General Principles and Processes of Isolation of Elements

EXERCISE-I (MHT CET LEVEL)

Q.1 (2)
Argentite is a sulphide ore of silver & having formula Ag_2S.

Q.2 (1)
Cinnabar is ore of mercury having formula HgS

Q.3 (3)

Q.4 (3)
Siderite is an ore of iron which have formula $FeCO_3$.

Q.5 (2)
All minerals are not ore but all ores are not mineral.

Q.6 (1)

Q.7 **(3)**

Q.8. **(2)**

Q.9 **(2)**

Q.10 (1)
Limestone ($CaCO_3$) is mixed with Fe_2O_3 and it acts as flux to form slag ($CaSiO_3$).

Q.11 (2)
Calcination is used for removed of volatile impurities and decompose carbonates.

Q.12 (2)

Q.13 (4)

Q.14 (4)

Q.15 (1)

Q.16 (2)
When ore is heated below melting point in the absence of air, the process is called Calcination & Calcination is done of carbonate ores.

Q.17 (2)
Cupellation process is used for the extration of copper & in this process metals are treated under very high temperature and have controlled operations to separate metal

Q.18 (4)

Q.19 **(3)**

Q.20 **(2)**

Q.21 **(2)**

Q.22 **(3)**

Q.23 **(1)**

Q.24 **(1)**

Q.25 **(1)**

Q.26 **(4)**

Q.27 **(4)**

Q.28 (3)
Flux is added during smelting it combines with infusible gangue present in the ore to form a fusible mass known as slag. $\text{Flux} + \text{Gangue} \rightarrow \text{Slag}$

Q.29 (4)
$CaO \rightarrow$ It is hygroscopic in nature

Q.30 (1)
In thermite process a mixture of aluminium powder and ferricoxide in the rate of 1 : 3 is used.

Q.31 (2)
Semiconductor materials like Si and Ge are usually purified by zone refining. Zone refining is based on the principle of fractionl crystallisation i.e. difference in solubities of impurities in solid and molten states of metal, so that the zones of impurities are formed and finally removed.

Q.32 (2)
Cupellation method is used when the impure metals contain impurity of another metal which forms volatile oxide.

Q.33 (1)
Metals are electropositive elements because they have tendency to loose e^- and forms + *ve* ions

$$Na \rightarrow Na^+ + e^-$$

Q.34 (2)

Q.35 (3)
Because Na is very reactive and cannot be extracted by means of the reduction by C, CO etc. So it is extracted by electrolysis.

Q.36 **(4)**

Q.37 (2)

Q.38 (2)
Carbonates ore
Siderite & malachite.

EXERCISE-II (NEET LEVEL)

Q.1 **(3)**

Zn^{+2} present in alternate tetrahedral avoid

$$=\frac{1}{2}\times 8=4$$

S^{2-} present in ccp = 4

$\therefore$ $Zn_4s_4 = ZnS$ i.e., AB type compound.

Q.2 (1)

Second most common element is Helium in the universe

Q.3 (3)

Diamond made up of carbon only.

Q.4 (2)

$$\left.\begin{array}{l}\text{Bauxite } (Al_2O_3)\\ \text{Cryolite } (Na_3AlF_6)\\ \text{Corundum } (Al_2O_3)\end{array}\right\}\text{Minerals of } Al$$

Gypsum $(CaSO_4.2H_2O)$

Q.5 (2)

Chile salt petre $\rightarrow NaNO_3$

Q.6 (3)

Na_3AlF_6 Sodium hexafluoro aluminate (III)

Q.7 (3)

Q.8 (3)

$$4Ag + 8CN^- + 2H_2O + O_2 \longrightarrow 4[Ag(CN)_2]^- + 4OH^-$$

Q.9 (2)

Plam oil function $\longrightarrow$ frother.

Q.10 (2)

Tin and lead can be refined by liquation method due to their fusible nature..

Q.11 (4)

tatracalcim phospata $Ca_4(PO_4)_2O$ is called Thomas slag.

Q.12 (3)

Q.13 (1)

Q.14(1)

Q.15 **(4)**

Q.16 (3)

$$Ni + 4CO \xrightarrow{50^\circ C} Ni(CO)_4 \xrightarrow{230^\circ C} Ni + 4CO$$

Q.17 (2)

Thermometallurgy

$$Cu_2S + \frac{3}{2}O_2 \longrightarrow Cu_2O + SO_2 \text{ (Roasting)}$$

$$2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2 \text{ (Auto reduction)}$$

Q.18 (1)

Poling process is used for removel of Cu_2O from Cu.

Q.19 (1)

Fe is more reactive than Cu.

Q.20 (3)

Chemical separation or Leaching.

In this powdered ore is treated with a suitable reagent which can dissolve the ore but not the impurities.

Q.21 (4)

Copper pyrite $CuFeS_2$ (Chalcopyrite)

Q.22 (3)

Sulphides ores are always concentrated by froth floatation process

Q.23 (4)

Q.24 (1)

Froth floatation because it is sulphide ore (ZnS)

Q.25 (3)

Q.26 (2)

Smelting is a process of reducing metal oxide to metal by means of coke or CO.

$$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$$

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Q.27 **(1)**

Q.28 (2)

Q.29 (2)

In Blast furnace CaO flux is added to remove gangue of SiO_2, to form $CaSiO_3$ slag.

Q.30 (1)

Cryolite flonsfer are added during reduction Alumina.

Q.31 (4)

Q.32 (2)

Q.33 (4)

Q.34 (3)
An form complex which is frater soluble.

Q.35 (2)
Al forms thin filmofoxide
⇒ So Al becomes possive in nitric acid.

Q.36 (2)
Mg and *Al* can not be obtained by the electrolysis of aqueous solution of their salts because instead of metal H_2 gas is liberated at cathode.

Q.37 (1)

$$Ti + 2I_2 \xrightarrow{500K} \underset{\substack{\text{Volatile} \\ \text{Stable compund}}}{TiI_4} \xrightarrow{1700K} \underset{\text{Pure metal}}{Ti + 2I_2}$$

Q.38 (3)

$$\underset{\text{(Fused)}}{2NaCl} \to 2Na^+ + 2Cl^-$$

Anode: $2Cl^- \to 2e^- + Cl_2$ (oxidation)

Cathode: $2Na^+ + 2e^- \to 2Na^-$ (reduction)

Q.39 (2)
$Fe_2O_3 + 3CO \to 3CO_2 + 2Fe$

Q.40 (4)

$$2Cu_2S + 3O_2 \to 2Cu_2O + 2SO_2$$

$$3Cu_2O + \underset{\substack{\text{(From green} \\ \text{logs of wood)}}}{CH_4} \to 6Cu + 2H_2O + CO$$

Q.41 (2)
Heating with carbon in absence of air is known as carbon reduction.
This is used in Iron metallurgy.

$$Fe_2O_3 + C \xrightarrow{\text{(in blast furnace)}} Fe\ .$$

Q.42 (2)
Slag composed mainly of $FeO + SiO_2 \Rightarrow FeSiO_3$

Q.43 (2)
Blister copper $\longrightarrow$ Cu with 2% Impurity.

Q.44 **(2)**

$$\underset{\text{(Impure)}}{Ni} + 4CO \xrightarrow{50° to\, 60°C} \underset{\text{Volatile compound}}{\left[Ni(CO)_4\right]}\uparrow$$

$$\xrightarrow{200\ to\ 230°C} \underset{\text{pure}}{Ni} + 4CO\uparrow$$

Q.45 **(1)**

Q.46 (3)
Leaching
$Ag_2 + 4NaCN \longrightarrow Na[Ag(CN)_2] + Na_2S$
$2Na[Ag(CN)_2] + Zn \longrightarrow Na_2[Zn(CN)_4] + 2Ag$

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (3)
Metal cannot be economically and conveniently extracted from salt cake (Na_2SO_4).

Q.2 (3)
Aluminothermite process, Al act as reducing agent.
e.g. $Mn_3O_{4(s)} + 8Al \to Mn_{(\ell)} + Al_2O_3(s)$
$Cr_2O_{3(s)} + Al \to Cr_{(\ell)} + Al_2O_3$

Q.3 (4)
(4) Feldspar is $K_2O.Al_2O_3.6SiO_2$. beryl is $Be_3Al_2Si_6O_{18}$
.

Q.4 (4)
Egg shell is made up of $CaCO_3$.
Dolomite : $CaCO_3.MgCO_3$; Calamine : $ZnCO_3$
Lime stone : $CaCO_3$; Feldspar : $K_2O.Al_2O_3.6SiO_2$.

Q.5 (3)
(1) Malachite $Cu(OH)_2\ .\ CuCO_3$
(2) Calamine $ZnCO_3$
(3) Cerussite $PbCO_3$
Stellite is an ore

Q.6 (2)
Some transition metal can form poly nuclear metal carbonyls also.

Q.7 (1)
Sea water contains 0.13% Mg as salt and extracted by Dow's process and also from ore magnesite found in earth crust.

Q.8 (1)
NaCl and $CaCl_2$ both being ionic compounds ionise to give ions which lowers the melting point and increase the conductivity of the mixture.

Q.9 (2)
(1) Calamine $\to ZnCO_3$

Siderite → $FeCO_3$
(2) Argentite → Ag_2S
Cuprite → Cu_2O
(3) Zinc blende → Zns
Pyrite → Sulphide
(4) Malackite (green) $CuCO_3 . Ca(OH)_2$
Azurite $2CuCO_3 . Cu(OH)_2$
(Blue)

Q.10 (1)
German silver in an alloy of Cu and Zn. It does not contain silver.

Q.11 (1)
Fool's gold is Iron pyrite.

Q.12 (3)
Sulphide ore is roasted in presence of excess of air or O_2 below its melting point to convert into the oxide and to remove the impurities of S, P, Sb etc., as their volatile oxides. In some cases roasting of certain sulphide ores provide directly the metals.

Q.13 (3)
(1) Calamine → $ZnCO_3$
Siderite → $FeCO_3$
(2) Argentile → Ag_2S
Cuperite → Cu_2S
(3) Zinc blende → ZnS
Iron pyrite → FeS_2
(4) Malachite → $CuCO_2 . Cu(OH)_2$
Azurite → $CuCO_3 . 2Cu\ (OH)_2$

Q.14 (3)
Fe_3O_4 → Ore of iron

Q.15 (2)
$ZnS + 4NaCN \rightarrow Na_2[Zn(CN)_4] + Na_2S$
$PbS + NaCN \rightarrow$ No such complex formation.

