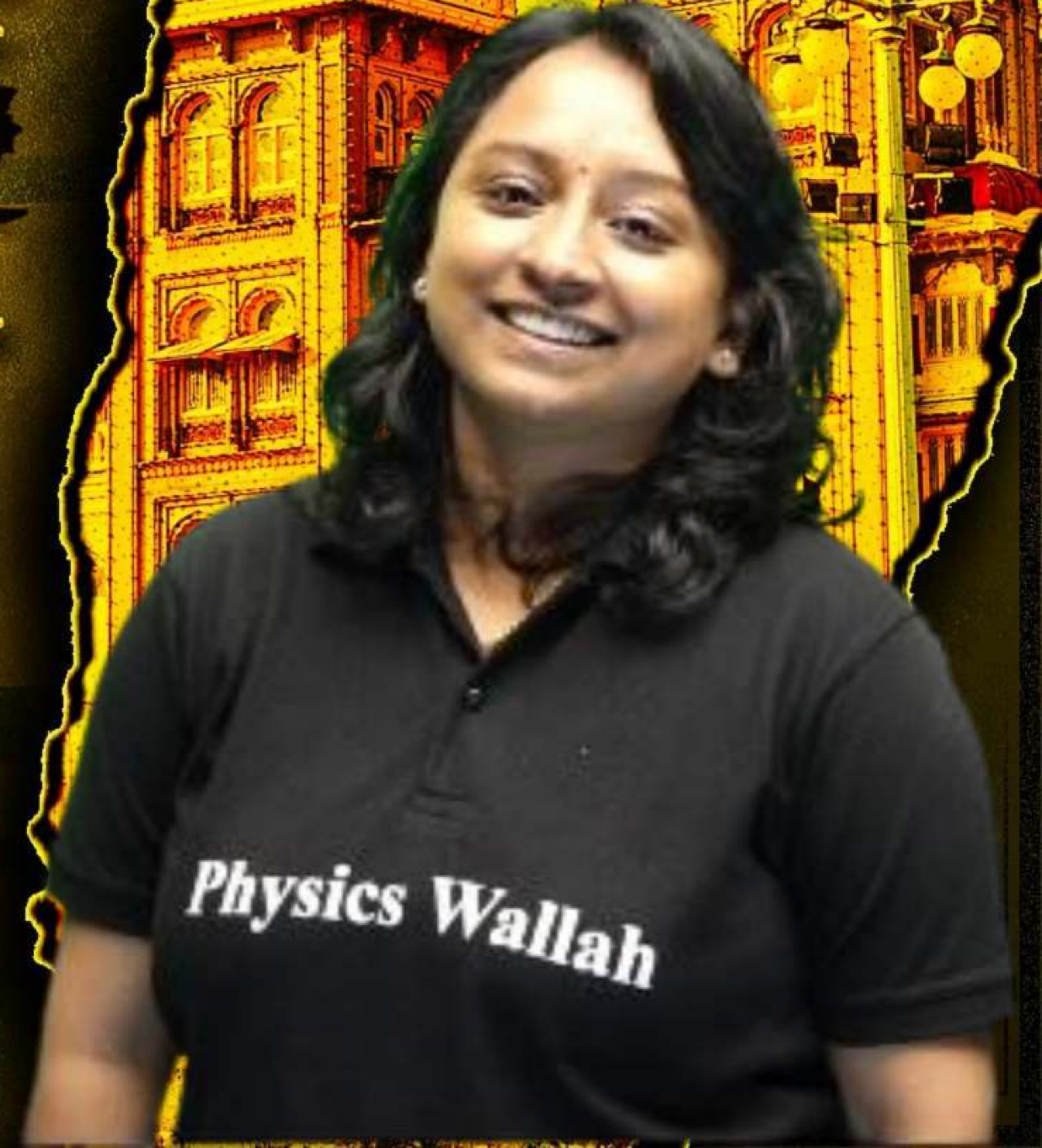
ULTIMATE KCET

CRASH COURSE 2026

Chemistry | Lecture - 01

Coordination compounds

By – Sreeja Ma'am



Recap *of previous lecture*

1. D and f block elements

Topics *to be covered*

1. Coordination compounds

VVV IMP

Example for double salt :

- Carnallite - $KCl \cdot MgCl_2 \cdot 6H_2O$,
- Mohr's salt, $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$.
- Potash alum, $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$.

$\boxed{K^{\oplus} + Cl^{\ominus} + Mg^{2+} + 2Cl^{\ominus}}$

$\rightarrow Fe^{2+} + SO_4^{2-} + 2NH_4^{+} + SO_4^{2-}$ No. of ions $= 5$

5 ions

$2K^{\oplus} + SO_4^{2-} + 2Al^{3+} + 3SO_4^{2-}$ = No. of moles of ions

= 8 moles of ions

$\boxed{\text{Complex salt}}$ ⟶ Co-ordination compounds.

Example: ① $[NiCl_2]^{2-}$ ⟶ anionic complex compound.

② $[Ni(CO)_4]$ ⟶ Neutral complex compound.

③ $[Cu(NH_3)_4]^{2+}$ ⟶ Cationic complex salt

Types of complexes:

There are following three types of complexes:

(i) A complex in which the complex ion carries a net positive charge is called cationic complex,

e.g., $[Co(NH_3)_6]^{3+}$, $[Ni(NH_3)_6]^{2+}$, etc.

(ii) A complex in which the complex ion carries a net negative charge is called anionic complex,

e.g., $[Ag(CN)_2]^{-}$, $[Fe(CN)_6]^{4-}$, etc.

(iii) A complex carrying no net charge is called a neutral complex or simply a complex,

e.g., $[Ni(CO)_4]$, $[Co(NH_3)_3Cl_3]$, etc.)

Ligands → Substance which donate pair of electrons to central metal atom or ions.

if one atom is donating → unidentate.

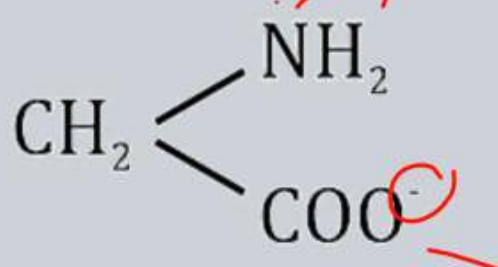
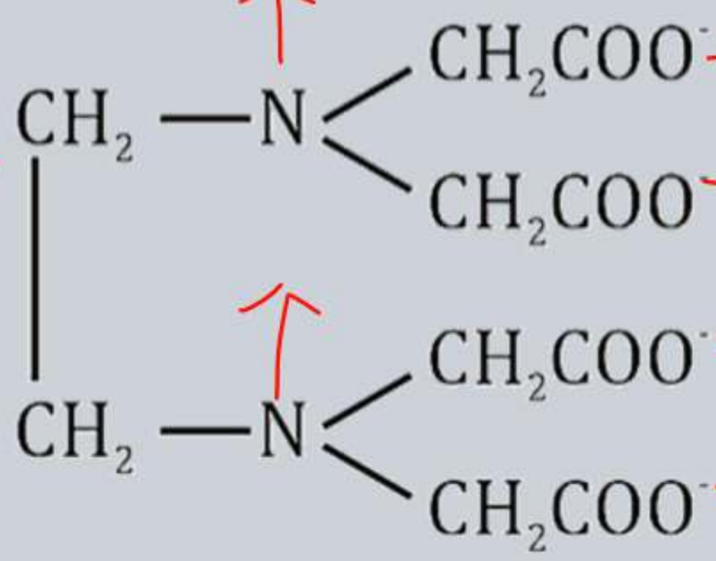
if two atoms " " → bidentate

