EXERCISE

QI : Select the right answer from the choices given with each question.

1) Coinage metals are actually

a) Halogens
b) Alkali metals
c) Transition metals
d) Alkaline earth metals

2) Zinc is a transition element but it does not show variable valency because:

a) It does not form colored salts
b) It has incomplete d-subshell
c) It has completely filled d-subshell
d) Has two electrons in outer most orbit

3) Which of the following is non-typical transition element?

a) Fe
b) Mn
c) Zn
d) Cr

4) Which element form alloy

a) Alkali metals
b) Alkaline earth metals
c) Halogen
d) Transition elements

5) Which are repelled by magnetic field?

a) Paramagnetic
b) Ferromagnetic
c) Diamagnetic
d) None

6) Magnetic moment (u) of an atom or ion is the measure of its number of unpaird

a) Electron b) Proton

c) Neutron d) Nucleons

7) The unit of magnetic moment is

a) Coulombs (Q) b) Amperes (A)

c) Bohr magneton (BM) d) Watts (W)

8) Bronze alloy contains:

a) Cu and Sn b) Ni and Cr

c) Cu and Zn d) Cr and Fe

9) Give the systematic name for $Fe(CO)_5$

a) Pentacarbonyl iron (III) b) Pentacarbonyl iron (o)

c) Pentacarbonyl iron (II) d) Pentacarbonyl ferrate (III)

10) Give the chemical formula of a complex compound sodium monochloropnetacyanoferrate (III).

a) $[Na_3FeCl(Cn_5)]$ b) $Fe_3[NaC]$

c) $[Na_3FeCl(Cn_5)]$ d) $Na_2[Fe]$

11) The complexes having coordination number (C.N) = 4 have geometry:

a) Tetrahedral
b) Linear
c) Square plane
d) both a and c

12) If we add HNO_3 to the original vanadium (II) solution, it produces

a) blue ions
b) green ions
c) dull grey blue ions
d) pink ions

13) Which metal oxide is used in contact process as a catalyst:

a) Cr
b) Mn
c) V
d) Cu

14) In oxidation of chromium (III) to chromium (VI) the green color will change into

a) colorless
b) bright yellow
c) pink
d) None

15) Acidified potassium permanganate act as a strong

a) oxidizing agent
b) reducing agent
c) electrolytic agent
d) hydrolyzing agent

16) Following element shows maximum number of oxidation states?

a) Mn
b) Fe
c) Cr
d) Cr

17) The color of Mn^{2+} in hydrated form is:

a) Blue
b) Yellow
c) Light Pink
d) Green

18) Which of the following metals show more than one oxidation state?

a) Al b) Mg c) Fe d) Ca

19) Iron is used as a catalyst in:

a) Brikland Process b) Contact Process

c) Haber Process d) both b and c

20) During the reaction of Ammonia with iron, it acts as both a base and a:

a. Ligand b) Acid c) Iron d) Salt

Answers

l)	c	**2)**	c	**3)**	c	**4)**	d
5)	c	**6)**	a	**7)**	c	**8)**	a
9)	b	**10)**	a	**11)**	a	**12)**	a
13)	c	**14)**	b	**15)**	a	**16)**	a
17)	c	**18)**	c	**19)**	c	**20)**	a

Q2. Give short answers of the following questions.

Ql: Why are d-block elements are called transition elements?

Answer

Please see Answer ofQ2. i, iii.

Q2: Why do the d-block elements show different oxidation state?

Answer

Please see Answer ofQ2. i, iii.

Q3: Why does Mn show the maximum number of oxidation states in the series?

Answer

Mn has 5 unpaired electrons in its 3d-orbitals and 2 electrons in its 4s-orbital therefore

it may lose 2 to 7 electrons and shows oxidation state +2 to +7.

Q4: What is difference between double salts and coordination complex compounds?

Answer

In a double salt two salts are crystallized together in one crystal such salts have some water of crystallization also For example:

Potash alum K_2SO_4 Al_2 $(SO_4)_3$ 24 H_2O

Where as in a transition metal complex some ligands are attached with a central metal atom through coordinate covalent bond.

For example: $[Cu(NH_2)_4]Cl_2$

Tetraamine copper (ii) chloride.

Q5: Explain the following terms

(a) Ligands **(b) Coordination sphere** **(c) Central metal atom**

Answer

Ligands

The species which may attach with a metal atom by donating an electron pair is called a ligand. Ligands are of three types:

(i) **Neutral Ligands:**

For example NH3, NH2, NH2

(ii) **Negative Ligands:**

For example Cl, Br. OH

(iii) **Positive Ligands:**

For example $\tilde{N}H_2$ -N^+H_3, NO^+

Coordination sphere:

The whole of the sphere in which some ligands are attached with a metal atom through coordinate covalent bond is called coordination sphere.

For example: $K_4[Fe(CN)_6]$ Potassium hexacyanoferrate (ii)

$[Fe(CN)_6]^{2-}$ is the coordination sphere.

Q6: How chromate ions are converted into dichromate ions?

Answer

Please see Answer of Q.no 38 of chapter.

Q7: What is the difference between paramagnetism and diamagnetism?

Answer

Please see Answer of Q.no 10 of chapter.