Q.16 (3)
(3) Carbonate ores are calcined in absence of air to obtain the metal oxides.

Q.17 (2)
An infusible acidic impurity is removed by reacting with basic oxide, e.g., SiO_2 forming fusible slag.
$CaCO_3 \rightarrow CaO + CO_2$; SiO_2 (acidic oxide) + CaO (basic oxide) → $CaSiO_3$ (slag).

Q.18 (1)
Sodium ethyl xanthate acts as collector.

Q.19 (1)
$FeCr_2O_4$ due to magnetic nature is separated by magnetic seperation

Q.20 (2)

$4Ag + 8CN^- + 2H_2O \longrightarrow 4[Ag(CN)_2]^-$ (soluble complex) $+ 4OH^-$

$2[Ag(CN)_2]^- + Zn \longrightarrow 2Ag + [Zn(CN)_4]^{2-}$

Q.21 (4)
Molten silver preferentially dissolves in molten zinc forming silver-zinc alloy - Which is lighter and has higher melting point. Therefore, (D) option is correct.

Q.22 (4)
(1) When the oxide undergoes a phase change, there will be an increase in the entropy of the oxide.

(2) It is true statements, $HgO \xrightarrow{\Delta} Hg + 1/2O_2$

(3) For a reduction process the change in the free energy, ΔG^0 must be negative and to make ΔG^0 negative temperature should be high enough so that $T\Delta S^0 > \Delta H^0$.

Q.23 (1)
Reduction of oxides of Mn, Cr etc., by electropositive aluminium metal is called as alumino thermite process.

Q.24 (3)
Mercury from cinnarbar (HgS)
(Auto reductant and self reduction)
(Cu_2S, PbS, HgS)

Q.25 (3)
As PbS on self reduction with PbO and $PbSO_4$ gives metallic lead.

Q.26 (4)
Sulphide ore of Hg, Cu, Pb are heated in air, a part of these is changed in to oxides or sulphate that then react with the remaining part of the sulphide ore to give its metal and SO_2. This is called self reduction, auto reduction or air reduction method.

Q.27 (3)
Aluminium is extracted by electrolytic reduction of mixture of molten $Al_2O_3 + Na_3AlF_6 + CaF_2$.
Due to very high energy of dissociation of Al_2O_3, the reduction at such high temperature will give carbide in place of metallic Al according to the following reaction.

$2Al_2O_3 + 6C \xrightarrow{\Delta} Al_4C_3 + 3CO_2$.

Q.28 (3)

$Na_3[AlF_6] \longrightarrow 3NaF + AlF_3$
NaF and AlF_3 both are ionic compounds and so ionise to give ions. This increases the electrical conductivity and lowers the melting point of Al_2O_3.

At cathode : Al^{3+} (melt) + $3e^- \longrightarrow$ Al.
At anode : C(s) + O^{2-} (melt) $\longrightarrow$ CO (g) + $2e^-$; C(s) + $2O^{2-}$ (melt) $\longrightarrow CO_2$ (g) + $4e^-$.

Q.29 (3)
Cynide process used for Au and Ag comlexes formed in this, are : $Na[Au(CN)_2]$, $Na[Ag(CN)_2]$, $Na_2[Zn(CN)_4]$.

Q.30 (1)
Si and Ge is used for semiconductors are required to be high purity and hence purified by zone refining.

Q.31 (2)
Reactive metal can not be reduced by carbon hence process of electrolysis is used.

Q.32 (4)
Electrolyte contains $PbSiF_6$ containing 8-12% of H_2SiF_6.

Q.33 (3)
It is not called van Arkel method. Van Arkel method is used for the purification of Zr and Ti. Reaction (C) is simple thermal decomposition of Ag_2CO_3.

Q.34 (4)
Gold is not attacked by sulphuric acid, nitric acid and Cl_2 use to separate it from borax so, parting of gold can be done with these.

Q.35 (2)
The process mention is rxn is known as Mc. Arthur forest
Method :
$Ag_2S + 4NaCN \rightarrow 2[Ag(CN)_2]^- + 2Na^+ + S_2^{2-}$
$[Ag(CN)_2]^- + Zn \rightarrow (Zn(CN)_4)^{2-} + 2Ag\downarrow$

Q.36 (3)
By cupellation it is urea for the removal of Pb from Ag and Au

Q.37 (3)
Iron obtained from blast furnace is pig iron

Q.38 (3)

$$Ni + 4CO \xrightarrow{T_1} Ni(CO)_4 \xrightarrow{T_2} Ni + 4CO$$

$T_1 = 50^\circ C$
$T_2 = 230^\circ C$

Q.39 (3)
$FeO + SiO_2 \rightarrow FeSiO_3$ (Slag)
$CaO + SiO_2 \rightarrow CaSiO_3$

Q.40 (3)
Parkes process

Q.41 (3)
It is obtained by electrolytic reduction of molten anhydrous $KCl.MgCl_2$ (other methods are not economical/ feasible for the extraction of Mg metal).

Q.42 (3)
Electrolyte used is $Al_2O_3 + Na_3AlF_6 + CaF_2$

Q.43 (1)
The Hooper process is a process for the electrolytic refining of aluminium. Impure Al forms the anode and pure Al forms the cathode of the Hooper's cell which contains three liquid layers. The bottom layer is molten impure Al, the middle is a fused salt layer containing sodium fluoride, aluminum fluoride and barium fluoride, and the top layer is pure Al. At the anode (bottom layer), Al passes with solution as aluminium ion (Al^{3+}), and at the cathode (top layer), these ions are reduced to the pure metal. In operation, molten metal is added to the bottom of the cell and pure aluminium is drawn off the top.

At anode : $Al \longrightarrow Al^{3+} + 3e^-$

At cathode : $Al^{3+} + 3e^- \longrightarrow Al$.

Q.44 (3)
Anode mud obtained in electrolytic refining of lead contains, Sb, Cu, Ag and Au.
Therefore, (C) option is correct.

Q.45 (4)
Due to low discharge potential of Na^+, it will deposited first.

EXERCISE-IV

Q.1 [4]
Q.2 (3)
Q.3 (3)
Q.4 (4)
Q.5 (1)
Q.6 (2)
Q.7 (3)

PREVIOUS YEAR'S

MHT
Previous Question
Q.1 (1)

Q.2 (3)

Q.3 (1)

Q.4 (2)

Q.5 (2)

Q.6 (1)

Q.7 (1)

Q.8 (2)

Q.9 (4)

Q.10 (3)

Q.11 (3)
Q.12 (2)

Q.13 (1)

Q.14 (3)

Q.15 (2)

Q.16 (2)

Q.17 (2)

Q.18 (2)

Q.19 (1)

Q.20 (3)

Q.21 (1)

Q.22(2)

Q.23 (4)

Q.24 (3)

Q.25 (2)

Q.26 (3)

Q.27 (4)

Q.28 (3)

Q.29 (3)

Q.30 (3)

NEET

Q.1 (1) The metal which is more reactive than 'Al' can reduce alumina i.e. 'Mg' should be the correct option.

Q.2 (4) Malachite ore = $CuCO_3.Cu\,(OH)_2$

Q.3 (3)
Q.4 (3)
Q.5 (1)
Q.6 (2)
Q.7 (1) Haematile Fe_2O_3
Magnetite Fe_3O_4
Calamine $ZnCO_3$
Kaolinite $[Al_2(OH)_4Si_2O_5]$

JEE MAIN

Q.1 (2) Enamel on the surface of the teeth.
$3Ca_3(Po_4)_2{\cdot}CaF_2$

Q.2 (1)
(1) Sphalerite $\rightarrow ZnS$
(2) Calamine $\rightarrow ZnCO_3$
(3) Galena $\rightarrow PbS$
(4) Siderite $\rightarrow FeCO_3$

Q.3 (3) $Au + 2NaCN + O_2 \rightarrow \underset{(A)}{Na[Au(CN)_2]}$
$Zn + 2Na[Au(CN)_2] \rightarrow \underset{(B)}{Na_2[Zn(CN)_4]}$

Q.4 (1) Anode mud of electrorefining of Cu have Ag, Au, Pt etc

Q.5 (2) Hall - Heroult Process → Electrolytic Reduction of Al_2O_3

Q.6 (4) Higher value of ΔG^o, metal oxide will be less stable. In Ellingham diagram lower situated metals is more reactive, it can reduce higher metal oxide.

Q.7 (1) Depressant prevent one component from coming to the froth.
For eg., in Galena ore, the depressant(NaCN) prevents impurity(ZnS) from coming to the froth

Q.8 (2)
Q.9 (2) Melting points for
Aluminium : 933 .47 K
Magnesium : 923 K

Q.10 (4)
$4Au(s) + 8CN^- + 2H_2O(aq) + O_2 \rightarrow 4[Au(CN)_2]^- + 4OH^-(aq)$
$2[Au(CN)_2]^-(aq) + Zn(s) \longrightarrow 2Au(s) + [Zn(CN)_4]^{2-}(aq)$
$0 \quad \underbrace{\qquad\qquad\qquad\qquad}_{\text{Oxidation}} \quad +2$
Zinc is oxidised during the displacement reaction carried out for gold extraction.

Q.11 (4) FeO = Gangue
$FeSiO_3$ = Slag

Q.12 (4) $M + CaCN + O_2 \rightarrow Na[M(CN)_2](aq)$
M = Au, Ag, this is leaching of Ag and Au.
$CN^\ominus$ is not used in extraction of Cu metals.
Options (D) is correct.

Q.13 (1)
Malachite → $CuCO_3.Cu(OH)_2$
Calamine → $ZnCO_3$
Galena → Pbs
Siderite → $FeCO_3$
Sphalerite → ZnS

Q.14 [3]
(2) Galena – PbS
(3) Zinc blende – ZnS
(4) Copper pyrite – $CuFeS_2$

Q.15 [4]
Haematite → Fe_2O_3
Magnetite → Fe_3O_4
Siderite → $FeCO_3$
Limonite → $Fe_2O_3.3H_2O$

Q.16 (2) Cast iron has slightly lower carbon content (about 3%) Cast iron is made by melting pig iron with scrap iron and Coke using hot air blast

Q.17 (4) Copper pyrite has Impurity of FeO
$\underset{\text{Imp.}}{FeO} + \underset{\text{Flux}}{SiO_2} \rightarrow \underset{\text{slag}}{FeSiO_3}$

Q.18 (1)

Methods for concentration	Methods for refining
Calcination	Liquation
Leaching	Electrolysis
	Distillation

Q.19 (3) In Leaching process.
$Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2Na[Al(OH)_4]$

Q.20 (3, 4) $NaOH(aq.) + Zn \rightarrow Na_2[Zn(OH)_4] + H_2\uparrow$
$\therefore$ So, we can write it in ionic form as $[Zn(OH)_4]$.
$NaOH(aq.) + Zn \rightarrow Na_2ZnO_2 + H_2\uparrow$
So, we can write it in ionic form as $(ZnO_2)^{-2}$
So, correct option is (3, 4)

Q.21 (1) Gangue : Ore usually contaminated with earthly or undesired materials known as gangue. [direct from n.c.e.r.t]

Q.22 (3) **Liquation process :** In this method, a low melting metal tin can be made to flow on a sloping surface. In this way it is Separated from higher melting impurities so correct option is (3)

Q.23 (1) $\Delta G = \Delta H - T\Delta S$
So on melting entropy increases and ΔG become more negative so metal ion get easily reduced.