more atoms are donating ↳ polydentate

Ligand	Charge	Type
H_2O	0	Unidentate
NH_3	0	Unidentate
CO	0	Unidentate
CH_2—NH_2 | CH_2—NH_2 ethylenediamine (en) (or ethane-1, 2-diamine)	0	~~Unidentate~~ didentate.
Cl^-, Br^-, $I^-CH_3COO^-$, CN^-, SCN^-	0	Unidentate

Neutral ligands.

→ Ambidentate ligands

Ligand	Charge	Type
 glycinate ion (gly) $H_2N-CH_2-COO^{\ominus}$	-1	Didentate
 (oxalate ion)	-2	Didentate
 Edta^{4-}	-4	Hexadentate

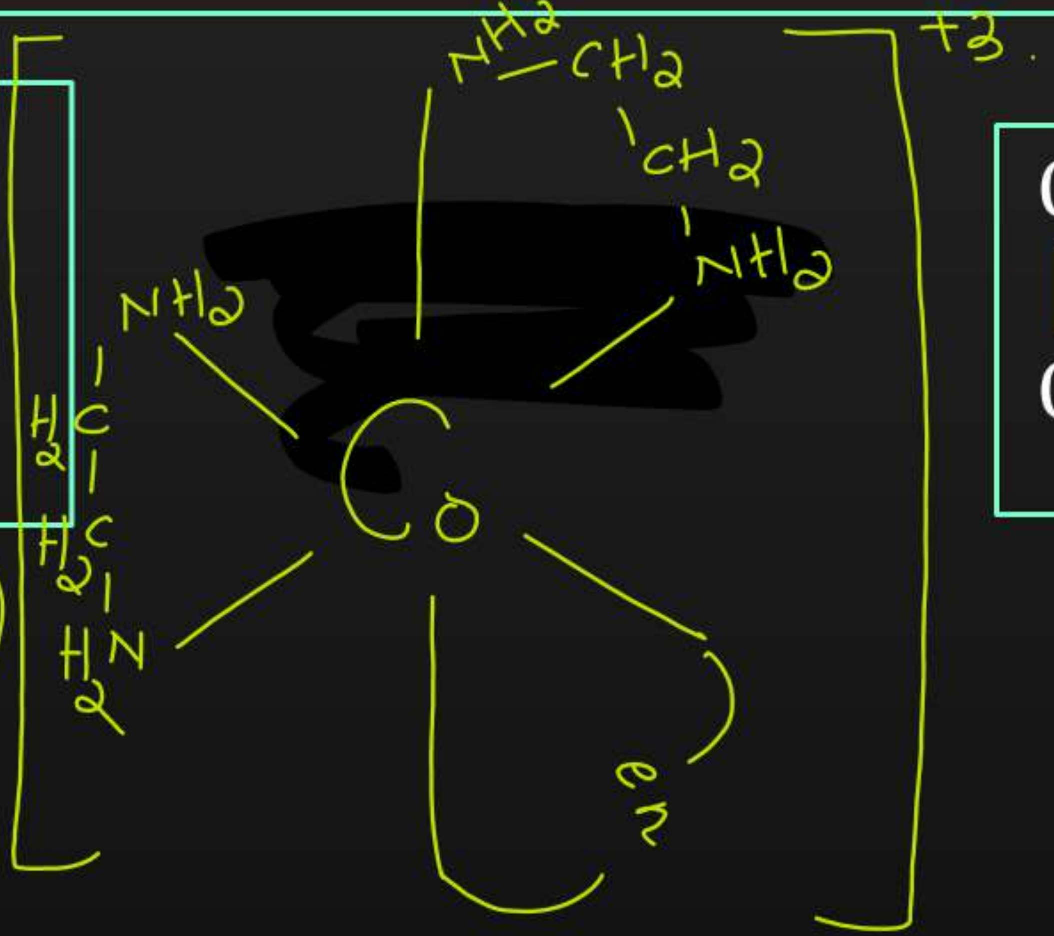
→ No. of donar atoms

→ ring formation.

Denticity and Chelation - The ligand may contain two donor atoms positioned in such a way that a five or a six membered ring is formed with the metal ion, then it is called bidentate or bidentate chelating ligand and the ring is called chelate ring, the resulting complex is called a metal chelate and this property is called chelation.

$$\begin{array}{l} CH_2 - \ddot{N}H_2 \\ | \\ CH_2 - \ddot{N}H_2 \end{array}$$

en



$$\begin{array}{l} O = C - O:^- \\ | \\ O = C - O:^- \end{array}$$

$CH_2 - NH_2$
$|$
$CH_2 - NH_2$

Some important characteristics of chelates. These are as follows :

(i) Chelating ligands form more stable complexes than the unidentate analogs. This is called chelating effect.

donar atoms

(ii) Greater the denticity of the ligand, more stable is the complex (chelate) formed.

[redacted]

iii (iv) Ligands with large groups form unstable rings than the ligands with smaller groups due to steric hinderance.

Importance of chelates: Chelates are widely used in industry and laboratory

(i) in the softening of hard water

(ii) in the separation of lanthanoids and actinoids

(iii) in the detection of some metal ions in qualitative analysis

(iv) in the estimation of nickel (II), magnesium (II) and copper (II) ions quantitatively.

Ambidentate ligands.

→ they are also Unidentate ligands.

Unidentate ligands containing more than one coordinating atoms are called ambidentate ligands.

nitrito-N

and $M \leftarrow O-N=O$

nitrito-O

or $M \leftarrow SCN$

thiocyanato

and $M \leftarrow NCS$

isothiocyanato

Metal ion

→ ligands having more than one donar atoms but only one atom donates pair of electrons to central atom.

5 Min break.

Coordination sphere or Coordination entity & Counter Ions.

- The central atom and the ligands which are directly attached to it are enclosed in square brackets and are collectively termed as the coordination sphere or coordination entity.
- The ligands and the metal atom inside the square bracket behave as a single constituent unit.
- The ionizable groups are written outside the brackets and are called counter ions.

