2}{4^2} = \frac{-13.6 \times 9}{16} = -7.65 \text{ eV atom}^{-1}$$

21. Protons can be accelerated in particle accelerators. Calculate the wavelength (in A) of such accelerated proton moving at 2.85×10^8 ms^{-1} (the mass of proton is 1.673×10^{-27} Kg).

Given :-

$v = 2.85 \times 10^8 ms^{-1}$; $m_p = 1.673 \times 10^{-27}$ Kg ; $h = 6.626 \times 10^{-34}$

$$\lambda = \frac{h}{mv}$$

$$\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}}{1.673 \times 10^{-27} \times 2.85 \times 10^8} = 1.389 \times 10^{-15} m$$

$\lambda = 1.389 \times 10^{-5} A^0$ $(1A^0 = 10^{-10} m)$

22. What is the de Broglie wavelength (in cm) of a 160g cricket ball travelling at140 Kmhr^{-1}.

$m = 160\ g = 160 \times 10^{-3}\ kg$

$v = 140\ km\ hr^{-1} = \frac{140 \times 1000}{60 \times 60} = 38.88\ ms^{-1}$

$h = 6.626 \times 10^{-34}$

$\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}}{160 \times 10^{-3} \times 38.88} = 1.065\ 10^{-34}$

$\lambda = 1.065\ 10^{-34}\ m$

23. Which has stable electronic configuration ? Ni^{2+} or Fe^{3+}

Ni (Z = 28) $\Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2 3d^8$

Ni^{2+} $\Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8$

Fe (Z = 26) $\Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2 3d^6$

Fe^{3+} $\Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$

If d – orbital is ***half filled***, Fe^{3+} is more stable. So is more stable Fe^{3+} than Ni^{2+}

24. What is meant by nodal surface? .

- The region where there is probability density function reduces to zero is called nodal surface or a radial node
- For ns orbital, (n-1) nodes are found in it.

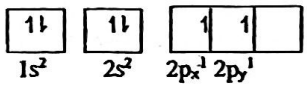
25. What are degenerate orbitals?

- Three different orientations in space that are possible for a p-orbital. All the three p - orbitals namely p_x, p_y and p_z have same energies and are called degenerate orbitals.
- In the presence of magnetic or electric filed the degeneracy is lost.

26. State hund's rule of maximum multiplicity

It states that electron pairing in the degenerate orbitals does not take place until all the available orbitals contain one electron each.

Ex :- Electronic configuration of Carbon



27. What are the limitations of Bohr's atom model?

- The Bohr's atom model is applicable only to species having one electron.
- It was unable to explain the splitting of spectral lines in the presence of *magnetic field (Zeeman's effect* or an *electrical field (Stark effect).*
- Bohr's theory was unable to explain why the electron is restricted to revolve around the nucleus in a fixed orbit in which the angular momentum of the electron is equal to $\frac{nh}{2\pi}$

28. How many unpaired electrons are present in the ground state of Cr^{3+}(Z = 24) and Ne(Z=10)

Cr (Z=24) $\Rightarrow$ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1 3d^5$

Cr^{3+} $\Rightarrow$ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$ it contains 3 unpaired electrons

Ne (Z=10) $\Rightarrow$ $1s^2\ 2s^2\ 2p^6$ no unpaired electrons in it

29. Which is the actual electronic configuration of Cr (Z=24) why?

Cr (Z=24) $\Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1 3d^5$

Cr with $3d^5$ is ***half filled*** and it will be ***more stable***

30. Which is the actual electronic configuration of Cu (Z=29) why?

Cu (Z=29) $\Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1 3d^{10}$

Cu with $3d^{10}$ is ***completely filled*** and it will be ***more stable***

31. Define Quantum number and what are its types?

The electron in a atom can explained by Quantum numbers

Types of quantum numbers

1, Principal quantum number 2, Azimuthal quantum number 3, magnetic quantum number and 4, Spin quantum number

32. Write a notes on Principal quantum number

- It is denoted by the symbol 'n'
- The 'n' can have the values 1,2,3....

Shell	K	L	M	N
'n' value	1	2	3	4

- The maximum number of electrons in a shell can be calculated by the formula $2n^2$.
- The energy of the electron is given by

$$E_n = \frac{-1312.8Z^2}{n^2} KJmol^{-1}.$$

- The distance of the electron nucleus is given by $r_n = \frac{(0.529)n^2}{z} A^0$.

33. Write a notes on Azimuthal quantum number

- It is denoted by the symbol 'l'
- l = (n-1) ,the 'l' can have the values 0, 1,2,3....