Q8: What is advantage of potassium dichromate in titration?

Answer

Please see Answer of Q.no 12 of chapter.

Q9: How does dichromate in converted into chromate ions?

Answer

Please see Answer of Q.no 38 of chapter.

Q3. Give detailed answers for the following questions.

QI .a) What is the valence shell configuration of transition elements? How does it effect the following properties? (i) Binding energy. (ii) Paramagnetism. (iii) Oxidation states.

b) **What are typical and non-typical transition elements?**

c) **Explain catalytic activity of transition elements.**

d) **Write composition, properties and uses of Brass, Bronze and Nichrome alloys.**

Answer

a) Valence shell 3d electronic configuration

Elements of 3d series have 3d 4s electronic configuration of valence shell.

$$Eg\ SC = 2_1 = 4S^2, 3d^1$$

$$Zn = 30 = 4S^2, 3d^{10}$$

Valence shell 4d electronic configuration

Elements of4d series have 4d 4s electronic configuration of valence shell

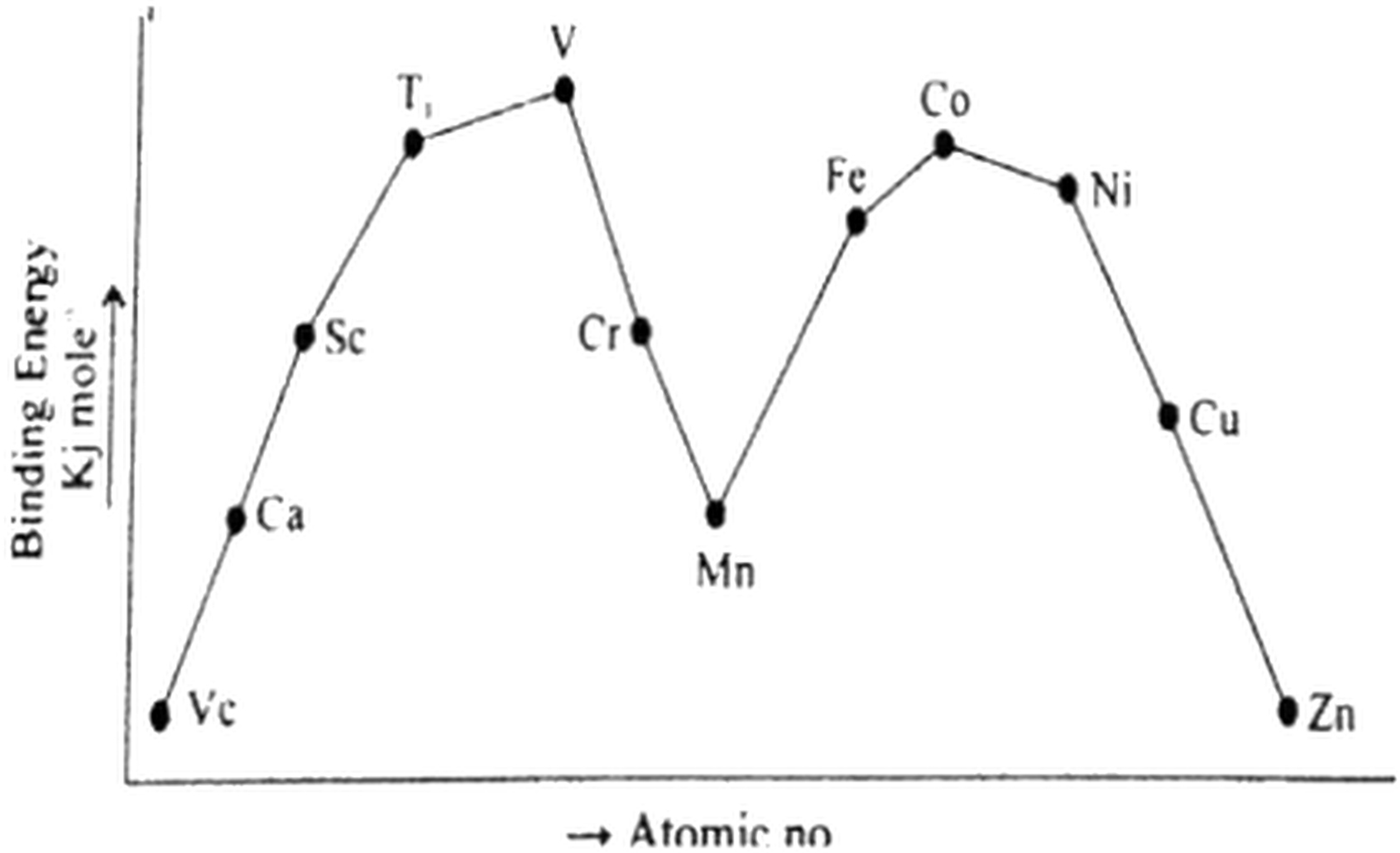
$$Eg\ y = 39 = 5s^2, 4d^1$$

$$Z_r = 40 = 5s^2, 4d^2$$

(i) Electronic configuration of transition elements and Binding Energy:

Transition elements are hard, strong, malleable and ductile.