Central atom ← $[Cu(\underbrace{NH_3}_{\text{ligand}})_4]Cl_2$ → counter ion

Co-ordination sphere

$Fe_4[Fe(CN)_6]_3$

Counter ion

co-ordination sphere

Co-ordination entity

Coordination polyhedron

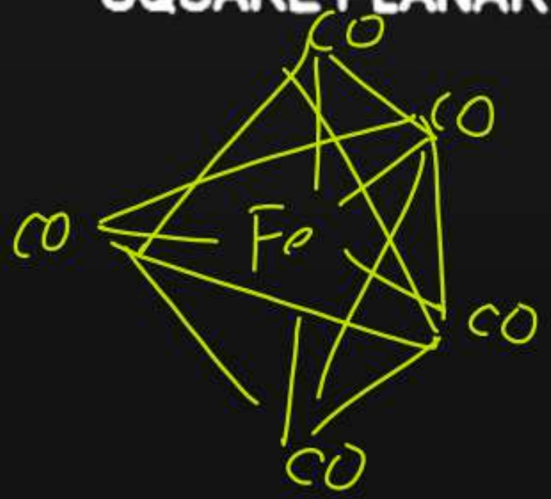
$\left[\begin{array}{c} Cl \\ Cl \end{array} > Pt \begin{array}{c} -Cl \\ -Cl \end{array}\right]^{2-}$

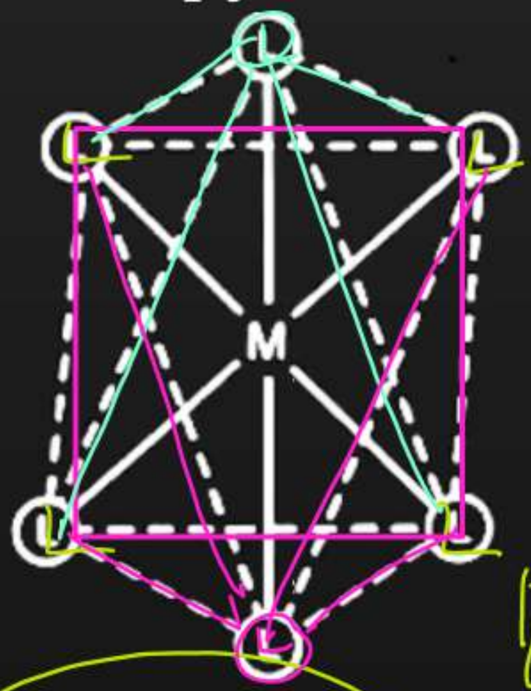
This spatial arrangement of the ligand atoms which are directly attached to the central atom/ ion is called coordination polyhedron

For example, $[PtCl_4]^{2-}$ is square planar, $Ni(CO)_4$ is tetrahedral, $[Co(NH_3)_6]^{3+}$ is octahedral while $Fe(CO)_5$ is trigonal bipyramidal.

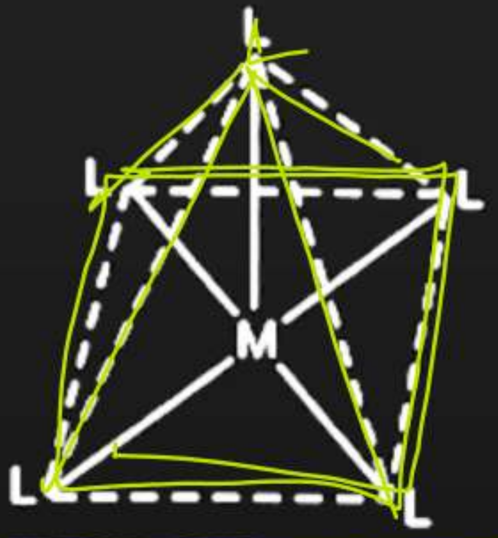
TETRAHEDRAL

SQUARE PLANAR

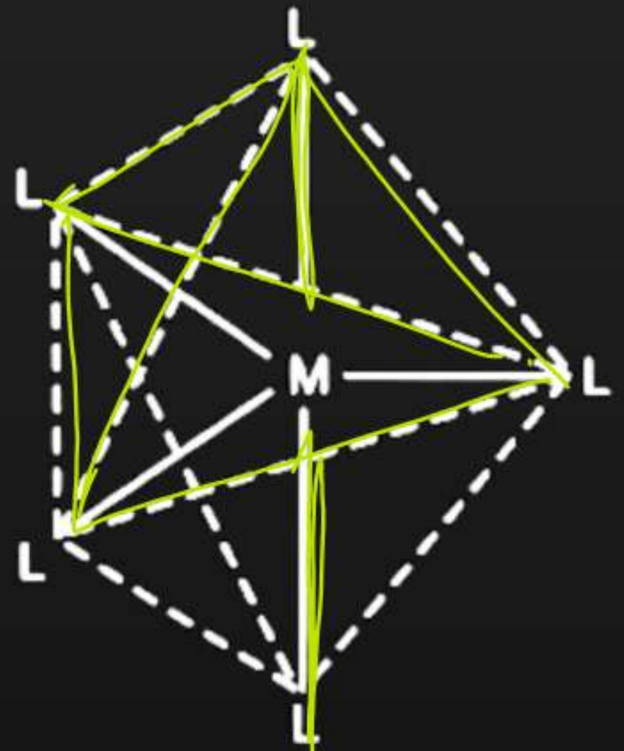




OCTAHEDRAL



SQUARE PYRAMIDAL



TRIGONAL BIPYRAMIDAL

Oxidation number or Oxidation state.

I^{-1}

$K_2[HgI_4]$ nesler's reagent

HOTS

$+2$

$1\times2 + x + (-1\times4) = 0$

$x = 2$

$[Pt\,(gly)_2]$ → $+2$.

$[Ni(dmg)_2]$ ($+4$)

→ $x + (-1\times2) = 0$

$x = 2$

$H_2N - CH_2 - COO^{\ominus}$ → glycinate

gly

$[Pt(gly)_2]$

$x + (-1\times2) = 0$

$x - 2 = 0$

$x = +2$

Calculation of Oxidation no. of central metal atom.

$[Cu(NH_3)_2]^{+2}$

$x+0=+2$

$x=+2$

Cu: +2

$[Co(NH_3)_3]Cl_3$ (Co: +3)

$x+0-3=0$

$x=+3$

$[Ni(CO)_4]$

$x+0=0$

$\overset{+1}{Na}\overset{-1}{Cl}$

$Fe_4[Fe(CN)_6]_3$ (+3, +2, −4)

$\overset{+3}{Fe}$

$[Fe(CN)_6]^{-4}$

$x-6=-4$

$x=-4+6$

$x=+2$

$K_4[Fe(CN)_6]$ (4, 1)

positive metals

$4+x-6=0$

$x-2=0$

$x=+2$

$\overset{+1}{K}$ $[Fe(CN)_6]^{-4}$

$x+(-1\times6)=-4$

$x-6=-4$

$x=+2$

Ligands charge

NH_3, H_2O, CO } Neutral ligands.

$NO^{\oplus}$ } Nitrosonium ligand.