The p-Block Elements

EXERCISE-I (MHT CET LEVEL)

Q.1 (1)

The average residence time for Nitrogen oxide is 4 days not a month.

Q.2 (2)

Q.3 **(4)**

Q.4 **(3)**

Q.5 (4)

All nitrides react with H_2O to give NH_3 and $CaCN_2$ also react with H_2O

$$CaNCN + 3H_2O \rightarrow CaCO_3 + NH_3$$

Q.6 (2)

Q.7 (1)

Q.8 (2)

Q.9 (4)

Q.10 **(2)**

Q.11 **(4)**

Q.12 **(3)**

Q.13 (2)

Red P does not react with NaOH to give PH_3

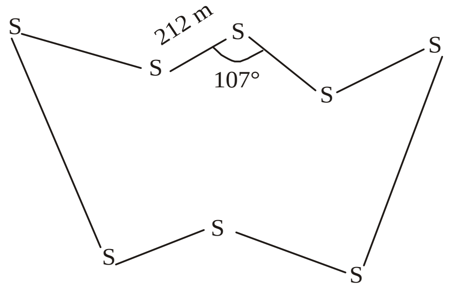
Q.14 (1)

The acids which contain P-H bond have strong reducing properties. Thus H_3PO_2 acid is good reducing agent as it contains two P-H bonds. For example, it reduces $AgNO_3$ to metallic silver.

Q.15 (1)

In P_4 molecule, the four sp^3–hybridised phosphorus atoms lie at the corners of a regular tetrahedron with $\angle PPP = 60°$.

In S_8 molecule S-S-S angle is 107° rings.



Q.16 (3)

Q.17 **(3)**

Q.18 **(3)**

Q.19 **(1)**

Q.20 (1)

Reactivity follows the order F >Cl >Br >I

Q.21 (4)

chalcogens are defined as ore-forming elements.

Q.22 **(1)**

Q.23 **(1)**

Q.24 **(1)**

Q.25 (1)

F_2 is strongest oxidising agent. F^- is not oxidised by MnO_2

Q.26 (4)

F_2 is expected to have highest bond energy but the correct decreasing order is $Cl_2 > Br_2 > F_2$ because of fluorine atom has very small size due to which there is a high inter electronic repulsion between two fluorine atoms so the bond between two fluorine gets weaker and need less energy.

Q.27 (2)

Nitrous oxide (i.e., N_2O) is the laughing gas.

Q.28 (1)

$3Cl_2 + 2NaI \rightarrow 2NaCl + I_2$

I_2 gives violet colouration in $CHCl_3$.

$$5Cl_2 + 6H_2O + I_2 \rightarrow \underset{\text{Colourless}}{HIO_3} + 10HCl$$

Q.29 **(4)**

Q.30 **(4)**

Q.31 **(3)**

Q.32 **(1)**

Q.33 **(3)**

Q.34 (1)

Q.35 (1)

Q.36 (3)

Q.37 (1)

Q.38 **(4)**

Q.39 **(3)**

Q.40 **(2)**

Q.41 **(3)**

Q.42 (2)
Order of basic character is $NH_3 > PH_3 > AsH_3 > SbH_3$. Basic-character decreases down the group from N to Bi due to increase in atomic size.

Q.43 **(2)**

EXERCISE-II (NEET LEVEL)

Q.1 (1)
White phosphorus is soluble in CS_2 whereas red phosphorus is insoluble in it.

Q.2 (1)
Phosphorus is kept in water due to it burt at 30°C.

Q.3 (2)
The laboratory method for preparation of N_2 is mixing of NH_4Cl & KNO_2

$$NH_4Cl + KNO_2 \longrightarrow KCl + \underbrace{N_2} + 2H_2O$$

Q.4 (3)
Catenation tendency is higher in phosphorus when compared with other elements of same group.

Q.5 (1)
Birkeland – Eyde process
Dinitrogen is prepared commercially from air by liquification and fractional distillation. When liquid air is allowed to distil, dinitrogen having lower b.pt (77K) distils over first leaving behind liquid oxygen (bpt 90*K*). World wide production of dinitrogen from liquid air is more than 50 million tonns per year.

Q.6 (1)
PCl_5 exist as $[PCl_4]^2$ & $[PCl_6]^-$

Q.7 (4)

$$\underset{\text{Nitric acid}}{2HNO_3} \rightarrow N_2O_5 + H_2O$$

Q.8 (4)

$$4HNO_3 \rightarrow 4NO_2 + O_2 + 2H_2O$$

Q.9 (2)
When N_2O is inhaled in moderate quantities, it produces hysterical laughter, hence the name laughing gas.

Q.10 (4)
N_2O_5 is an anhydride of HNO_3
$2HNO_3 \rightarrow N_2O_5 + H_2O$
Therefore, it can act only as oxidising agent.

Q.11 **(3)**

Q.12 (3)
N_2O is a linear molecule

Q.13 (3)
PCl_5 in moist air hydrolyses to $POCl_3$ & finally converted to prosphoric acid
$PCl_5 + H_2O \longrightarrow POCl_3 + 2HCl$
$POCl_3 + 3H_2O \longrightarrow H_3PO_4 + 3HCl$

Q.14 **(1)**

$$\underset{sp^3d}{2PCl_5} \rightleftharpoons \underset{sp^3}{PCl_4^+} + \underset{sp^3d^2}{PCl_6^-}$$

Q.15 (1)

Q.16 (1)
NH_4Cl

Q.17 (3)
$NH_3 \longrightarrow$ Basic
can't be dried by acidic P_2O_5 & H_2SO_4.

Q.18 (4)

$$3H_2O + PCl_3 \rightarrow H_3PO_3 + 3HCl$$

Q.19 (3)
Due to less reactivity of red phosphorus

Q.20 (4)

Due to absence of *d*-orbitals in *N* atom, it cannot accept electrons from H_2O for hydrolysis of NF_3.

Q.21 (1)
Paramagnetism because of two unpaired electrons in the antibonding molecular orbitals.

Q.22 (3)
$2H_2O + 2F_2 \rightarrow 4HF + O_2$
2 unpaired electrons

Q.23 (1)

Q.24 (4)
Ozone O_3 is an allotropic form of oxygen.

Q.25 (2)

Q.26 (3)

Q.27 (1)
$H_2O + SO_3 \rightarrow H_2SO_4$

Q.28 (4)

Q.29 (3)

Q.30 (2)

Q.31 **(3)**

Q.32 (1)
Sulphur has 8 atoms in a molecule because in nature it is found in form of S_8.

Q.33 **(1)**
In a group as we go down size of atom increases, so F is smallest atom among all halogen atom.

Q.34 **(1)**
Fluorine is shows only one oxidation state which is –1 oxidation state.

Q.35 **.**(3)

$$Cl_2 + H_2O \rightarrow 2HCl + \frac{1}{2}O_2$$

Hydroogen has more affinity for chlorine.

Q.36 (3)
Fluorine, since it is the most electronegative element.

Q.37 **(2)**

Q.38 **(3)**

Q.39 **(1)**
Fluorine is the strongest oxidising agent because it oxidises the other element & reduces itself.

Q.40 (4)
Reactivity order
$I^- > Br^{3-} > Cl^- > BF^-$

Q.41 (3)

Both Mno_2 and $kMno_4$ used for the preparation of chlorine by the action of cons.
HCI

$$Mno_2 + 4HCI \rightarrow MnCI_2 + 2H_2O + CI_2$$

$$2KMno_4 + 16HCI \rightarrow 2KCI + 2MnCI_2 + 8H_2O + 5CI_2$$

Chlorine is not obtained by dil. HCI

$$Ag_2S_2O_3 + H_2O \rightarrow Ag_2S + H_2SO_4$$

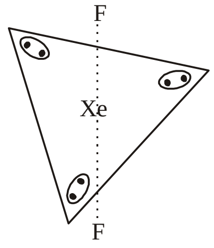
Q.42 (2)

$$\underset{2:1}{Xe + F_2} \xrightarrow{673K} XeF_2$$

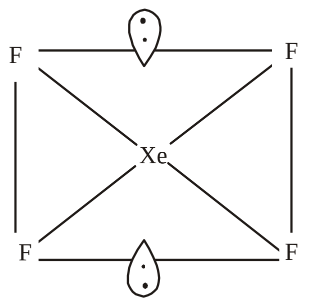
$$\underset{1:5}{Xe + 2F_2} \xrightarrow[5-6Atm]{673K} XeF_4$$

$$\underset{1:20}{Xe \div 3F_2} \xrightarrow[50-60Atm]{573K} XeF_6$$

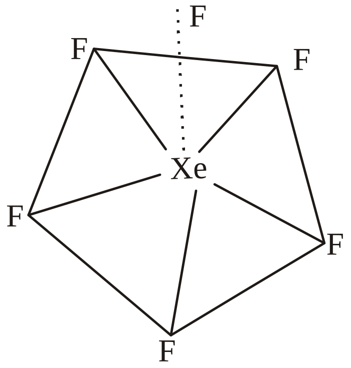
Structures of Xenon fluorides
Xc F_2 : Hybridization sp^3d



Linear
Xe F_4 : Hybridization sp^3d^2



square planar
Xc F_6 : Hybridization sp^3d^3



Pentagonal pyramidal or distorted octahedral

Q.43 **(4)**
Clathrate formation involves dipole-induced dipole interaction.

Q.44 (4)

Q.45 **(4)**

Q.46 **(2)**

Q.47 **(4)**
Order of reactivity
$I^- + Br^- > Cl^- > F^-$

Q.48 (1)
Oxidation number of $HBrO_4$ is more than that of $HOCl, HNO_2$ and H_3PO_3 so it is the strongest acid among these.