In moving from left to right in a transition series the number of electrons increase up to VB and VIB after that the pairing of takes place in 3d and 4d series and number of unpaired electrons in d-orbitals goes on decreasing which become zero at II.B.



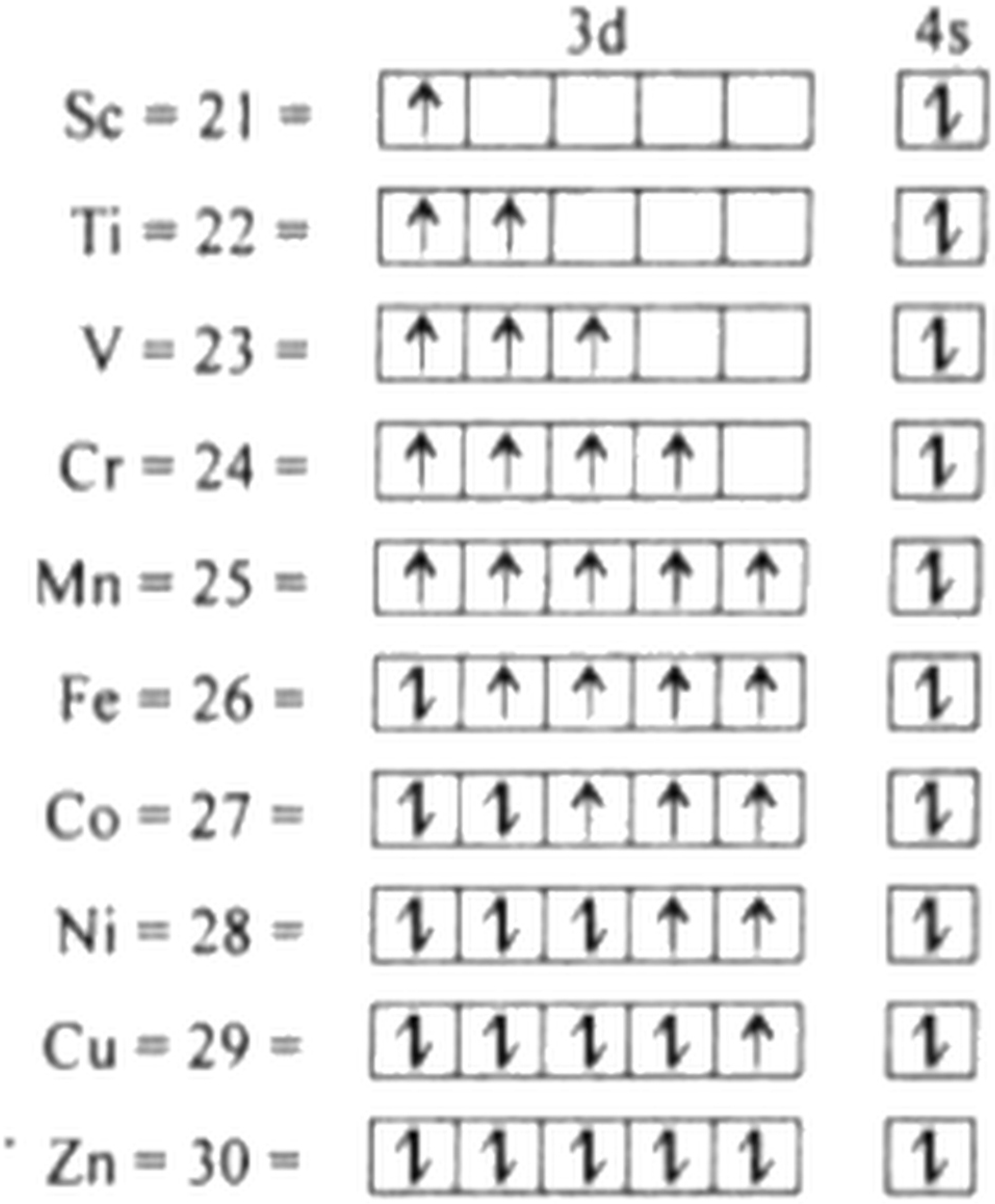
As manganese have 5 electrons in its. 3d orbital which is stable state therefor binding energy of Mn is low

$$Mn = 25 = 4s^2\ 3d^5$$ 3d [↑|↑|↑|↑|↑] 4s [N]

(ii) Electronic configuration of transition elements and Paramagnetism:

I he elements in which one effected or by a magnetic field are called paramagnetic and the elements which are very strongly by magnetic field are called ferromagnetic. Whereas the elements which are not affected by magnetic field or weekly repelled by magnetic field are called diamagnetic.

The paramagnetic character elements depend upon the number of unpaired electrons in their outermost d-orbitals. The paramagnetic character of transition elements d-creases with the increase in the number of unpaired electrons in the outermost d orbitals.