−ve charge

$Cl^{\ominus}$ $OH^{\ominus}$ SO_4^{2-}

$Br^{\ominus}$ $CN^{\ominus}$ $C_2O_4^{2-}$

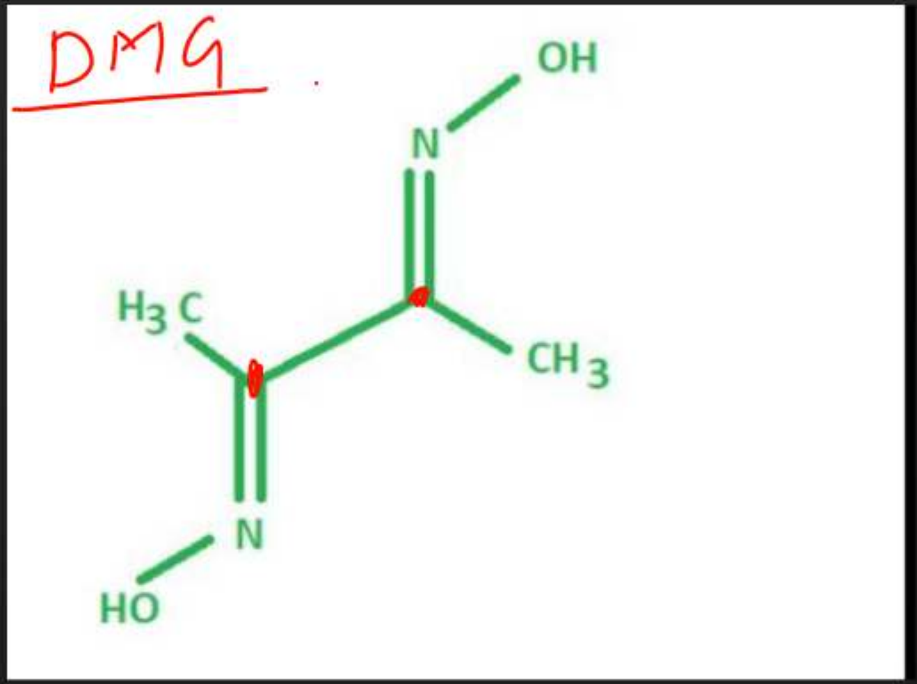
CO_3^{2-}

counter ion

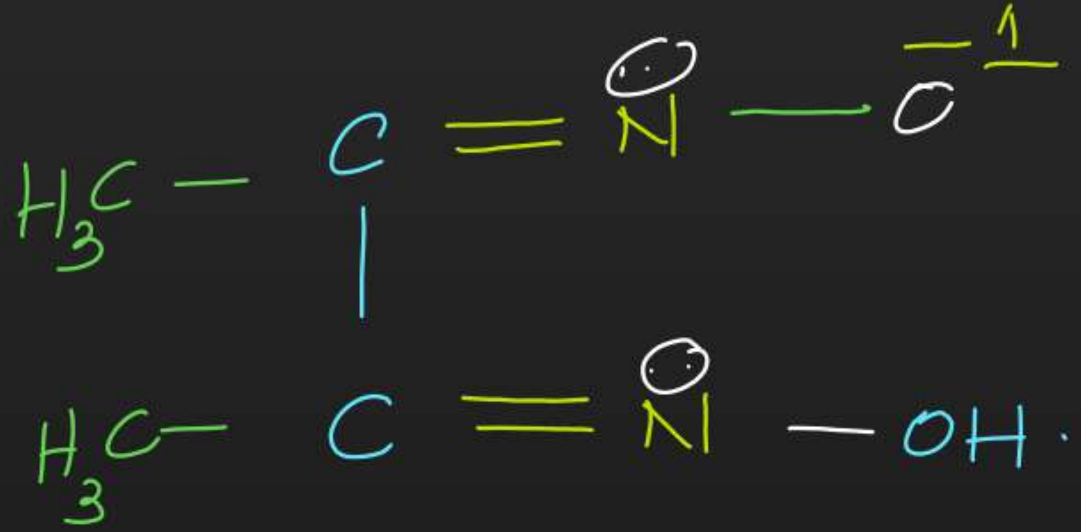
$K \rightarrow K^{+}$

$Fe \rightarrow Fe^{+3} / Fe^{+2}$.

$Cl^{\ominus}$, SO_4^{2-}, $Br^{\ominus}$



oxime



DMG = charge = -1

DmG → dimethyl glyoxime = -2

Homoleptic and Hetero-leptic complexes:

Complexes in which the metal atom or ion is linked to only one type of ligands are called homoleptic complexes, e.g., $[Co(NH_3)_6]^{3+}$.

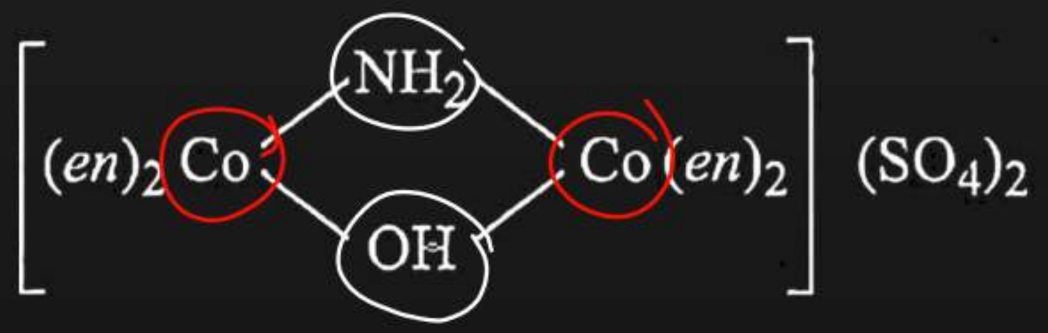
The complexes in which the metal atom or ion is linked to more than one kind of ligands are called heteroleptic complexes, e.g., $[Co(NH_3)_4Cl_2]^{+}$.

Homonuclear and Polynuclear complexes

Complexes in which only one metal atom is present are known as homonuclear complexes.

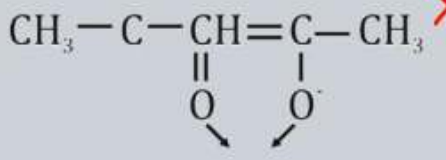
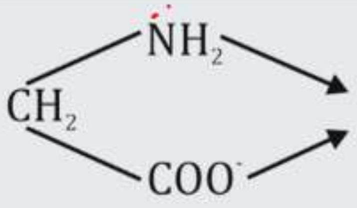
Complexes in which more than one metal atom is present are known as polynuclear complexes.