Sub Shell (orbitals)	s	p	d	f
'n' value	0	1	2	3

- The maximum number of electrons in a orbital can be calculated by the formula 2(2l+1).
- It is used to calculate the orbitals angular momentum by using

Angular momentum $\sqrt{l(l+1)}\frac{h}{2\pi}$

34. Write a notes on Magnetic quantum number

- It is denoted by the symbol 'm'
- Its value ranging from –l to + l through 0

  i.e, if l = 1 ⇒ m = -1, 0 and +1
- The values of 'l' represent different orientation of orbitals in space
- The Zeeman effect experimental justification of this quantum number.

35. Write a notes on Spin quantum number

- It is denoted by the symbol 's'
- The electron in an atom revolves around the nucleus and also spins in a clockwise direction or in an anti clockwise direction.

Spin direction	clockwise	anti-clockwise
's' value	+½	-½

36. Write a notes on Zeeman efeect

The *spitting of spectral lines* in the presence of *magnetic field*.

37. Write a notes on Stark efeect

The *spitting of spectral lines* in the presence of *electrical field*.

38. How many unpaired electrons are present in the ground state of Fe^{3+} (Z = 26), Mn^{2+} (Z =25) and Ar (Z = 18)

Fe (Z=26) ⇒ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$

Fe^{3+} ⇒ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^5$

$3d^5$

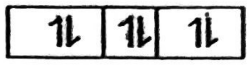
Number of unpaired electrons = 5

Mn (Z=26) ⇒ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^5$

Mn^{2+} ⇒ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^5$

Number of unpaired electrons = 5

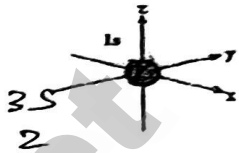
Ar (Z=18) ⇒ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$



No unpaired electrons in it

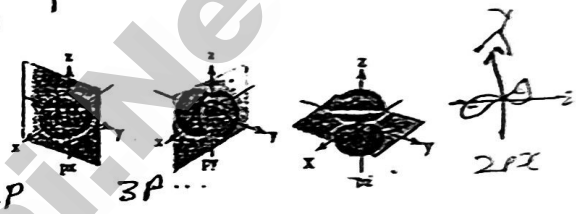
39. Sketch and explain the shapes of s-orbital.

- For s-orbital $l = 0$ and hence, m can have only one value, i.e., $m = 0$.
- This means that the probability of finding the electron in s-orbital is the same in all directions at a particular distance.
- In other words s-orbitals are *spherically symmetrical.*



40. Sketch and explain the shapes of p-orbitals.

- p-orbitals, $l = 1$ and the corresponding m values are −1, 0 & +1.
- The three different 'm' values indicates that there are three different possible orientations as p_x, p_y and p_z and the angular distribution along the x, y and z axis respectively.



41. Sketch and explain the shapes of d-orbitals.

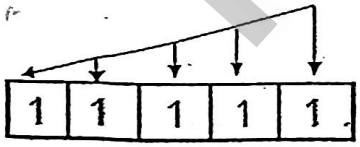
- For 'd' orbital $l = 2$ and the corresponding m values are -2, -1, 0, +1, +2.
- The shape of the d orbital looks like a 'clover leaf'.
- The five m values give rise to five d orbitals namely d_{xy}, d_{yz}, d_{zx}, d_{x2-y2} and d_{z2}.

42. Sketch and explain the shapes of f-orbitals.

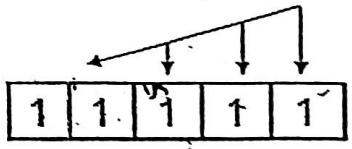
- For 'f' orbital, $l = 3$ and the m values are -3, -2, -1, 0, +1, +2, +3 .
- Corresponding to seven f orbitals f_{z^3}, f_{xz^2}, f_{yz^2}, f_{xyz}, $f_{z(x^2-y^2)}$, $f_{x(x^2-3y^2)}$, $f_{y(3x^2-y^2)}$

43. Define Exchange energy

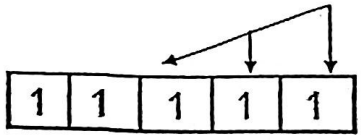
- If two or more electrons with the same spin are present in degenerate orbitals, there is a possibility for exchanging their positions.
- During exchange process the energy is released and the released energy is called exchange energy.
- For example, in chromium the electronic configuration is $[Ar]3d^5\ 4s^1$. The 3d orbital is half filled and there are ten possible exchanges.



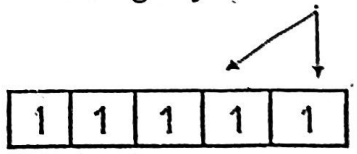
4 exchanges by electrons



3 exchanges by electrons



2 exchanges by electrons



1 exchanges by electron

Overall electron exchanges (4 + 3 + 2 + 1 = 10)

(44) Identify the missing quantum numbers and the sub energy level

n	l	m	Sub energy level
?	?	0	4d
3	1	0	?
?	?	?	5p
?	?	-2	3d

n	l	m	Sub energy level
[redacted]	[redacted]	0	4d
3	1	0	[redacted]
[redacted]	[redacted]	[redacted]	5p
[redacted]	[redacted]	-2	3d

50) BB What is the de-Broglie wavelength of an electron accelerated from the rest through a potential of 100V?