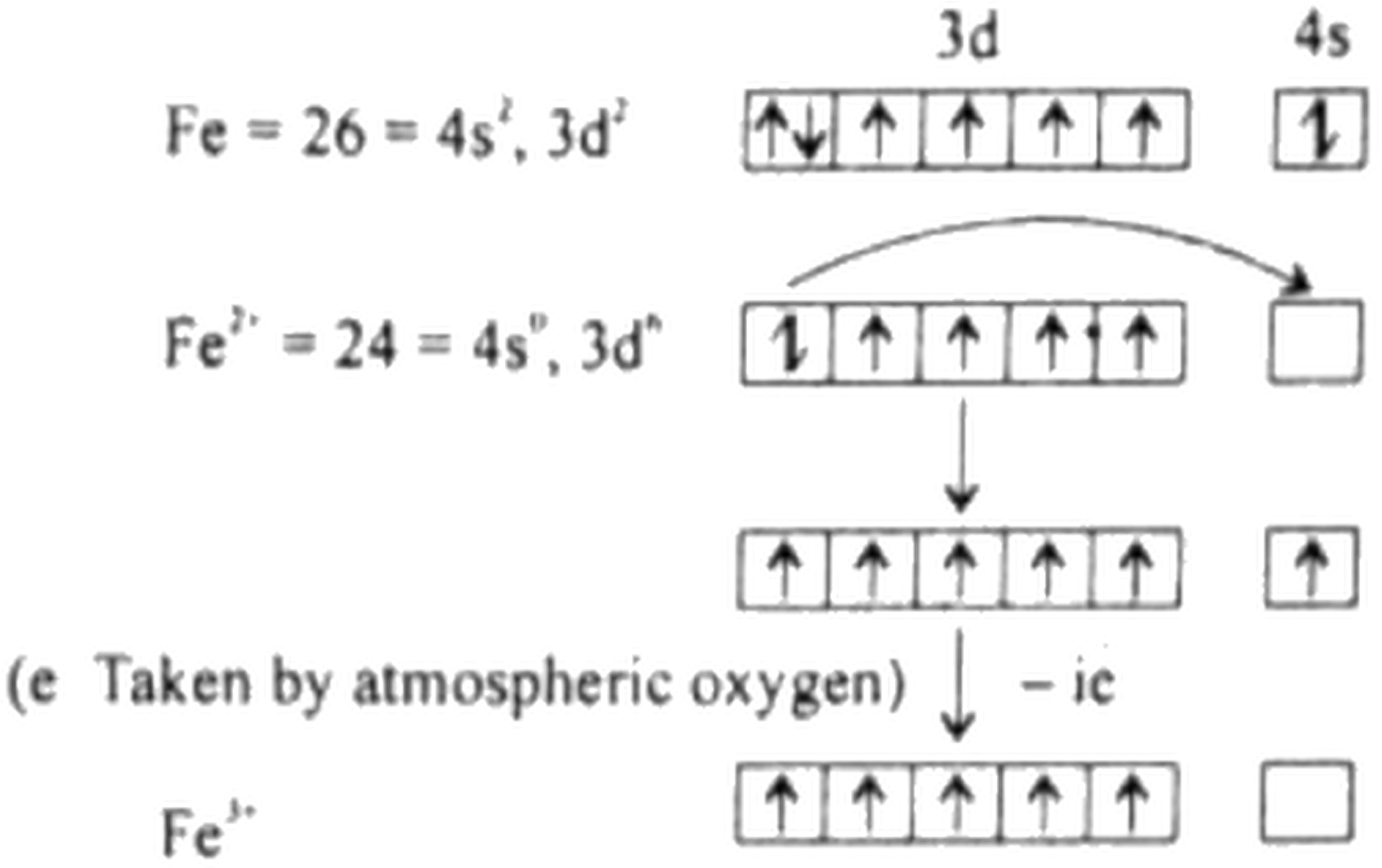
As the number of unpaired electrons increase from Sc to Zn therefore the paramagnetic character increases from Sc to Mn.

Cr, Mn and Fe having 4 or 5 unpaired electrons are ferromagnetic Zn having no unpaired electron is diamagnetic.

(iii) Transition elements and oxidation states:

Due to small difference of energv of outermost ns and (n — l) d-orbitals the transition elements show variable oxidation states.

For example:



b) Typical and non-typical transition element:

d-block elements are classified into non-typical and typical transition elements.

Non typical transition elements (II-B & III-B)

lone of II-B elements eg $Zn^{2}+$ ($Zn^{2}+ = 4s^{\circ}, 3d^{10}$) and III-B elements have completely filled d-orbital electronic configuration therefore their properties are somewhat different from transition elements so II-B and III-B elements are called non-typical transition elements.

Typical Transition Elements:

Except II-B and III-B, all other transition elements have partially filled d-orbitals. Therefore, they are called typical elements.

For example:

$$Zn = 26 = 4s^2, 3d^6$$

$$cu = 29 = 4s^2, 3d^9$$

$$Ag = 47 = 5s^2, 4d^9$$

c) Explain catalytic activity of Transition Elements:

Transition elements due to partially filled outermost d-orbitals pull the electron densityof a molecule and make it polar by creating charges at different pans of the molecule. This phenomenon increases the reactivity of molecules which is called catalytic property. That is why many of the transition elements like Pd, Pt, Ni, Ti and V metals are used as catalyst in industry.