$[Co(NH_3)_6]^{3+}$

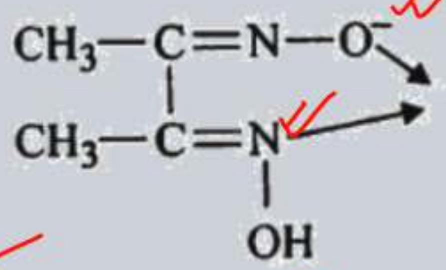
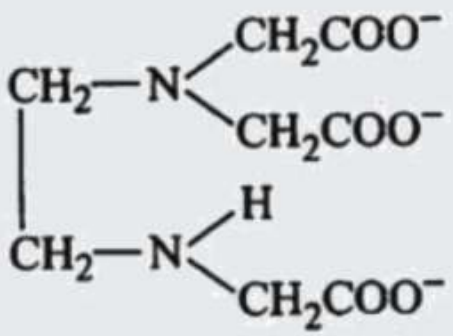
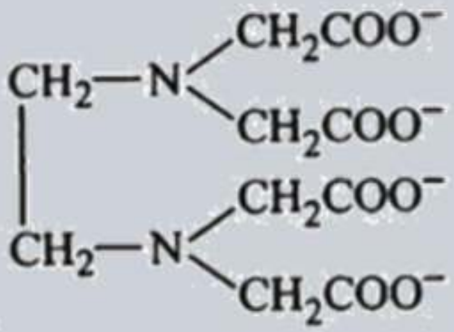


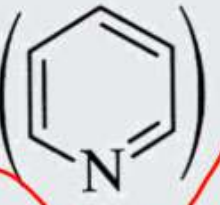
Some Common ligands and their names

Actual Name (Symbol Used)	Formula	Charge	Donor atom/ atoms	Name given in the Complex
		Negative Ligands		
(a) Unidentate Cyanide ion	$:CN^-$ $X^-(F^-, Cl^-, Br^-, I^-)$	-1	C	Cyano or cyanido halido (fluorido/ chlorido / bromido / iodido)
Hydride ion	H^-	-1	H	hydrido
Nitro	$\leftarrow NO_2^-$	-1	N	nitro Nitrito-N
Nitrite ion	$\leftarrow ONO^-$	-1	O	nitrito — O
Nitrate ion	NO_3^-	-1	N	nitrato
Hydroxide ion	OH^-	-1	O	hydroxo
Amide ion	NH_2^-	-1	N	amido

Thiocyanate ion	SCN^-	-1	S	thiocyanato —S
Isothiocyanate ion	NCS^-	-1	N Thiocyanato-N	isothiocyanato
Acetate ion	CH_3COO^-	-1	O	acetato
Oxide ion	O^{2-}	-2	O	oxo
Peroxide ion	O_2^{2-}	-2	O	peroxo
Sulphide ion	S^{2-}	-2	S	sulphido
Sulphite ion	SO_3^{2-}	-2	S	sulphito
Sulphate ion	SO_4^{2-}	-2	S	sulphato
Thiosulphate ion	$S_2O_3^{2-}$	-2	S	thiosulphato
Carbonate ion	CO_3^{2-}	-2	O	carbonato
Imide ion	NH^{2-}	-2	N	imido
(b) Didentate Oxalate ion (ox)	COO^- | COO^- $C_2O_4^{2-}$	-2	Two O-atoms	oxalato
Acetyl acetonate (acac)		-1	Two O-atoms	acetylacetonato
Glycinate ion* (gly)		-1	One N and one O-atom	glycinato

Remember : Glycine is aminoacetic acid, NH_2CH_2COOH

Dimethyl glyoxime ion (dmg)	 * No logic *	-1	One N and one O-atom	dimethylgl-yoximato
(c) Pentadentate Ethylenediamine triacetate ion ($edta^{3-}$)		-3	Three O and two N-atom	ethylenediamine triacetate
(d) Hexadentate Ethylenediamine tetraacetate ion ($edta^{4-}$)		-4	Two N and four O - atoms	ethylenedi – amine tetraacetato

Neutral Ligands				
(A)Unidentate				
Methyl amine	CH_3CH_2	zero	N	methylamine
Ammonia	NH_3	zero	N	ammine
Water	H_2O	zero	O	aqua or aquo
Nitric oxide	NO	zero	N	nitrosyl
Carbon monoxide	CO	zero	O	carbonyl
Thiocarbonyl	CS	zero	S	thiocarbonyl
Phosphine	PH_3 phosphine	zero	P	phosphine
Triphenyl Phosphine	$(C_6H_5)_3P$	zero	P	triphenyl
Thiourea (tu)	H_2NCSNH_2	zero	S	thiourea
Pyridine (py)	$C_5H_5\ddot{N}$ ()	zero	N	pyridine
(b) Bidentate Ethylenediamine	CH_2-NH_2 / CH_2-NH_2	zero	Two N atoms	ethylene diamine

POSITIVE LIGANDS				
Hydrazinium ion	$NH_2 - NH_3^+$	+1	N	hydrazinium
Nitrosonium ion	NO^+	+1	N	nitrosonium
Nitronium ion	NO_2^+	+1	N	nitronium

$\leftarrow :NH_2$

$|$

NH_3^{+}

$NO_2^{+} \rightarrow$ Nitronium

$NO_2^{-} \rightarrow$ Nitrito-N

$ONO \rightarrow$ Nitrito-O

$NO_3^{-} \rightarrow$ Nitrato

$NO \rightarrow$ Nitrosyl.

Complex Compound	Name
I. Coordination compounds containing cationic complex ion	
1. $[Co(NH_3)_6]Cl_3$	hexaamminecobalt (III) chloride
2. $[Cr(H_2O)_4Cl_2]NO_3$	tetraaquadichlorochromium (III) nitrate
3. $[Co(NH_3)_4Cl(NO_2)]\ NO_3$	tetraamminechloronitrocobalt (III) nitrate
4. $[Cr(en)_3]Cl_3$	tris (ethane-1, 2-diamine) chromium (III) chloride
5. $CoCl_2\ (en)_2\ SO_4$	dichlorobis (ethane-1, 2-diamine) cobalt (IV) sulphate
6. $[Co(NH_3)_4(H_2O)\ Br]\ (NO_3)_2$	tetraammineaquabromocobalt (III) nitrate
7. $[Cr(H_2O)_6]\ Cl_3$	hexaaquachromium (III) chloride
8. $[CrCl_2(en)_2(ONO)]^+$	chloridobis (ethane-1, 2-diamine) nitrocobalt (III) ion
9. $[Cr(H_2O)_4Cl_2]\ Cl$	tetraaquadichlorochromium (III) chloride
10. $[Co(NH_3)_5(CO_3)]\ Cl$	pentaamminecarbonatocobalt (III) chloride
11. $[CoCl_2(en)_2]\ SO_4$	dichlorobis (ethane-1, 2-diamine) cobalt (IV) sulphate
12. $[Co(NH_3)_6]\ ClSO_4$	hexaamminecobalt (III) chloride sulphate
13. $[(NH_3)_5Cr\text{-}OH\text{-}Cr(NH_3)_5]\ Cl_5$	pentaamminechromium (III)-μ-hydroxo pentaamminechromium (III) chloride