Q.49 **(1)**
$CaOCl_2 \longrightarrow CaCl_2^+ + OCl^-$

Q.50 **(2)**

Q.51 **(3)**
I_2 forms complex ion I_3^- in KI solution due to which it dissolves in it.

Q.52 **(2)**

Q.53 (3)
Helium (In Greek Helios = Sun)

Q.54 **(2)**

EXERCISE-III (JEE MAIN LEVEL)

Q.1 **(4)**
Black phosphorus is thermodynamically most stable form of phosphorus as it is a highly polymerised form of phosphorus. Hence it is least reactive.

Q.2 **(2)**
Has one lone pair of electrons on central atom which they can donate to lewis acid.

Q.3 **(1)**
The basic strength of the hydrides of group 15 elements down the group decreases because down the group as electronegativity decreases p-orbital take part in the bond and lone pair present in s-orbital :
s-orbital is larger and non directional hence it has less effective tendency of bond formation.

Q.4 **(3)**

Q.5 **(4)**
NH_4Cl gives NH_3, NH_4NO_3 gives N_2O and $AgNO_3$ gives NO_2.

(1) $NH_4Cl \xrightarrow{\Delta} NH_3 + HCl$

(2) $NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

(3) $AgNO_3 \xrightarrow{\Delta} Ag + NO_2 + \frac{1}{2}O_2$

(4) $NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

Q.6 **(1)**

Q.7 **(3)**

$:N\equiv\underset{sp}{N}\rightarrow\ddot{\underset{..}{O}}: \longleftrightarrow :\overset{-}{\underset{..}{N}}=\overset{+}{\underset{sp}{N}}=\ddot{O}: \longleftrightarrow :N\equiv\overset{+}{\underset{sp}{N}}-\overset{-}{\ddot{\underset{..}{O}}}:$ (linear)

Q.8 **(4)**

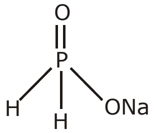
$4HNO_3 + P_4O_{10} \xrightarrow{250\,K} 4HPO_3 + N_2O_5$ (anhydride of HNO_3)

Q.9 **(4)**

Q.10 (1)

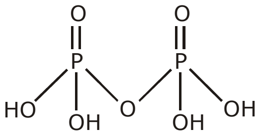
Q.11 **(2)**

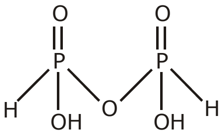
Q.12 (1)



Q.13 (1)

Q.14 (3)





Q.15 (2)

Q.16 (1)

Q.17 (1)

A moelcular weight of molecule increase it convert to gas → liquid → solid

Q.18 **(3)**

Q.19 **(4)**

Q.20 (3)

SO_2 & Cl_2

$Cl_2 + H_2O \longrightarrow 2HCl + O$

Cl_2 is a powerful bleaching agent bleaching action is due to oxidation

$Cl_2 + H_2O \longrightarrow 2HCl + [O]$

Q.21 (2)

Acidic properties $\propto \dfrac{\text{Non metallic character}}{\text{metallic character}}$

Q.22 (1)

$\overset{+4}{SO_2} \xrightarrow{\text{reduction}} S^o$

oxidising agent.

Q.23 (3)

$3O_2 \xrightarrow{U.V.} 2O_3$

Q.24 (1)

$2O_3\ 3O_2$

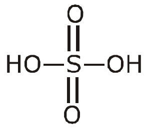
Q.25 (3)

Q.26 (3)

Q.27 (2)

Ripole moment ∝ ΔEN of atom.

Q.28 (1)



Q.29 (1)

Q.30 **(4)**

Amongst halogens fluorine is the strongest oxidising agent on account of low bond dissociation energy and high enthalpy of hydration.

Q.31 **(2)**

Fluorine, being most electronegative element, always show the oxidation state of –1. Other halogens can show higher positive oxidation state in addition to negative oxidation of –1.

Q.32 **(2)**

$SiO_2 + 6HF \rightarrow H_2SiF_6 + 2H_2O$

Q.33 **(4)**

Standard reduction potential (in volts) of the perhalate ions are gives as below –

$ClO_4^- + 2H^+ + 2e^- \longrightarrow ClO_3^- + H_2O$;

$E° = 1.19V$

$BrO_4^- + 2H^+ + 2e^- \longrightarrow BrO_2^- + H_2O$;

$E° = 1.74V$

$IO_4^- + 2H^+ + 2e^- \longrightarrow IO_3^- + H_2O$;

$E° = +1.65V$

more the standard reduction potential, the more is tendency of perhalite ion to undergo reduction and more stronger it will be an oxidizing agent.

Q.34 **(3)**

It's bleaching action is due to nascent oxygen.

Q.35 **(2)**

Pseudohalides contain at least one N atom and their properties are similar to halides.

Q.36 **(1)**

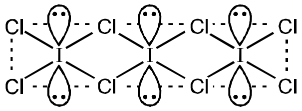
e.g. CN^-

Q.37 (1)

NCCN is pseudohalogen but CN^- and N_3^- are pseudohalide but I_3^- is only polyhalide.

Q.38 **(1)**

ICl_3, exist as dimer in **solid state**.



and $ICl_3 + 2H_2O \longrightarrow$ HIO_2 (iodous acid) + 3HCl (Hydrochloric acid)

Q.39 **(3)**

In March 1962, Neil Bartlett, then at the University of British Columbia, observed the reaction of a noble gas. First , he prepared a red compound which is formulated as O_2^+ $[PtF_6]–$ and it is already know that the first ionisation enthalpy of molecular oxygen (1175 kJ mol^{-1}) is almost similar with that xenon (1170 kJ mol^{-1}). Then he made efforts to prepare same type of compound by mixing Pt F_6 and Xenon Xe^+ $[PtF_6]–$. After this discovery, a number of xenon compounds mainly with most electronegative elements like fluorine and oxygen, have been synthesised.

Q.40 **(2)**

Noble gases exist as monoatomic molecules.

Q.41 **(1)**

All the noble gases except radon occur in the atmosphere. Xenon and radon are the rarest elements of the group. Radon is obtained as a decay product of 226Ra.

$$^{226}_{88}Ra \longrightarrow ^{222}_{86}Rn + ^{4}_{2}He$$

Q.42 **(1)**

Most abundant element in air is Ar. Order of abundance in the air is Ar > Ne > Kr > He > Xe.

Q.43 **(2)**

XeF_5 does not exist at all.

Q.44 **(2)**

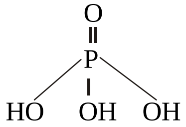
Xenon form maximum number of compounds like XeF_2 , XeF_4 , XeF_6, XeO_3, XeO_4 etc.

EXERCISE-IV

Q.1 5

(i) NO Nitric oxide Colourless gas (ii) N_2O Nitrous oxide Colourless gas (iii) N_2O_3 Dinitrogen trioxide Blue liquid (iv) N_2O_4 Dinitrogen tetraoxide colourless liquid (v) N_2O_5 Dinitrogen pentaoxide colourless gas

Q.2 3



3 - *OH* groups are present hence it is tribasic.

Q.3 8

$Ar_{18} \rightarrow 2, 8, 8$

Q.4 4

Suppose the oxidation state of Xe is x . $XeOF_2$

$x + (-2) + 2(-1) = 0 \Rightarrow x - 2 - 2 = 0 \Rightarrow x = 4$.

Q.5 (3) **Q.6** (3) **Q.7** (3) **Q.8** (1)

Q.9 (1) **Q.10** (4)

PREVIOUS YEAR'S

MHT

Q.1	(2)
Q.2	(4)
Q.3	(1)
Q.4	(2)
Q.5	(4)
Q.6	(2)
Q.7	(2)
Q.8	(1)
Q.9	(3)
Q.10	(3)
Q.11	(2)
Q.12	(3)
Q.13	(3)
Q.14	(3)

Q.15 (1)

Q.16 (2)

Q.17 (2)

Q.18 (4)

Q.19 (1)

Q.20 (1)

Q.21 (2)

Q.22 (3)

Q.23 (4)

Q.24 (2)

Q.25 (2)

Q.26 (3)

Q.27 (2)

Q.28 (2)

Q.29 (1)

Q.30 (4)

Q.31 (1)

Q.32 (3)
Q.33 (2)
Q.34 (2)
Q.35 (3)
Q.36 (4)
Q.37 (2)

Q.38 (2)
Q.39 (2)

Q.40 (4)

Q.41 (4)

Q.42 (2)

Q.43 (2)
Q.44 (3)

Q.45 (3)

Q.46 (4)

Q.47 (2)

Q.48 (1)

Q.49 (3)

Q.50 (4)

Q.51 (1)

Q.52 (2)

Q.53 (3)

Q.54 (2)

Q.55 (3)

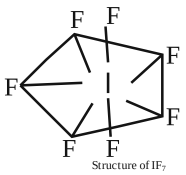
Q.56 (2)

Q.57 (4)

Q.58 (4)
IF_3 is a yellow powder powder whereas ClF_3, ClF and IF_7 is colourless gas

Q.59 (1)
Oxygen is the most reactive among the other elements of group 16 As we move down the group the reactivity decreases because there is an increase in atomic radius down the group and hence the effective nuclear charge decreases which leads to decrease in chemicla reactivity So, the reactivity order will be O > S > Se > Te > Po.

Q.60 (4)



Structure of IF_7

numbers of lone pair of electron in IF_7 is 0

Q.61 (2)

$$Na_2B_4O_7 \xrightarrow{760°C} \underset{(A)}{2NaBO_2 + B_2O_3}$$

$$Si + 2KOH + H_2O \rightarrow \underset{(B)}{K_2SiO_3} + 2H_2\uparrow$$

$$P_2O_5 + 2HNO_3 \rightarrow 2HPO_3 + \underset{(C)}{N_2O_5}$$

$$NH_3 + 3Cl_2\,(excess) \rightarrow \underset{(D)}{NCl_3} + 3HCl$$

Q.62 (1)

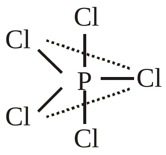
Q.63 (1)

NEET

Q.1 (1)

Q.2 (4)

It is reactive gas as easily provide Cl_2 gas



$$\left[(P-Cl)\ \begin{matrix}Axial\\ Bond\\ Lenath\end{matrix}\right\rangle (P-Cl)\ \text{Equatorial bond length}\Bigg]$$

NCERT XII Page 183, p - block

Q.3 (3)

In oxygen family down the group thermal stability decreses order of thermal stability

$H_2O > H_2S > H_2Se > H_2T > H_2Po]$

This is because M - H bond dissociation energy decreases down the group with the increase in the size of central atom.