For example:

Ni is used as a catalyst for hydrogenation of vegetable oil, V205 acts as a catalyst in manufacturing of H2S04. Zeigler Natta (TiC14. AIR3) is veo• useful in polymerization of olefins.

d) Composition, properties and uses of Brass, Bronze and Nichrome alloys:

Composition of these alloys are as follows

i) Brass Cu + Zn

ii) Bronze Cu + Zn + Ti

iii) Nichrome = Fe + NI + Cr

All these alloys are strong than their individual metals.

Brass is used to make daily home utensils. Bronze is used to make medals and some daily home utensils. Nichrome is used to make elements of electric heater and electric iron.

Q2.a) Explain different type of ligands with example.

b) Describe the rules for naming of the coordination complexes with examples.

Answer

a) Ligands

The atoms or ions or neutral molecules which surround the central metal ion and donate electron pairs are called ligands. They may be cations, anions or natural molecules. For example NH 2 —N+H3, NH3

I Neutral Ligands. Eg $\ddot{N}H_2 - \ddot{N}H_2$, $H_2\ddot{O}$
(Hydrazine) (Aquo or Aqua)

II Negitive Ligands. Eg $F^{\ominus}$, $Cl^{\ominus}$, $OH^{\ominus}$
(Flouro) (Chloro) (Hydroxo)

III Positive Ligands eg No^{+} $\ddot{N}H_2 - N^{+}H_3$
(Nitrosonium) (Hydrazinium)

(b) Rules for naming of the coordination complexes with examples:

The nomenclature of transition metal complexes is based upon the recommendation by the Inorganic Nomenclature committee of IUPAC. The rules for naming the complex compounds are as follows.

(I) Cations are named before anions.

(II) In naming the coordination sphere ligands are named in alphabetical order regardless of the nature and number of each followed by the name of central metalion.

(III) The prefixes di, tri, tetra, penta, hexa, etc are used to specify the number of coordinated ligands.

(IV) The names of anions ligands and in suffix o, eg hydroxo, (OH) carbonate (CO_3^{2-}).

(V) The names of natural legands are usually unchanged eg for NH, ammine and for H_2O aqua.

(VI) The suffic 'late" comes at the end of the names of metal if the complex represents and anion, otherwise it remains unchanged.

(VII) The oxidation number of the metal ion is represented by a Roman numeral in parenthesis following the name of the metal. Example:

$K_2[Cu (CN_4)$ Poasium tetracyanocupute(ii)

$[Pt(OH)_2 (NH_3)_4]SO_4$ dihydroxo tetra ammine platinum (iv) sulphate

$[Co(NH_3)_6]Cl_3$ Hexa Ammine Cobalt(iii) Chloride

Q3: (a)Explain shapes and origin of colours of coordination compounds.

(b)Relate the coordination number of pons to the crystal structure of the component of which they are part.

Answer

(a) Shapes of transition metal complexes.

(I) Metals having coordination number 2:

Such complexes are linear in shape

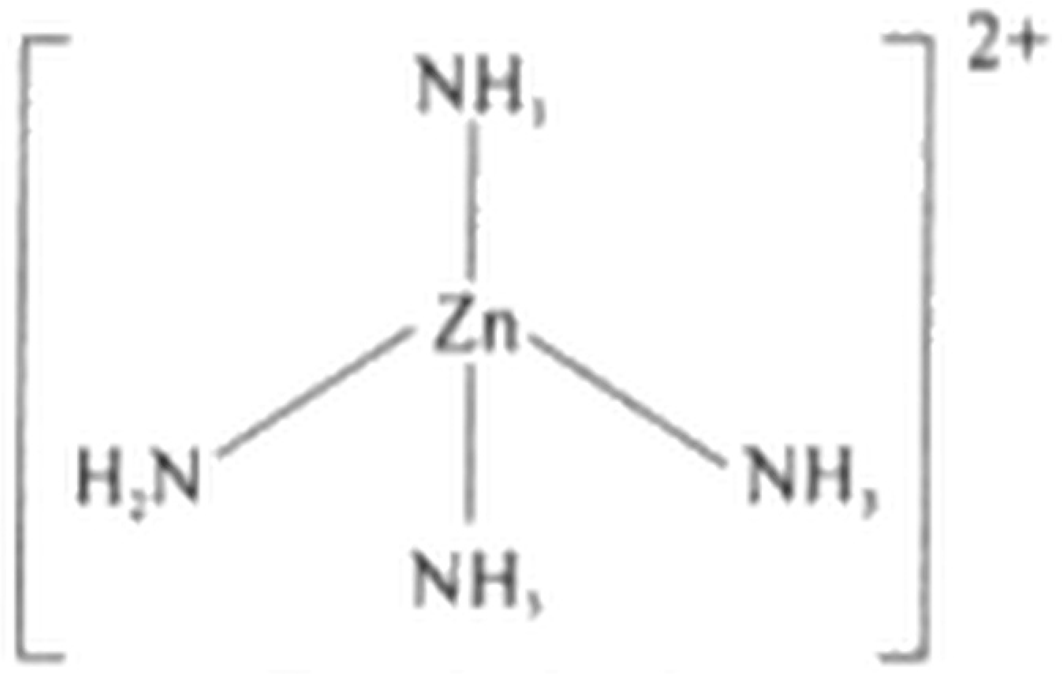
Eg $[Ag(NH_3)_2]^+$ ($H_3\tilde{N} \rightarrow Ag^+ \leftarrow \tilde{N}H_3$)

diamminesilava (I) ion linear

(II) Metal having coordination number 4:

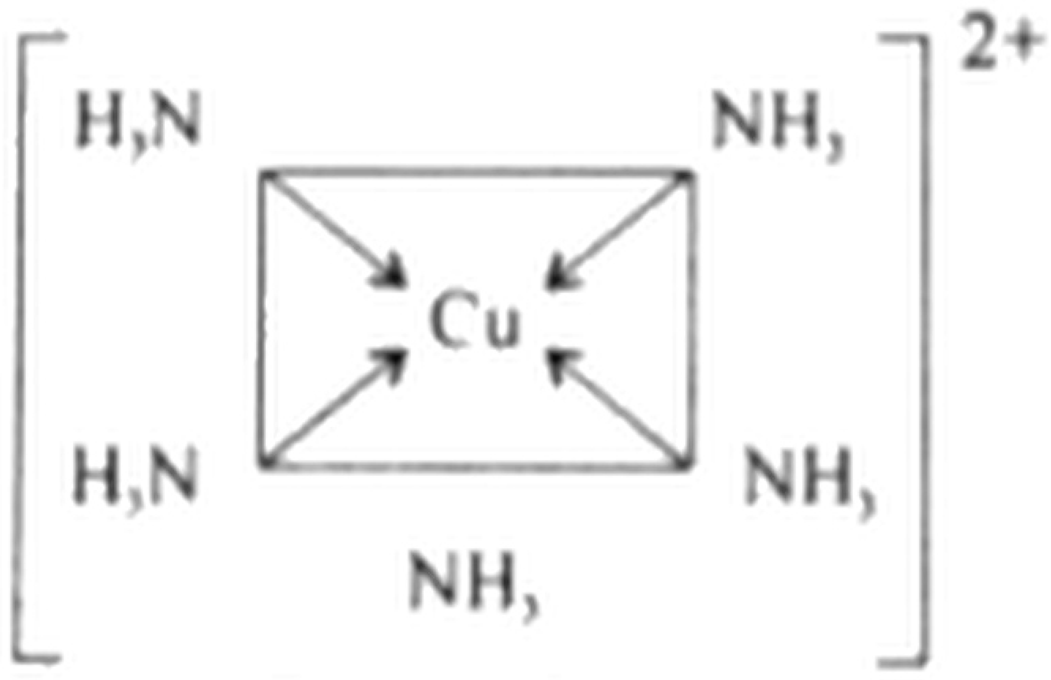
Such complexes are tetrahedral and square planer in shape

$[Zn(NH_3)_4]^{2+}$



Tetra ammine Zinc (ii) ion — Tetra hederal

$[Cu(NH_3)_4]^{2+}$

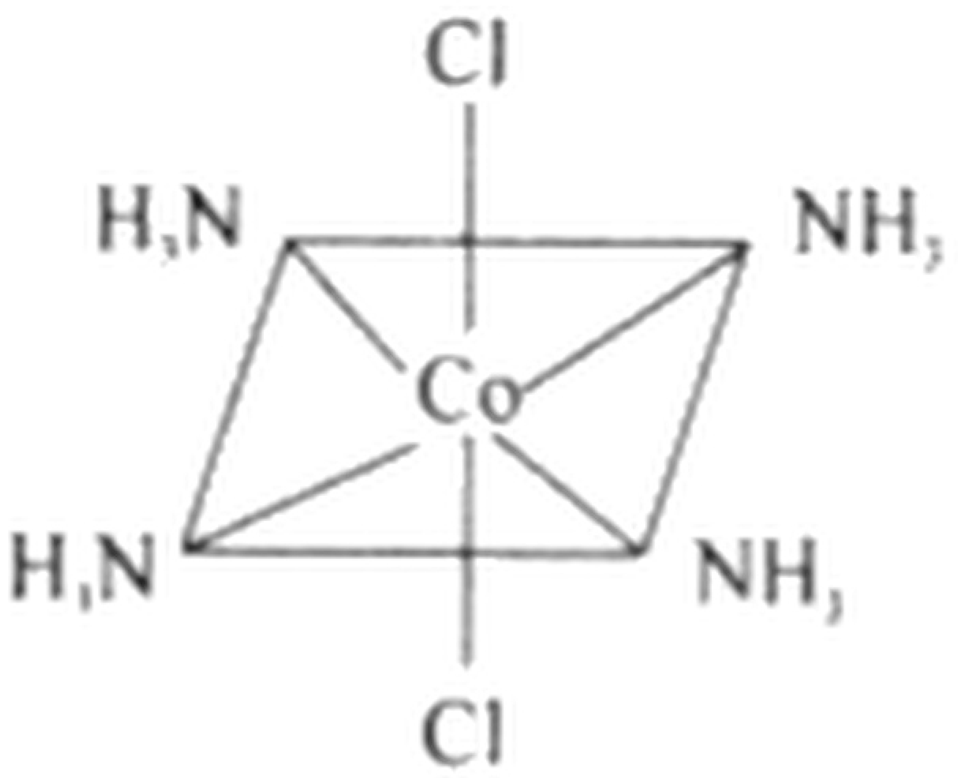


Tetra ammine copper (ii) ion — Square plomar

III Metal having coordination number 6:

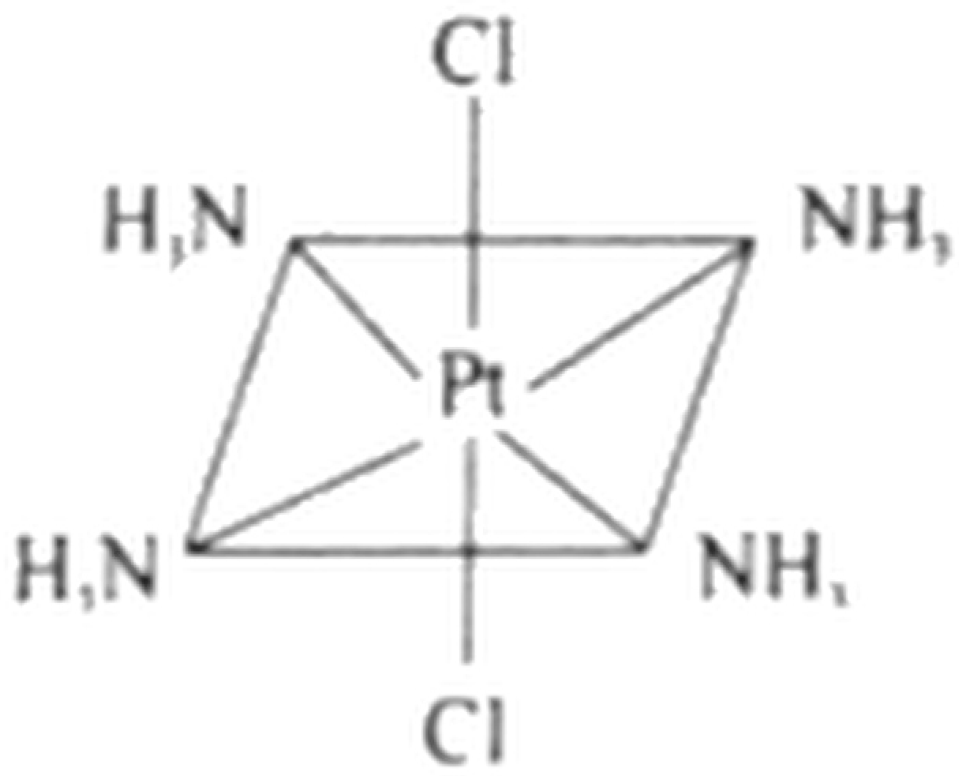
Such metal complexes have octahedral shape.

For example:



$[Co(NH_3)_4(Cl_2)]^+$

dichlorotetra ammine Cobalt (iii) ion



$[pt(NH_3)_4Cl_2]$

dichlorotetra ammine Platinum (iii)

Colour of Transition Metal Complexes.

According to crystal field theory the colour of transition metal complexes is olue to d-d transition of electrons. According to this theory.

(i) d-orbitals are of five types.

$$dxy\ dyz\ dxz\ dx^2 — Y^2\ dz^2$$

(ii) These d-orbitals are of two types

(a)t2g orbitals (dxy, dyz, dxz)

(b)eg orbitals ($dx^2 — y^2$and dz^2)

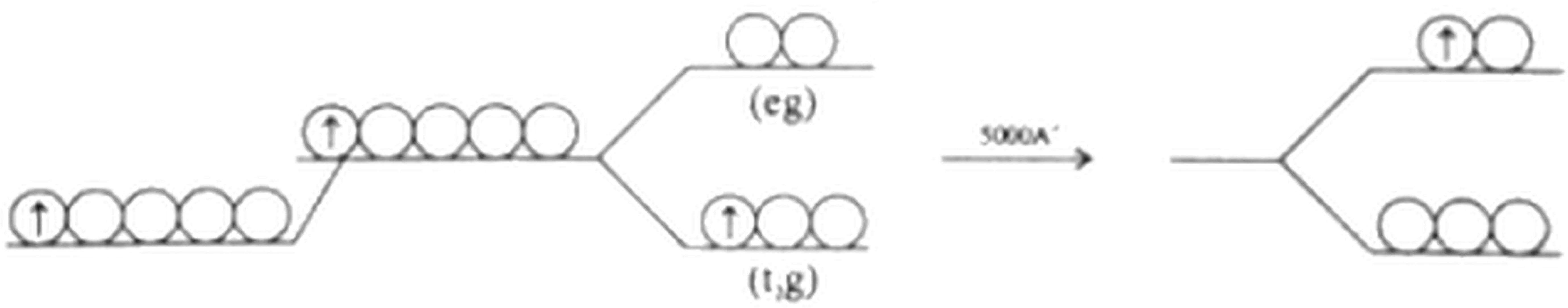
(iii) tag orbitals are of low energy and eg orbitals have somewhat higher energy.