II. Coordination compounds containing anionic complex ion	
14. $K_3\,[Fe(C_2O_4)_3]$	potassium trioxalatoferrate (III)
15. $K_3\,[Co(CN)_5(NO)]$	potassium pentacyanonitrosylcobaltate (II)
16. $K\,[Pt(NH_3)Cl_3]$	potassium amminetrichloroplatinate (II)
17. $Na_2[CrF_4O]$	sodium tetrafluoridooxochromate (IV)
18. $Na_2[SiF_6]$	sodium hexafluoridosilicate (IV)
19. Dextro $K_3\,[Ir(C_2O_4)_3]$	potassium (+) or d-trioxalatoiridate (III)
20. $Na_3\,[Fe(C_2O_4)_3]$	sodium trioxalatoferrate (III)
21. $Hg\,[Co(NCS)_4]$*	mercury tetrathiocyanatocobaltate (II) or mercury tetrathiocyano-N-cobaltate (II)
III. Coordination compounds containing complex cationic and anionic ions	
22. $K_4\,[Ni(CN)_4]$	potassium tetracyanonickelate (0)
23. $Fe_4\,[Fe(CN)_6]_3$	ferric hexacyanoferrate (II)
24. $Li\,[AlH_4]$	lithium tetrahydridoaluminate (III)
25. $[Pt(NH_3)_4Cl_2]\,[PtCl_4]$	tetraamminedichloroplatinum (IV) tetrachloroplatinate(II)

27. $[Ag(NH_3)_2$ $[Ag(CN)_2]$	**diamine silver (I) dicyanido argentite (I)**
28. $[Pt(py)_4]$ $[PtCl_4]$	tetrapyridine platinum (II) tetrachloride platinate (II)
29. $[Cr(NH_3)_5$ $(NCS)]$ $[ZnCl_4]$	pentaamine isothiocyanato chromium (III) tetrachloridozincate (II)
IV. Non-ionic coordination compounds	
30. $[Co(NH_3)_3(NO_2)_3]$	triamminetrinitrocobalt (III)
31. $[Pt(NH_3)_2Cl_2]$	diamminedichloridoplatinum (II)
32. $[Cr(PPh_3)(CO)_5]$	pentacarbonyltriphenylphosphinechromium (0)
33. $[Fe(C_5H_5)_2]$	bis(cyclopentadienyl) iron (II)
34. $[Ni(CO)_4]$	tetracarbonylnickel (0)
35. $[Mn_3(CO)_{12}]$	dodecacarbonyltrimanganese (0)
36. $[Ni(dmg)_2]$	bis(dimethylalyoximato) nickel (II)

ISOMERISM IN COORDINATION COMPOUNDS

Two or more substances having the same molecular formula but different structural or spatial arrangements are called isomers and the phenomenon is called isomerism.

- **Structural isomerism and**
- **Stereo isomerism or space isomerism.**

Optical

Geometrical

$[Co(NH_3)_6][Cr(CN)_6]$

$[Co(CN)_6][Cr(NH_3)_6]$

Linkage Isomerism

Linkage isomerism arises in a coordination compound containing ambidentate ligand. A simple example is provided by complexes containing the thiocyanate ligand, NCS^-, which may bind through the nitrogen to give M–NCS or through sulphur to give M–SCN. Jørgensen discovered such behaviour in the complex $[Co(NH_3)_5(NO_2)]Cl_2$, which is obtained as the red form, in which the nitrite ligand is bound through oxygen (–ONO), and as the yellow form, in which the nitrite ligand is bound through nitrogen ($–NO_2$).

Coordination Isomerism

This type of isomerism arises from the interchange of ligands between cationic and anionic entities of different metal ions present in a complex. An example is provided by $[Co(NH_3)_6][Cr(CN)_6]$, in which the NH_3 ligands are bound to Co^{3+} and the CN^- ligands to Cr^{3+}. In its coordination isomer $[Cr(NH_3)_6][Co(CN)_6]$, the NH_3 ligands are bound to Cr^{3+} and the CN^- ligands to Co^{3+}.

$[Cr(NH_3)_6][Co(CN)_6]$

Ionisation Isomerism

This form of isomerism arises when the counter ion in a complex salt is itself a potential ligand and can displace a ligand which can then become the counter ion. An example is provided by the ionisation isomers $[Co(NH_3)_5(SO_4)]Br$ and $[Co(NH_3)_5Br]SO_4$.