Q.4 (4)

$$2NaN_3 \xrightarrow{\Delta} 2Na + 3N_2$$

$$Ba(N_3)_2 \xrightarrow{\Delta} 2NH_3(g)$$

Pure N2 obtained (NCERT XII Page 174)

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

[Haber process] [NCERT XII] Page 176 Contact Process

$$2SO_2(g) + O_2(g) \xrightarrow{V_2O_5} 2SO_3(g)$$

$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$(Oleum)

$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$(96-98% pure)

[NCERT XII page 195]

Deacon process

$$4HCI + O_2 \xrightarrow{CuCI_2} 2Cl_2 + 2H_2O$$

[NCERT Class XII page 202]

Q.5 (2)

Q.6 (1)

Q.7 (1)

Q.8 (4)

Q.9 (4)

Q.10 (2)

In diamond each carbon is bonded with four other carbon atoms. So hybridisation of carbon atom is sp^3. In graphite each carbon is bonded with three other carbon atoms. So hybridisation of carbon atom is sp^2.

Q.11 (4)

Interhalogen compound group 17th

ICl is more reactive due to polar bonds.

From NCERT - X–X' bond is weaker then X–X bond except F_2

Q.12 (1)

Hydrides of group 16th

$$\underset{H-bond}{H_2O}\ \underbrace{H_2S\quad H_2Se\quad H_2Te}_{VWA \propto mol.wt.}$$

B.P. $\rightarrow H_2S < H_2Se < H_2Te < H_2O$

JEE MAIN

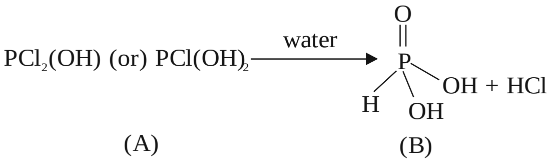
Q.1 (1)

Stability of Covalent compound $\propto$ Bond strength

$$\frac{NF_3\quad NCl_3\quad NBr_3\quad NI_3}{Size\uparrow\quad BL\uparrow\quad Bondstrength\downarrow}$$

Q.2 (2)

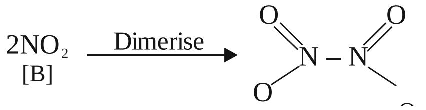
$$PCl_3 + H_2O \xrightarrow[hydrolysis]{Partial} \underset{(A)}{PCl_2(OH)\,(or)\,PCl(OH)_2} + HCl$$



no. of ionizable protons in B = 2

Q.3 (1)

$$\underset{[A]}{Pb(NO_3)_2} \xrightarrow{673K} NO_2 + PbO + O_2$$



Q.4 (2)

NCl_5 is not known because nitrogen doesn't have d-orbitals in valency shell.

Q.5 (1)

$P_4 + \text{Alkali} \rightarrow H_3PO_4$
(white)

Q.6 (1)

M.P. of H_2O is higher than other hydrides due to intermolecular H.B. and m.p increases down the group due to increasing vwf.

Q.7 (4)

Explanation : As we know that non metallic character decrease down the group, the acidic character decreases down the group.

Q.8 (2)

$Ba(N_3)_2 \xrightarrow{\Delta} Ba + 3N_2$

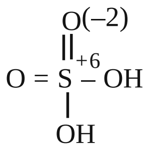
Q.9 (2)

$NH_4CL + NaNO_2 \rightarrow NaCl + N_2\uparrow + 2H_2O$

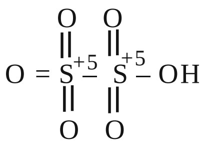
Q.10 (1)

Flourine forms only one oxoacid known as Hypofluorous acid (HOF) because of smaller in size & highly electronegative.

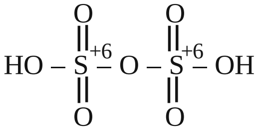
Q. 11 (1)



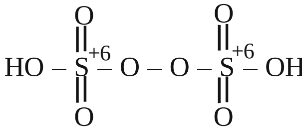
$H_2S_2O_3$



$H_2S_2O_6$



$H_2S_2O_7$

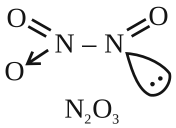


$H_2S_2O_8$

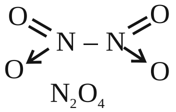
Q. 12 (3)

$N\equiv\overset{+}{N}-O^-$

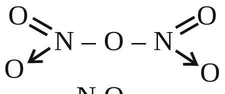
N_2O



N_2O_3

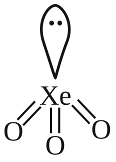


N_2O_4

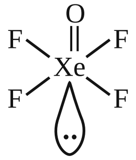


N_2O_5

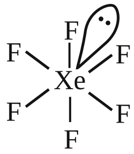
Q.13 [3]



lp on C.A. = 1



lp on C.A. = 1



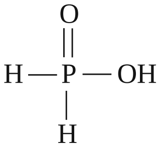
lp on C.A. = 1

Total lp = 1 + 1 + 1 = 3

Q.14 (2)

When Alkali react with white phosphorous, then hypo phosphorous acid or phosphinic acid is formed.

Formula→ H_3PO_2

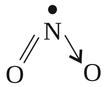


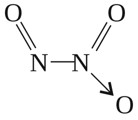
Hence option (2) is correct

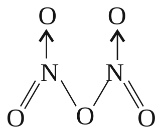
Q.15 (4)

Q. 16 (2)

$N\equiv N\rightarrow O$







Q.17 (B)

$NO_3^- + \underset{\text{Conc.}}{H_2SO_4} \rightarrow \underset{\text{Brown fumes}}{NO_2}$

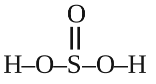
$NO_3^- + 5H_2 + FeO_4 \xrightarrow{\text{Conc.}H_2SO_4} \underset{(\text{Brown Ring})}{[Fe(H_2O)_5\,NO]SO_4}$

Q. 18 (2)

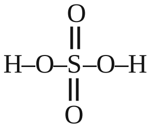
More stable and common oxidation state of lanthanoids is + 3

$\underset{(\text{O.A.})}{Ce\,(IV)} + e^- \rightarrow Ce\,(III)$

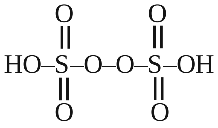
Q.19 (1)



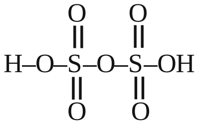
$$H-O-\overset{\overset{O}{\|}}{S}-O-H$$ (H_2SO_3)



$$H-O-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-O-H$$ (H_2SO_4)



$$HO-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-O-O-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-OH$$ ($H_2S_2O_8$)



$$H-O-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-O-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-OH$$ ($H_2S_2O_7$)

Q.20 (3)

(1) $4NH_3 + 5O_2 \xrightarrow{pt} 4NO + 6H_2O$

(2) $N_2(g) + 3H_2(s) \xrightarrow{Fe} 2NH_3(g)$

(3) $C_{12}H_{22}O_{11}(aq) + H_2O(l) \xrightarrow{H_2SO_4}$
$C_6H_{12}O_6$(Glucose) + $C_6H_{12}O_6$ fructose

(4) $2SO_2(g) + O_2(g) \xrightarrow{NO} 2SO_3$

Q.21 [4]

If total electron = even $\Rightarrow$ diamagnetic except {10, 16, 32}
If total electron = odd = paramagnetic

Na_2O	KO_2	NO_2	N_2O	CO_2	NO	SO_2	Cl_2O
$\Downarrow$ O^{-2} $\Downarrow$ 10^{e^-}	$\Downarrow$				$\Downarrow$ (odd)		
para	para	para	dia	dia	para	dia	dia

Q.22 [2]

Diagmagnetic species are N_2, O_2^{-2}

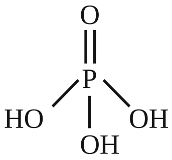
Q.23 (2)

$Br_2 + 5F_2 \longrightarrow 2BrF_5$
excess

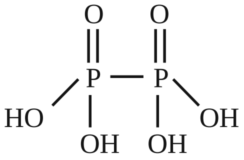
$Br_2F_5 + 3H_2O \longrightarrow HBrO_3 + 5HF$

Q.24 (4)

Which oxo acid of phosphorous has the highest number of oxygen atoms present in its chemical formula
Phosphoric acid
H_3PO_4

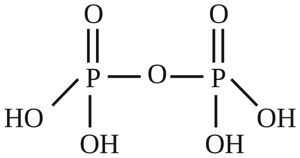


Hypo phosphoric acid
$H_2P_2O_6$



2(Phosphoric acid) – H_2O_2
$\Rightarrow$ Hypophosphoric acid

Pyrophosphoric acid
$H_4P_2O_7$

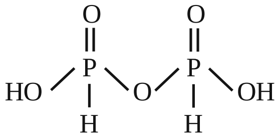


$2(H_3PO_4) - H_2O \Rightarrow H_4P_2O_7$
2(Phosphoric acid – H_2O)
$\Rightarrow$ Pyro phosphoric acid

Phosphoric acid –O $\Rightarrow$ Phosphorous acid
$H_3PO_4 - O \Rightarrow H_3PO_3$
$2(H_3PO_3) - H_2O \Rightarrow H_6P_2O_6 - H_2O \Rightarrow H_4P_2O_5$
So, pyrophosphoric acid has maximum number of oxygen

Q.25 [2]

$C_2H_5OH + PCl_3 \rightarrow C_2H_5Cl + H_3PO_3$
$H_3PO_3 + PCl_3 \rightarrow H_4P_2O_5 + HCl$



Q.26 (3)

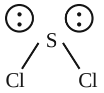
Square pyramidal structures are
BrF_5, IF_5 and CIF_5

Q.27 (3)

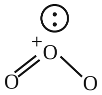
(A) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + H_2O$
(B) $KMnO_4 + HCl \rightarrow Cl_2\uparrow + KCl + MnCl_2 + H_2O$
(C) $Al + NaOH + H_2O \rightarrow Na[Al(OH)_4] + H_2\uparrow$

(D) $NaNO_3 \xrightarrow{\Delta} NaNO_2 + O_2\uparrow$

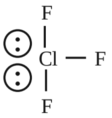
Q.28 (2)



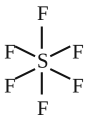
no. of l.p = 2



no. of l.p = 1



no. of l.p = 2



no. of l.p = 0

Correct option is '(2)'

Q.29 (3)

$I_2 + 10HNO_3 \rightarrow 2HIO_3 + 10NO_2 + H_2O$

So on melting entropy increases and ΔG become more negative so metal ion get easily reduced.