(iv) When a light falls on a complex the d-electrons of central metal atom jump from t2g to eg orbitals by absorbing some light. This absorbed light is responsible for colour of transition metal complexes. For examples:

Ti^{3+} complexes are purple in colour

$Ti = 22 = 4s^2\ 3d^2$

$Ti^{3+} = 19 = 4s^0,\ 3d^1$



(This light of 5000A° is a yellow colour)

There are three basic colour of light i-red ii-blue iii-yellow. When yellow light is absorb by Ti3+ salt in d-d transition (to jump the electron from t2g to eg orbitals). There are left blue and red lights which mix and give purple colour to the complex.

(b) Coordination number and shape of a complex:

Please see Answer of Q. No 23(a)

Q4: a) Write systematic names of following complexes:

i) $[Co(NH_3)_6]Cl_3$

ii) $[Fe(H_2O)_6]^{2+}$

iii) $Na_3[CoF_6]$

iv) $[Cr(OH_2)\ (NH_3)_4]$

v) $K_3[ptcl_6]$

vi) $[Pt(OH)_2\ (NH_3)_4\ ]SO_4$

vii) $K_2[Cu\ (CN_4)$

viii) $Na_2(NiCl_4)]$

ix) $Pt(NH_3)2Cl_4$

x) $[Ag(NH_3)2Cl]$

b) write chemical formula of following complexes:

i) Potassiumhexacyan of errate(II)

ii) sodiumtetrachaloronickelate(II)

iii) Tetramine copper(II) Sulphate

iv) Potassium Hexachloroplatine (IV)

v) Dichlorotetramine cobalt(III) Chloride

Answer

$[Co(NH_3)_6]Cl_3$	Hexa Ammine Cobalt(iii) Chloride
$[Fe(H_2O)_6]^{2+}$	Hexa Aquo(ii) ion
$Na_3[CoF_6]$	Sodium hexa flouro cobaltate(ii)
$[Cr(OH_2)\ (NH_3)_4]$	trihydroxotriaquo chromium (iii)

$K_3[ptcl_6]$	Potassium hexachloro platinat (iv)
$[Pt(OH)_2\ (NH_3)_4\ ]SO_4$ sulphate	dihydroxo tetra ammine platinum (iv)
$K_2[Cu\ (CN_4)$	Poasium tetracyanocupute(ii)
$Na_2(NiCl_4)]$	Sodium tetrachloro diamine platinum(iv)
$Pt(NH_3)2Cl_4$	tetrachloronicle(iv)
$[Ag(NH_3)2Cl]$	diamine silver (i) chloride

b)

i) Potassiumhexacyan of errate(II)	K4[Fe(CN)6]
ii) sodiumtetrachaloronickelate(II)	Na2[NiCl4]
iii) Tetramine copper(II) Sulphate	[Cu(Nh3)4]SO4
iv) Potassium Hexachloroplatine (IV)	K4(ptcl6)
v) Dichlorotetramine cobalt(III) Chloride	[CoCl2(NH3)4]Cl

Q5: (a)Discuss vanadium (v) oxide as a catalyst with example.

(b)How does chromium (III) changes to chromium (VI)

(c)Discuss Potassium dichromate (VI) and Potassium manganate (VII) as an oxidizing agent in organic chemistry.

Answer

(a) $\underline{V_2O_3}$ Catalyst:

V_20_5 is used as oxidizing during the reaction the V_2O_5 give O_2 and is converted into V_2O_3 but at the end of the reaction V_2O_3 itself oxidized and again is converted into V_2Os.

Example:

In contract process to manufacture sulphuric acid, S02 gas is oxidize to get S03 in presence of V205 as catalyst.

$$SO_2 + \frac{1}{2} O_2 \xrightarrow{V_2O_3} SO_3$$

(b) How chromium (iii) changes to chromium (vi):

When excess of sodium hydroxide solution is added to a solution of hexaaquachromium (iii) ions there are produce trihydroxotriaqua chromium (iii) complex which in presence of access of NaOH solution is converted into very dark green hexahydroxochromate (iii) ions

$$[Cr(H_2O)_6]^{3+} \xrightarrow{NaOH} [Cr(H_2O)_3(OH)_3] \xrightarrow[NaOH]{Excens} [Cr(OH_3)]^{3-}$$

Green Dark green Very dark green

If this solution is heated with hydrogen 2 peroxide (HO) green chromium (iii) ions are converted into bright yellow Cr04- which is actually chromium (vi)

$$2[Cr(OH)_6]^{3+} + 3H_2O_2 \longrightarrow 2Cro_4^{2-} + 2OH^- + 8H_2O$$

(very dark green) (bright yellow)

On addir. an acid to yellow $Cr04^{2-}$ it is oxidized into orange $Cr_2O_7^{2-}$

$$2CrO_4^{2-} + 3H^+ \longleftrightarrow Cr_2O_7^{2-} + H_2O$$

(yellow) (orange)

(C) $K_2Cr_2O_7$ and $KMnO_4$ as oxidizing agents:

$K_2Cr_2O_7$ and $KMnO_4$ generate atomic oxygen on adding H2S04 to them. Therefore, act as oxidizing agents.

$$K_2Cr_2O_7 + H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O + 3(0)$$

$$KMnO_4 + H_2SO_4 \longrightarrow K_2SO_4 + MnSO_4 + H_2O + 5(0)$$