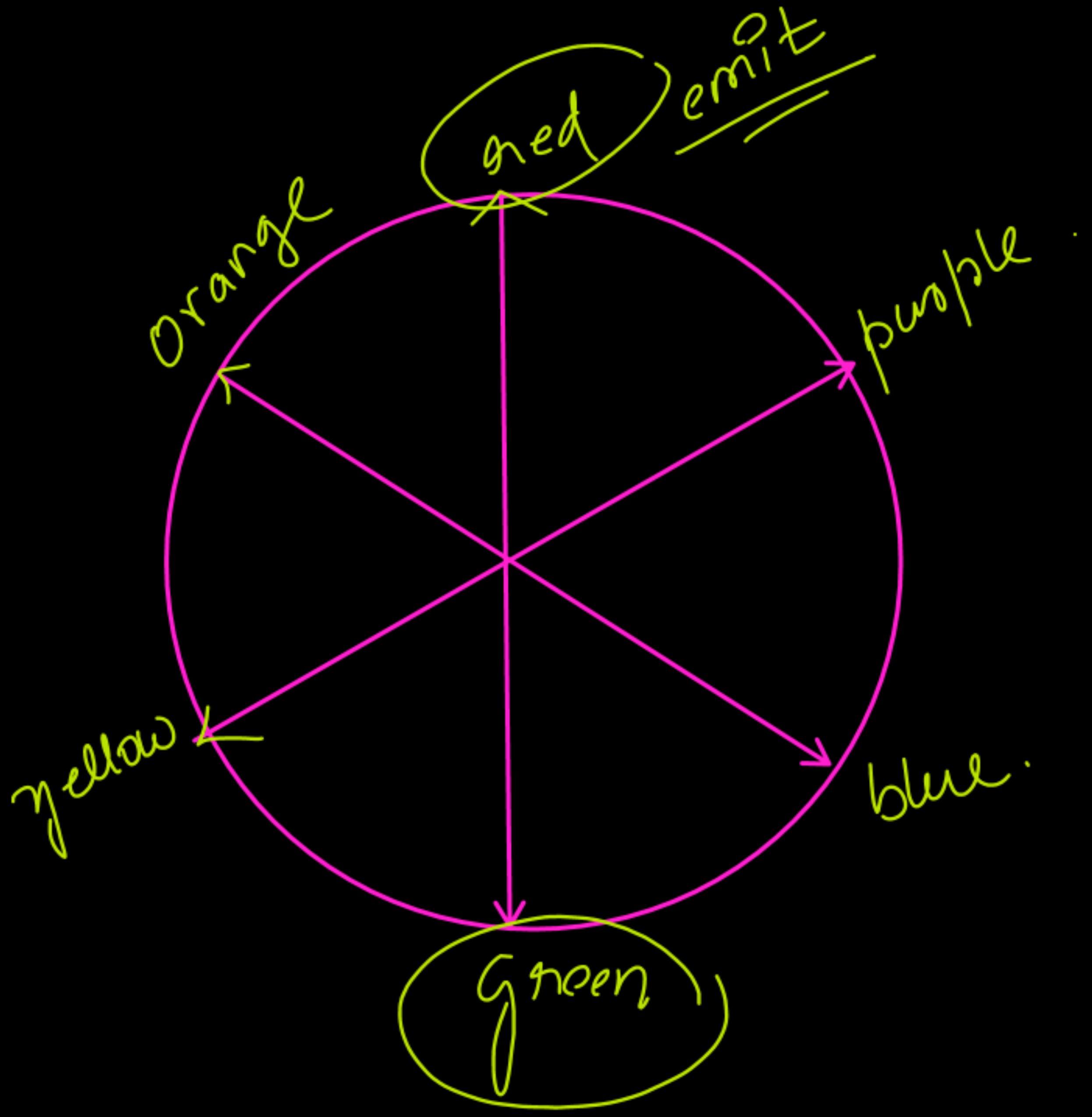
AgBr ← $AgNO_3$

$BaCl_2$ ✗

$[Co(NH_3)_5NO_2]Cl_2$

$AgNO_3$ ✗

$BaCl_2$ ✓ $\longrightarrow BaSO_4 \downarrow$



red
emit
orange
purple
yellow
blue.
Green

5.4.6 $\boxed{\text{Solvate Isomerism}}$

This form of isomerism is known as '**hydrate isomerism**' in case where water is involved as a solvent. This is similar to ionisation isomerism. Solvate isomers differ by whether or not a solvent molecule is directly bonded to the metal ion or merely present as free solvent moleculesin the crystal lattice. An example is provided by the aqua complex $\boxed{[Cr(H_2O)_6]Cl_3}$ (violet) and its solvate isomer $\boxed{[Cr(H_2O)_5Cl]Cl_2.H_2O}$ (grey-green).

Ionization isomerism:-

$[Pt(NH_3)_4(OH)_2]SO_4$ and $[Pt(NH_3)_4(SO_4)](OH)_2$

$[Pt(NH_3)_4Cl_2]Br_2$ and $[Pt(NH_3)_4Br_2]Cl_2$

$[Co(NH_3)_5NO_3]SO_4$ and $[Co(NH_3)_5(SO_4)]NO_3)$

$[CoCl(NH_3)_4(H_2O)]Br_2$ and $[Co(NH_3)_4Br_2]Cl \cdot H_2O$.

ionisation isomerism

Co-ordination isomerism.

Solvate or Hydrate isomerism

$[Cr(H_2O)_6]Cl_3$
Violet
(three ionic chlorines)

$[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$
Blue green
(two ionic chlorines)

$[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$
Dark green
(One ionic chlorine)

(i) $[Co(NH_3)_4(H_2O)Cl]Cl_2$ and $[Co(NH_3)_4Cl2]Cl \cdot H_2O$
(ii) $[CoCl(NH_3)_4(H_2O)]Br_2$ and $[Co(NH_3)_4Br_2]Cl \cdot H_2O$.

Linkage isomerism

(i) $[Cr(H_2O)_5(SCN)]^{2+}$ and $[Cr(H_2O)_5(NCS)]^{2+}$

(ii) $[Co(NH_3)_2(NO_2)_2(py)]NO_3$ and $[Co(NH_3)_2(ONO)_2(py)_2]NO_3)$

Coordination isomerism. This type of isomerism is possible when both positive and negative ions of a salt are complex ions and the two isomers differ in the distribution of ligands in the cation (positive ion) and the anion (negative ion). Some important examples are :

(i) $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$

(ii) $[Cr(NH_3)_6][Co(C_2O_4)_3]$ and $[Co(NH_3)_6][Cr(C_2O_4)_3]$

(iii) $[Co(en)_3][Cr(CN)_6]$ and $[Cr(en)_3][Co(CN)_6]$

Thus, this type of isomerism is caused by interchange of ligands between the two complex ions.

Question

en $\longrightarrow$ ethylenediamine $\longrightarrow$ bis
tris
tetrakis.

Q. Which formula and name combination is incorrect?

R. [2023]

$COO^{\ominus}$
$|$
$COO^{\ominus}$ $= 2-ve$

A $K_3[Al(C_2O_4)_3]$ - Potassium trioxalatoaluminate (II)

ate

$3+x+(-2\times3)=0$

$3+x-6=0 \implies x=+3$

B $[Pt(NH_3)_2Cl(NO_2)]$-Diamminechloridonitrito-N-platinum (II) ✓

$x+0-1-1=0$

$x=+2$.

bis(ethylenediamine)

C $[CoCl_2(en)_2]Cl$ - Dichloridodiethylenediamine cobalt (II) chloride

$x-2+0-1=0$

$x-3=0,\ x=+3$

D $[Co(NH_3)_4(H_2O)Cl]Cl_2$- Tetraamminеaquachloridocobalt (III) chloride ✓ ✓ ✓

$x+0+0-1-2=0$

$x=+3$

Question ⟶ (error in q/sn)

Aqueous solution of a salt (A) forms a dense white precipitate with $BaCl_2$ solution. The precipitate dissolves in dilute HCl to produce a gas (B) which decolorizes acidified $KMnO_4$ solution.

A and B respectively are

(A) Na_2SO_3 ~~$BaSO_3$~~, SO_2

(B) Na_2SO_4 ~~$BaSO_4$~~, H_2S

(C) Na_2SO_3 ~~$BaSO_3$~~, H_2S

(D) Na_2SO_4 ~~$BaSO_4$~~, SO_2

SO_2 / H_2S

↓

Both decolourises $KMnO_4$ solution

$Na_2SO_3 \longrightarrow BaSO_3 \xrightarrow{\text{dil HCl}} H_2S / SO_2$

$BaSO_4$ ✗	→ does NOT dissolve in dilute HCl
$BaSO_3$ ✓	→ dissolves in HCl

SO_4^{2-}	→ $BaSO_4$ (white, insoluble)
SO_3^{2-}	→ $BaSO_3$ (white, but dissolves in acids)

Question

The metal that produce H_2 with both dil. HCl and NaOH(aq) is

(A) Zn / Al.