Q.30 (2)

$P4 + 8SO_2Cl_2 \rightarrow 4PCl_3 + 4SO_2 + 2S_2Cl_2$

The d and f-block Elements

EXERCISE-I (MHT CET LEVEL)

Q.1 (4)
In K_2CrO_4, oxidation state of Cr is +6, so higher the oxidation state, less is the ionic radii.

Q.2 (1)
Litharge $\rightarrow$ Oxide of Lead (PbO)
Oxidation state of Pb = +2

Q.3 (4)
It is mercury, because mercury exists as liquid at room temperature.

Q.4 (3)
Ag belongs to second (4d) transition series remaining all are in Ist transition series.

Q.5 (3)
Ac(89) = [Rn] [$6d^1$] [$7s^2$]

Q.6 (3)
Due to lanthanide contraction, the size of Zr and Hf (atom and ions) becomes nearly similar.

Q.7 (4)
P (At no. 15) has electronic configuration $1s^2$, $2s^2$ p^6, $3s^2$ p^3, hence no electron in d-subshell.

Q.8 . (4)
Most of the transition metal compounds (ionic as well as covalent) are coloured both in the solid state and in acqueous solution in contrast to the compounds of s and p-block elements due to the presence of incomplete d- subshell.

Q.9 (4)
Cobalt (60) isotope is used in the treatment of cancer.

Q.10 (1)
40 elements are present in d-block.

Q.11 (1)
Paramagnetic property depends upon the number of unpaired e^- and Mn^{2+} has highest no. of unpaired electron.

Q.12 (2)
Q.13 (3)
Q.14 (3)
Q.15 (4)
Q.16 (3)
Q.17 **(1)**
Q.18 **(3)**
Q.19 **(1)**
Q. 20 **(1)**
Q.21 **(1)**
Q.22 **(2)**
Q.23 **(4)**
Q.24 **(3)**
Q.25 **(1)**

Q.26 (2)
Most of the Ln^{3+} compounds except La^{3+} and Lu^{3+} are coloured due to the presence of f-electrons.

Q.27 **(4)**

Q.28 (2)
Most of the Ln^{3+} compounds except La^{3+} and Lu^{3+} are coloured due to the presence of f-electrons.

Q.29 **(2)**
Q.30 **(1)**

EXERCISE-II (NEET LEVEL)

Q.1 (4)
There are 6 electrons in its ultimate and penultimate shell.

Q.2 (2)

$$\underset{\text{Hot}}{2Cu} + \underset{\text{Steam}}{H_2O} \longrightarrow Cu_2O + H_2\uparrow.$$

Q.3 (1)
Control rods slowdown the motion of neutrons and help in controlling the rate of fission. Cadmium is efficient for this purpose.

Q.4 (2)

Q.5 (4)
Highest oxidation state +7 is shown by Mn and its configuration is
$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$ OR [Ar] $3d^5 4s^2$

Q.6 (2)
From Sc to Cr, no. of unpaired electron increases so metallic bond strength also increases.

Q.7 (3)
Iron (At. no. = 26)
Period = 4
Transition series = 1st (3d series)

Q.8 (1)

$$\left.\begin{array}{ll} Co^{+2} = [Ar]4s^0\,3d^7 & n = 3 \\ Cr^{+3} = [Ar]4s^0\,3d^3 & n = 3 \end{array}\right\} \quad \begin{array}{l} n = \text{No. of unpaired electrons} \\ \mu = \sqrt{15} \end{array}$$

Q.9 (3)
d-block elements; because
(i) Small atomic size

(ii) High nuclear charge
(iii) Presence of vacant d-orbitals.

Q.10 (3)
Cu, because last electron enters d-orbital ($3d^{10} 4s^1$).

Q.11 (2)
Cu due to the presence of vacant d-orbital.

Q.12 (3)
Copper, silver and gold; all the three were used for making coins.

Q.13 (4)
Cu^+ do not have any unpaired electron.

Q.14 (4)
In halogens, F to I, anionic size ↑, ionic character decreases.

Q.15 (2)
They are inert towards many common reagents.

Q.16 (1)
Availability of empty d-orbital to accept lone pair of electrons.

Q.17 (1)
Due to availability of voids (vacant spaces) in their crystal lattice.

Q.18 (4)
Transition elements act as catalyst as they show variable oxidation state.

Q.19 (2)
$Cr_2O_7^{2-} \rightleftharpoons 2CrO_4^{2-}$ (in basic medium)

Q.20 (2)
When CrO_3 dissolved in aq. NaOH gives CrO_4^{-2} (chromate yellow)

Q.21 **(2)**

Q.22 (1)
In $KMnO_4$, Mn is in +7 oxidation state having no unpaired electrons but posses colour due to charge transfer.

Q.23 (1)
Permanganic Acid → $HMnO_4$

Q.24 (2)
Mn is in higher oxidation state of +7 so acidic in nature.

Q.25 (4)
Some of the compounds are coloured due to charge transfer spectrum like $K_2Cr_2O_7$, $KMnO_4$ etc.

Q.26 (3)
At basic pH, dichromate ion change to chromate ion.

Q.27 (2)
General electronic configuration of lanthanides
$(n-2)\,f^{0-14}\,(n-1)\,d^{0-1}\,ns^{1-2}$

Q.28 (3)
As the atomic number increases in lanthanides due to very weak sheilding effect, Zeff increases and radius decreases.

Q.29 (3)
Oxidation state of Mn changes from +7 to +2 in acidic medium i.e. one mole of it accepts 5 mole of electrons.

Q.30 (2)
Ag^+ forms a complex ion with NH_3
$AgCl + 2NH_3 \rightarrow [Ag(NH_3)_2]Cl$

Q.31 **(4)**
Eu(63)=[Xe]$4f^7 6s^2$
Gd(64)=[Xe]$4f^7 5d^1 6s^2$
Tb(65)=[Xe]$4f^9 6s^2$

Q.32 **(1)**

Q.33 (1)
H_2O_2 reduces acidified $KMnO_4$ solution. As a result. The pink colour of $KMnO_4$ is changed.

Q.34 (1)
MnO is ionic due to lower oxidation state.

Q.35 (1)

Q.36 (4)
$\frac{1}{5} \times$ molecular weigth of $KMnO_4$

as transfer of $5e^-$ takes place when $KMnO_4$ acts as oxidant in acidic medium.

$$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5O$$

Q.37 (1)

Q.38 (1)

Q.39 (3)
$Cu + O_2 + CO_2 + H_2O \rightarrow Cu(OH)_2.CuCO_3$

Q.40 (1)

Q.41 (2)
AgBr is used in photography because it is light sensitive.

Q.42 (1)

Q.43 (4)

Q.44 (1)
Due to lanthanide contraction, basic strength from $La(OH)_2$ to $Lu(OH)_2$ decreases.

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (3)
Along the period the atomic radius decreases with the increase in nuclear charge (as atomic number increases), whereas the shielding effect of d-electrons added in inner orbitals is small.

Q.2 (1)
Strong metallic bonds between the atoms of transition elements attribute to their high melting and boiling points. Zinc has all electrons paired ([Ar] $3d^{10}$ $4s^2$) and thus do not participate in metallic bonding. So accordingly its melting point is least.

Q.3 (2)

Q.4 (3)
Energy of ns & (n–1)d have comparable energy so both participates in bonding

Q.5 (2)
The order of shielding effect of various orbital electrons is s > p > d > f. Due to the poor shielding effect of 4f-electrons in 5d-series elements, there is enhanced increase in effective nuclear charge. As a result of this the valence electrons are tightly bound with the nucleus and thus their removal require higher energy.

Q.6 (1)
Os shows + 8 oxidation state in its compound with oxygen i.e., in OsO_4 .

Q.7 (2)
Cr^{3+} is most stable because in aqueous solution it has higher CFSE on account of half filled t^3_{2g} energy level of 3d orbitals in octahedral spliting.

Q.8 (1)
Anode involves oxidation or loss of electron.

Q.9 (4)
(1) Greater the number of valence electrons, stronger is the resultant bonding and thus greater is the enthalpies of atomization.
(2) Cr^+ has half-filled valence shell electron configuration $3d^5$, so it has higher second ionisation energy. Similarly Cu^+ has completely filled stable valence shell electron configuration, $3d^{10}$, so it has higher second ionisation energy.
(3) Sum of first two ionisation energies (IE_1 + IE_2) of Ni(II) is less than that of Pt(II). Similarly sum of first four ionisation energies of Pt(IV) is less than that of Ni(IV).

Q.10 (3)
$3.87 = \sqrt{n(n+2)}$; n = number of unpaired electrons.
So n = 3.

Q.11 (4)
n ; Cr^{2+} $[Ar]^{18}$ $3d^4$; so n = 4 ; Mn^{2+} $[Ar]^{18}$ $3d^5$ so n = 5 ; Fe^{2+} $[Ar]^{18}$ $3d^6$ so n = = 4
n = Number of unpaired electron(s).

Q.12 (3)
$\sqrt{15} = \sqrt{n(n+2)}$; n = 3, and three unpaired electrons are found when Mn is in Mn^{4+} i.e., $3d^3$ $4s^0$ configuration as its metal electron configuration is $[Ar]^{18}$ $3d^5$ $4s^2$.

Q.13 (3)
The colour of the compounds of transition metals may be attributed to the presence of incomplete (n – 1) d-sub-shell. Under the influence of approaching ions towards the central metal ion, the d-orbitals of the central metal split into different energy levels. This phenomenon is called **crystal field splitting**. In the case of the transition metal ions, the electron can be easily promoted from one energy level to another in the same d-sub-shell. These are called **d-d transitions**. The amount of energy required to excite some of the electrons to higher energy states within the same d-sub-shell corresponds to energy of certain colours of visible light. Therefore, when white light falls on a transition metal compound, some of its energy corresponding to a certain colour, is absorbed and the electron gets raised from lower energy set of orbitals to higher energy set of orbitals.

Q.14 (1)
Complex pormation α (Zeff = Z $-\sigma$)
tendency

Q.15 (2)
$HgCl_2$ is volatile is reffered as corrosive sublimate.

Q.16 (1)
Mo is used become of its high melting point.

Q.17 (1)
Mn^{2+} acts as autocatalyst

Q.18 (4)
In Ti^{4+}, Cu^{+} and Zn^{2+}, all have electrons paired so all are diamagnetic. Cr^{3+} with electron configuration $[Ar]^{18}\,3d^3$ has three unpaired electrons. So it undergoes d-d transition of electrons in presence of ligands according to CFT and thus it is coloured.