Ans $V = 100 \times 1.6 \times 10^{-19} J$ $\lambda = \frac{h}{\sqrt{2meV}}$ $\lambda = \frac{6.62 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19} \times 100}}$

$\lambda = 1.22 \times 10^{-10} m$

(48) BB Suppose the uncertainty in determining the position of an electron in an orbit is 0.6 A°. What is the uncertainty in its momentum?

Ans $\Delta x = 0.6 A^0 ; 0.6 \times 10^{-10} m$ $\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$; $\Delta x \cdot \Delta p \geq 5.28 \times 10^{-35}$ $\Delta p \geq \frac{5.28 \times 10^{-35}}{0.6 \times 10^{-10}}$ $\Delta p \geq$ (m-v)

(49) BB Show that the measurement of the uncertainty in the location of the particle is equal to de-Broglie wavelength, the minimum uncertainty in its velocity (Δv) is equal to $\frac{1}{4\pi}$ of its velocity (v).

Ans $\Delta x = \lambda$ $\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$; $\lambda \times \Delta p \geq \frac{h}{4\pi}$

$\lambda \cdot m \cdot \Delta v \geq \frac{h}{4\pi}$; $\Delta v \geq \frac{h}{4\pi \times m\lambda}$; $\Delta v \geq \frac{h}{4\pi \times m \times \frac{h}{mv}}$; $\Delta v \geq$

minimum uncertainty velocity

(45) Write notes on assumptions of Bohr's atom model

(1) The energy of a electron is quantised.

(2) The electrons are moving around the nucleus in circular path called as stationary orbits.

(3) $mvr = \frac{nh}{2\pi}$

(4) As long as a electron is in a fixed orbit, it will not lose energy.

$\nu = \frac{E_2 - E_1}{h}$

(6) Derive de-Broglie equation as wave nature of electrons.

Ans

$E = mc^2$ | $h\nu = mc^2$

$E = h\nu$ | $\nu = c/\lambda$

$\frac{hc}{\lambda} = mc^2$; $\frac{h}{\lambda} = mc$

$\frac{\lambda}{h} = \frac{1}{mc}$; $\lambda = \frac{h}{mc}$

$\boxed{\lambda = \frac{h}{mv}}$ $\boxed{c = v}$

Explain Davisson and Germer experiment to verify wave character.

Ans

(1) A beam of electron obtained from a Tungsten filament is made to fall on a Nickel crystal.

(2) The diffraction pattern is obtained similar to that of X-Rays.

(3) Since X-Rays have wave character, Electrons should also have wave character.

It is used in the development of the electron microscope and low energy electron diffraction.

Observed

(1) most of the α-particle passes through the foil

(2) some of them are deflected by a small angle

(3) A very few reflected back by 180°

Proposed

(1) The center of the atom is the positive charged nucleus.

(2) Around the nucleus the electrons are moving in high speed.

Limitation

(1) Fails to explain distribution of electrons.

(2) Fails to explain energy of the electron.

Define Heisenberg's uncertainty principle.

Ans

It is impossible to determine both the position and momentum of microscopic particle simultaneously and accurately.

$\Delta x \cdot \Delta p \geq h/4\pi$

(50) write main features of the quantum mechanical model of atom

Ans

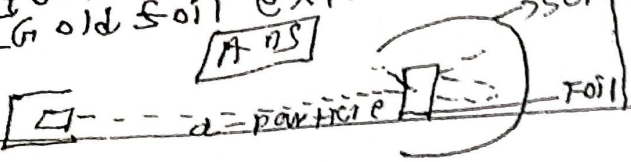
(1) The energy of electron in atom is quantised

(2) The solution of schrodinger wave equation gives the allowed energy levels

(3) According to Heisenberg uncertainty principle, the exact position and momentum of an electron cannot be determined with absolute accuracy.

Explain the Rutherford Atomic model theory [Gold foil experiment]

Ans



(51) Calculate the total number of angular nodes and Radial nodes present in 3d and 4S orbitals.

	n	l	Radial node (n-l-1)	Angular node (l)	Total node (n-1)
3d	3	2	0	2	2
4S	4	3	0	3	3

(52) What is the meaning of 4S2. and write quantum number.

Ans $4S^2$ → no of s-orbital

	n	l	m_l	m_s
$1e^-$	4	3	-3	$+\frac{1}{2}$
$2e^-$	4	3	-2	$+\frac{1}{2}$