(B) Mg

(C) Ca

(D) Fe

With HCl:

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2 \uparrow$$

With NaOH:

$$Zn + 2NaOH + 2H_2O \rightarrow Na_2[Zn(OH)_4] + H_2 \uparrow$$

Question

When $KMnO_4$ solution is added to oxalic acid solution, the decolourisation is slow in the beginning but becomes instantaneous after some time because

$$\begin{array}{c} COOH \\ | \\ COOH \end{array}$$

(A) CO_2 is formed as the product

(B) Reaction is exothermic

(C) MnO_4^- catalyses the reaction

(D) $\boxed{Mn^{2+} \text{ acts as autocatalyst}}$

$KMnO_4 + C_2O_4^{2-}$

$$\overset{+7}{2MnO_4^-} + 5C_2O_4^{2-} \longrightarrow 2\overset{2+}{Mn} + 10CO_2$$

$5e^-$

$2e^-$ lost

$2MnO_4^-$ ↓ decreases.

$2Mn^{2+}$ ↓ increases.

Question

There are 14 elements in actinoid series. Which of the following elements does not belong to this series ?

(A) U

(B) Np

(C) Tm

(D) Fm

Question

$$\frac{\begin{array}{r}7\\-2\end{array}}{5e^{\ominus}}$$

$KMnO_4$ acts as an oxidising agent in acidic medium. The number of moles of $KMnO_4$ that will be needed to react with one mole of sulphide ions in acidic solution is :

gained $5e^{\ominus}$

(+7) (+2)

$$2MnO_4^{-} + 5S^{2-} + H^{\oplus} \longrightarrow 2Mn^{2+} + 5S$$

lost $2e^{\ominus}$

A) $\frac{2}{5}$

B) $\frac{3}{5}$

C) $\frac{4}{5}$

D) $\frac{1}{5}$

$$5S^{2-} \longrightarrow 2MnO_4^{\ominus}$$

$$1S^{2-} \longrightarrow ?$$

$$\frac{1\cancel{S^{2-}} \times 2KMnO_4}{5\cancel{S^{2-}}}$$

Question

General electronic configuration of actinoids is $(n-2)f^{1-14}(n-1)d^{0-1}ns^2$. Which of the following actinoids have one electron in 6d orbital? ⟶ change case qusn.

(A) U (Atomic no. 92)

(B) Np (Atomic no.93)

(C) Pu (Atomic no. 94)

(D) Am (Atomic no. 95)

⟶ not having one electron in 6d orbital.

$Am \longrightarrow 5f^7 6d^0 7s^2$.

$Cm \longrightarrow 5f^7 6d^1 7s^2$

Question

Which of the following ions show higher spin only magnetic moment value?

(A) Ti^{3+} $\rightarrow {}_{22}Ti \rightarrow 3d^2 4s^2$

$Ti^{3+} \rightarrow 3d^1 4s^0 \rightarrow d^1 = n = 1$.

(B) $Mn^{2+} \rightarrow {}_{25}Mn \rightarrow 3d^5 4s^2$

$\rightarrow 3d^5$ $n=5$

(C) $Fe^{2+} \rightarrow {}_{26}Fe \rightarrow 3d^6 4s^2$

$\boxed{n=4}$

↿⇂ ↿ ↿ ↿ ↿

$n=4$

(D) $Co^{3+} \rightarrow {}_{27}Co \rightarrow 3d^7 4s^2$

$3d^6 4s^0$

↿⇂ ↿ ↿ ↿ ↿

$n=4$

unpaired $e^{\ominus}$ = zero

5d block ← La^{3+}

Lu^{3+} → 4f block

Lr^{3+} → 5f block

colourless

${}_{57}La \longrightarrow [\underset{54}{Xe}]\, 5d^1 6s^2$

$La^{3+} \longrightarrow [Xe]\, 5d^0 6s^0$

$n = 0 \longrightarrow$ colourless.

$Lu \longrightarrow 4f^{14} 5d^1 6s^2$

$Lu^{3+} \longrightarrow 4f^{14} 5d^0 6s^0$

↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓

$n = 0$

4f unpaired $e^{\ominus}$

5f block

$Lr \longrightarrow 5f^{14} 6d^1 7s^2$

Lr^{+3}

$5f^{14} 6d^0 7s^0$

Question (2020)

Aqueous solution of a salt (A) forms a dense white precipitate with $BaCl_2$ solution. The precipitate dissolves in dilute HCl to produce a gas (B) which decolourises acidified $KMnO_4$ solution.
A and B respectively are

$Ba^{2+}\ SO_3^{2-}$

(A) ~~$BaSO_3$~~, SO_2 — Na_2SO_3

(B) $BaSO_4$, H_2S — Na_2SO_4

(C) $BaSO_3$, H_2S — Na_2SO_3

(D) $BaSO_4$, SO_2 — Na_2SO_4

A ↓

salt + acid

$BaSO_3 + HCl \longrightarrow SO_2$ (B) → decolourises $KMnO_4$ purple.

$$\boxed{BaCl_2 + SO_2 + H_2O}$$

(A)

$Na_2SO_3 + BaCl_2 \longrightarrow \boxed{BaSO_3 \downarrow \text{ sulphite}}$ → dissolves in dil HCl
(aq)

$Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 \downarrow$ sulphate → does not dissolve in dil HCl.
(aq)

Question (2010)

The spin only magnetic moment of Mn^{4+} ion is nearly

(A) 3 BM

(B) 6 BM

(C) 4 BM

(D) 5 BM

$_{25}Mn \longrightarrow 3d^5 4s^2$

$Mn^{+4} \longrightarrow \boxed{3d^3} 4s^0$

$n = 3$

3.8BM

$\sqrt{n(n+2)} = \sqrt{3(3+2)} = \sqrt{15}$ BM.

$\sqrt{16} \rightarrow 4$

$4f \rightarrow$ promethium (only)

$5f \rightarrow$ all are radioactive.

Question (2009)

The incorrect statement in respect of chromyl chloride test is

(A) formation of red vapours

(B) formation of lead chromate

(C) formation of chromyl chloride

(D) liberation of chlorine

$$K_2Cr_2O_7 + \underset{\text{or } HCl}{NaCl} + H_2SO_4 \longrightarrow CrO_2Cl_2 + H_2O + KHSO_4 + NaHSO_4$$

Question (2009)

The magnetic moment of a transition metal ion is $\sqrt{15}$ BM. Therefore, the number of unpaired electrons present in it, is

(A) 3

(B) 4

(C) 1

(D) 2

$\mu = \sqrt{15}$ BM.

$n = 2$ $\qquad \mu = \sqrt{n(n+2)}$

$\sqrt{2(2+2)}$ $\qquad \mu = \sqrt{2(2+2)}$

$= \sqrt{4 \times 8} = \sqrt{8}$

$\sqrt{3(3+2)}$

$\sqrt{3 \times 5} = 15$ BM //

Question (2008)

Mercury is a liquid metal because

$$\left\{ \begin{array}{l} Zn \rightarrow 3d^{10} \\ Cd \rightarrow 4d^{10} \\ Hg \rightarrow 5d^{10} \\ Cn \rightarrow 6d^{10} \end{array} \right.$$

(A) it has a completely filled s-orbital

(B) it has a small atomic size

(C) it has a completely filled d-orbital that prevents d-d overlapping of orbitals

(D) it has a completely filled d-orbital that causes d-d overlapping

Thank you.