Q.19 (3)
As there is no unpaired electron in Mn(VII) – $[Ar]^{18}\,3d^0$; so d-d transition of electrons does not take place. The colour is due to charge transfer spectrum from O^{2-} to empty d-orbitals of Mn(VII).

Q.20 (3)
$2CrO_4^{2-}$ (yellow) + $2H^+ \longrightarrow Cr_2O_7^{2-}$ (organge) + H_2O.

Q.21 (2)
Mn_2O_7 is an acid anhydride of $HMnO_4$ and thus MnO_4^- is oxo-salt of Mn_2O_7.
$Mn_2O_7 + H_2O \longrightarrow 2HMnO_4$;
$2HMnO_4 + 2KOH \longrightarrow 2KMnO_4 + 2H_2O$.

Q.22 (1)
$KMnO_4$ acts as self indicator.

Q.23 (2)
$MnO_4^- + 2H_2O + 3e^- \longrightarrow MnO_2 + 4OH^-$ (weak alkaline medium).

Q.24 (2)
(1) $2MnO_4^- + 16H^+ + 10Cl^- \longrightarrow 2Mn^{2+} + 8H_2O + 5Cl_2$
(2) Chromyl chloride test ; $Cr_2O_7^{2-} + 4Cl^- + 6H^+ \longrightarrow 2CrO_2Cl_2\uparrow$ (deep red) + $3H_2O$.
(3) $MnO_2 + 4HCl \longrightarrow MnCl_2 + Cl_2 + 2H_2O$
(4) $2Cl^- + F_2 \longrightarrow Cl_2 + 2F^-$

Q.25 (1)
$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \longrightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$.

Q.26 (1)
$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + H_2O + \underset{\text{(green)}}{Cr_2O_3}$

Q.27 (1)
$2KMnO_4 + 3H_2SO_4 \longrightarrow 2KHSO_4 + (MnO_3)_2SO_4 + 2H_2O$
$(MnO_3)_2SO_4 + H_2O \longrightarrow Mn_2O_7 + H_2SO_4$

Q.28 (4)
$4FeSO_4 + 2H_2O + O_2 \longrightarrow 4Fe(OH).SO_4$ (basic ferric sulphate)

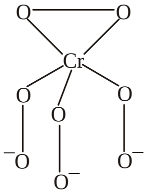
Q.29 (3)
Cold dilute alkaline $KMnO_4$ is Bayer's neagent.

EXERCISE-IV

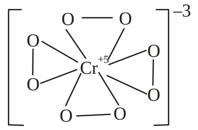
Q.1 5

$3K^+ \; [CrO_8]^{3-}$

CrO_8^{3-}

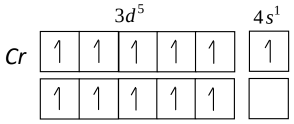


or



$\therefore$ Oxidation state of Cr = +5

Q.2 5



Q.3 3
$3.87 = \sqrt{n(n+2)}$; n = number of unpaired electrons.
So n = 3.

Q.4 5
Oxidation state of Mn changes from +7 to +2 in acidic medium i.e. one mole of it accepts 5 mole of electrons.

Q.5 49
$K_2Cr_2O_7 + 3H_2SO_4 \to K_2SO_4 + Cr_2(SO_4)_3 + 3(O) + 3H_2$
No. of electrons lossed = 12 – 6 = 6
$\therefore$ Equivalent weight = $\frac{M}{6} = \frac{294}{6} = 49$.

Q.6 (2) **Q.7** (4) **Q.8** (2) **Q.9** (2) **Q.10** (1)
Q.11 (1)

PREVIOUS YEAR'S

MHT CET

Q.1 (4)
Q.2 (1)
Q.3 (4)
Q.4 (3)
Q.5 (1)
Q.6 (3)
Q.7 (3)
Q.8 (2)
Q.9 (3)
Q.10 (1)
Q.11 (2)
Q.12 (4)
Q.13 (2)
Q.14 (3)
Q.15 (1)
Q.16 (4)
Q.17 (1)
Q.18 (4)
Q.19 (1)
Q.20 (1)
Q.21 (4)
Q.22 (3)
Q.23 (4)
Q.24 (2)
Q.25 (3)
Q.26 (3)
Q.27 (4)
Q.28 (2)
Q.29 (1)
Q.30 (1)
Q.31 (2)
Q.32 (2)
Q.33 (1)
Q.34 (2)
Q.35 (2)
Q.36 (4)
Q.37 (3)

Last element of lanthanoid series is Lu i.e. leutetium with atomic number 71 ans mass number 175.5 It is a silver white metal which resists corrosion in dry air , but not in moist air.

Q.38 (3)

Mn exhibits the maximum number of oxidation states, Mn(Z = 25) = [Ar]$3d^5 4s^2$. it shows +2, +3, +4, +5, +6 and +7 oxidation states.

Q.39 (4)

In lanthanide series as atomic number increases atomic radius decreases. Therefore Pr having lowest atomic number among the given element is having largest atomic radius.

Q.40 (1)

NEET

Q.1 (3)

Co^{3+} = [Ar] $3d^6$, Unpaired e^-(n) = 4

Spin magnetic moment = $\sqrt{4(4+2)} = \sqrt{24}$ BM

Cr^{3+} = [Ar]$3d^3$, Unpaired e^-(n) = 3

Spin magnetic moment = $\sqrt{3(3+2)} = \sqrt{15}$ BM

Fe^{3+} = [Ar] $3d^5$, Unpaired e^-(n) = = 5

Spin magnetic moment = $\sqrt{5(5+2)} = \sqrt{35}$ BM

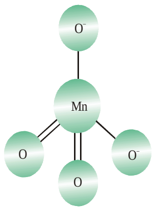
Ni^{2+} = [Ar] $3d^8$, Unpaired e^-(n) = 2

Spin magnetic moment = $\sqrt{2(2+2)} = \sqrt{8}$ BM

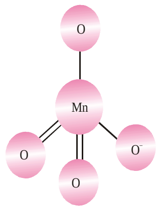
Q.2 (4)

$CrO_4^{2-} \Rightarrow Cr^{6+}$ = [Ar]
Unpaired electron (n) = 0; Diamagnetic
$Cr_2O_7^{2-} \Rightarrow Cr^{6+}$ = [Ar]
Unpaired electron (n) = 0; Diamagnetic
$MnO_4^{2-} = Mn^{6+}$ = [Ar] $3d^1$
Unpaired electron (n) = 1; Paramagnetic
$MnO_4^{-} = Mn^{7+}$ = [Ar]
Unpaired electron (n) = 0; Diamagnetic

Q.3 (1)



Tetrahedral manganate (green)ion



Tetrahedral Permanganate (Purple)ion

Q.4 (4)
Q.5 (1)
Q.6 (3)
Q.7 (1)
Q.8 (1)

$_{64}Gd$ = [Xe] $6s^2\,4f^7\,5d^1$
Gd^{+2} = [Xe] $4f^7\,5d^1$

After losing 5d electron 4f has maximum exchange energy so Gd has value of Third Ionisation energy

JEE MAIN

Q. 1 (1)

$E^o_{m^{3+}/m^{2+}}$ of mn^{3+} is highest in given ions

Q.2 (2)

Except - Hg, d-block metals have higher m.p. than s-block metals.

Q.3 (3)

$$\left\{\frac{V_2O_3V_2O_4V_2O_5}{\text{basic nature}\downarrow}\right\}$$

$V^{3+}(3d) \rightarrow n=2$

$\mu(s)=\sqrt{8}=2.84 \simeq 3$

Q.4 (3)

Q.5 (3)

Electronic configuration of Europium (Eu) is [Kr] $4f^7 6s^2$. It can loose two electron to gain the half filled stable state. Hence, +2 oxidation state is most stable.

Q.6 (3)

$Tb^{4+}: 4f^7 5d^0 b5^0$ & $Yb^{+2} = 4f^{14}$

Q.7 (3)

Copper having highest value of standard electrode potential

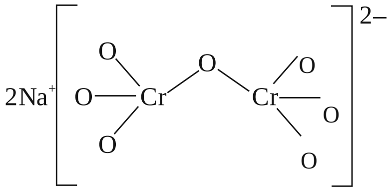
$E^0_{Cu^{+2}/Cu=+0.34\,\text{volt.}}$

Q.8 (6)

$$4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$$

$$2Na_2CrO_4 + 2H^+ \rightarrow 2Na_2Cr_2O_7 + 2Na^+ + H_2O$$

Structure of B is



Q.9 **(1)**

Atomic number of Pt is 78

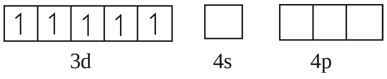
Electronic configuration is –

${}_{78}Pt \rightarrow [Xe]\ 4f^{14} 5d^9 6s^1$

Option (A) is correct.

Q.10 (6)

$[Mn\,Br_6]^{4-}$



n = 5

$\mu=\sqrt{n(n+2)} \qquad =\sqrt{5(5+2)}=\sqrt{35} \qquad = \quad 6$

MB

Q. 11 (1)

$$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$$

Q. 12 (1)

$Ce = [Xe]4f^1 5d^1 6s^2$

$Ce^{3+} = [Xe]4f^1 5d^0$

$Ce^{4+} = [Xe]4f^0 5d^0$ (Noble gas configuration)

Q.13 (2)

$V^{2+} + (3d^3) \rightarrow$ Three unpaired e^-

$Ni^{2+} (3d^8) \rightarrow$ Two unpaired e^-

$Cr^{2+} + (3d^4) \rightarrow$ four unpaired e^-

$Fe^{2+} (3d^6) \rightarrow$ four unpaired e^-

Q.14 [5]

Co^{+3}has more value of SRP so it cannot liberate H_2 from dilute acid solution.

Q.15 [4]

SRP $(E°/V)M^{3+}/M^{2+}$

	Ti	V	Cr	Mn	Fe	Co
$E^\circ_{M^{3+}/M^{2+}}$	–0.37	–0.26	–0.41	1.57	0.77	1.97

$$Cr^{3+}(3d^3) \rightarrow \mu=\sqrt{3(3+2)}=\sqrt{15}=3.89=4$$

Q.16 (1)

$KMnO_4$ act as oxidizing agent. It oxidises oxalic acid to CO_2 and itself changes to Mn^{2+} Ion which is colourless

$KMnO_4 \rightarrow\ Mn^{2+}$

$\downarrow \qquad \downarrow$

(+7) (+2)

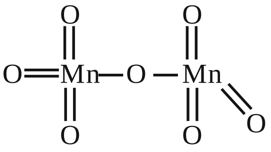
Change in oxidation no. = 5

Q.17 [2]

Fact

Q.18 (3)

Mn_2O_4



Mn = O ⇒ 6 bonds

Q.19 (2)

$$Cr_2O_7^{2-} + I^- \xrightarrow{H^+} Cr^{3+} + I_2$$

$$KMnO_4^- + I^- \xrightarrow{H^+} Mn^{2+} + I_2$$

But Fe^{3+} can not oxidise I^- to I_2 because $E^\circ_{(Fe^{3+}/Fe^{2+})}$ is lower than that of $E^\circ_{(I^-/I_2)}$

Statement-I is false

Statement-II magnate ion is paramagnetic but it consists of $d\pi$-$p\pi$ bonding

Q.20 (1)

(I) O_2, Cu^{2+} and Fe^{+3} are peramagnetic substance weakly attracted by magnetic field (Correct)

(II) H_2O and NaCl are diamagnetic substance are weakly oppose by magnetic field

[Correct Option (1)]

Q.21 [5]

The change from Mn^{2+} to Mn^{3+} results in the half-Filled (d5) configuration which has extra stability.

$MnF_3 \rightarrow$ most oxising agent

$Mn^{+3} \rightarrow 3d^4$

$$\mu = \sqrt{n(n+2)} = \sqrt{4\times 6} = \sqrt{24} = 5$$

Q.22 **[2]**

Fehling solutions is a complex of Cu^{++}

$Cu^{++} = 3d^9$

No. of unpaired e^- =1

$$\text{M.M.} = \sqrt{1(1+2)} = \sqrt{3} = 1.73\,\text{BM}$$

Q.23 **(1)**

When metal has low oxidation state it has more density in d orbital

So, it has more tendency to back donate electrons, thus compound thuse compound must have good π acceptor ligand.

Q.24 (1)

The transition metal whose either all d orbitals are completely filled or vacant in either neutral or ionic state is colorless or in other words.

→ that transition metal will show colour which has at least one unpaired electron

${}_{21}Sc \rightarrow$ $[Ar]3d^1 4s^2$; $Sc^{3+} \rightarrow [Ar]3d^0 45^0$
${}_{30}Zn \rightarrow$ $[Ar]3d^{10} 4s^2$; $Zn^{3+} \rightarrow [Ar]3d^{10} 45^0$
${}_{22}Ti \rightarrow$ $[Ar]3d^2 4s^2$; $Ti^{4+} \rightarrow [Ar]3d^0 45^0$
${}_{23}V \rightarrow$ $[Ar]3d^3 4s^2$; $V^{2+} \rightarrow [Ar]3d^3$
${}_{29}Cu \rightarrow$ $[Ar]3d^{10} 4s^1$; $Cu^{2+} \rightarrow [Ar]3d^9 45^0$
${}_{25}Mn \rightarrow$ $[Ar]3d^5 4s^2$; $Mn^{2+} \rightarrow [Ar]3d^5 45^0$

The colourless ions are : –Sc^{3+}, Zn^{2+}

So, the correct option is 'A'

Q.25 (1,4)

$Sm^{+2} \rightarrow 60e^-$ $Er^{+3} \Rightarrow 65e^-$	$yb^{+2} \rightarrow 68e^-$ $Lu^{+3} \rightarrow 68e^-$
$Eu^{+2} = 61e^-$ $Tb^{+4} = 61e^-$	$Tb^{+2} = 63e^-$ $Tm^{+4} = 65e^-$

Q.26 (2)

→ Generally hydration energy increases with increase in charge

→ and decreases with increase in radius

→ d block elements also follow similar trend with some exceptions

Ions

hydration enthalpy

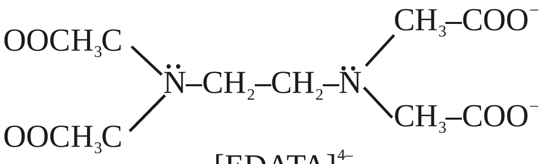
Cr^{2+} = –1925 KJ/mol
Mn^{2+} = –1862 KJ/mol
Fe^{2+} = –1998 KJ/mol
Co^{2+} = –2079 KJ/mol

Option (2)

Coordination Compounds

EXERCISE-I (MHT CET LEVEL)

Q.1 (4)



$[EDATA]^{4-}$

It can act as hexadentate ligand as it has six donar atoms (2 nitrogen atoms and 4 oxygen atom).

Q.2 (1)

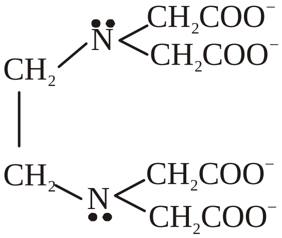
$$NH_3 + H^+(acidic\ medium) \rightarrow NH^+{}_4$$

Q.3 (1)
$CoCl_3.5NH_3.H_20$ is red in colour

Q.4 (3)
Complex compounds contains two different metallic elements but give test only for one of them. Because complex ions such as

$[Fe(CN)_6]^{4-}$ of $K_4[Fe(CN)_6]$, do not dissociate into Fe^{2+} and Cn^- ions.

Q.5 (1)
EDTA is hexadentate ligand



Q.6 (3)
Q.7 (1)
Q.8 (3)
Q.9 (3)
Q.10 (4)
Q.11 (3)

Q.12 (4)

Q.13 (3)
Q.14 **(1)**

Q.15 **(4)**

Q.16 (1)
The hypothetical complex chlorodiaquatriammine cobalt (III) chloride can be represented as $[Co(NH_3)_3(H_2O)_2Cl]$

Q.17 (3)

Q.18 (2)
Q.19 (1)
Q.20 (2)

Q.21 (1)

Q.22 **(1)**

Q.23 (3)
Q.24 (4)

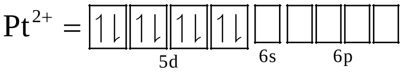
Q.25 (4)

Q.26 (1)
Q.27 **(4)**

Q.28 (1)

$\left[PtCl_4\right]^{2-}$ has square planar geometry.

Pt : $5d^96s^1$



Two electrons are removed from 5d shell and 6s shell, So, hybridisation takes place is dsp^2 i.e. square planar geometry.

Q.29 (3)
A more basic ligand forms stable bond with metal ion, CN^- is most basic amongst all.

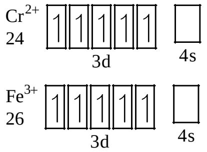
Q.30 **(2)**

Ion.	Mn^{2+}	Cu^{2+}	Fe^{2+}	Ni^{2+}
BC	$3d^5$	$3d^9$	$3d^5$	$3d^8$
Number oof Unapaired electrin	5	1	4	2

Hence lowest paramagnetism is shown by $CuSO_4 \cdot 5H_2O$

Q.31 (2)

$$\left[Cr\left(H_2O\right)_6\right]^{2+} \text{ Cr is in } Cr^{2+} \text{ form}$$



$$\text{In}\left[Fe\left(H_2O\right)\right]^{2+} Fe^{2+}$$ form. Both will have 4 unpaired electrons.

Q.32 (4)
Fe^{2+} electronic configuration is [Ar] $3d^6$ Since CNis strong field ligand d electrons are paired. In $Ni(CO)_4$ O. S. of Ni is zero electronic configuration is [Ar}$3d^8$ $4s^2$. In presence of CO it is [Ar] $3d^{10}$ $4s^0$, electrons aare paired. Electronic configuration of Ni^{2+} [Ar]$3d^8$ $4s^0$, due to CN^- ligand all electrons are paired. CO^{3+} is [Ar]$3d^6$ since F is weak lignd hence paranagnetic.

Q.33 (4)
Hybridisation :

$$\underset{d^2sp^3}{[Fe(CN)_6]^{4-}},\ \underset{d^2sp^3}{[Mn(CN)_6]^{4-}}$$

$$\underset{d^2sp^3}{[Co(NH_3)_6]^{3+}},\ \underset{sp^3d^2}{[Ni(NH_3)_6]^{2+}}$$

Hence $[Ni(NH_3)_6]^{2+}$ is outer orbital complex.

Q.34 (3)
Among these ligands, 'F' is a weak field ligand, makes only high spin complexes which has sp^3d^2 hybridization.

Q.35 (3) Be is the only group 2 element that does not form a stable complex with $[EDTA]^{4-}$. Mg^{2+} and Ca^{2+} have the greatest tendency to form complexes with $[EDTA]^{4-}$.

Q.36 (3)

Q.37 **(a,b)**

Q.38 **(3)**
Q.39 **(4)**

Q.40 **(1)**

Q.41 **(2)**

Q.42 **(3)**

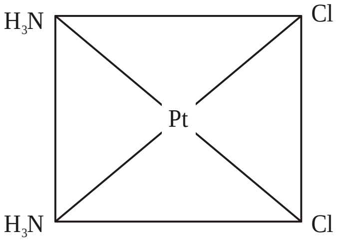
Q.43 (2)
Cobalt is present in vitamin B_{12}

Q.44 (1)
Fe^{3+} ion can be detected by $K_4[Fe(CN)_6]$

$$4Fe^{3+} + 3K_4[Fe(CN)_6] \rightarrow Fe_4\left[Fe(CN)_6\right]_3 + 12K^+$$

Q.45 **(1)**
As positive charge on the central metal atom increases, the less readily the metal can donate electron density into the π^* orbials of CO ligand (donation of electron density into π^* orbitals of CO result in weakening of C – O bond). Hence, the C – O bond would be strongest in $[Mn(CO)_6]^+$.

Q.46 (4)
Q.47 (2)
Q.48 (1)
The structural formula of cis-platin is



Since no carbon is involved it is not a organometallic compound.

EXERCISE-II (NEET LEVEL)

Q.1 (4)
Pyridine is monodestate ligand, so it is not chelating ligand.

Q.2 (4)
$K_4[Fe(CN)_6]$ Complex salt

Q.3 (1)

Q.4 (2)
$CN^- \longrightarrow$ Stranges ligant
The strength $\propto$ K (stability constant)

Q.5 (2)
The complexes can be written as follows

$$\underset{(A)}{[Co(NH_3)_6]Cl_3}\quad \underset{(B)}{[Co(NH_3)_5Cl]Cl_2}\quad \underset{(C)}{[Co(NH_3)_4Cl_2]Cl}$$

Hence, number of primary valencies are 3, 2 and 1 respectively.

Q.6 (3)
Ligand must have capacity to donate lone pair of electrons to form co-ordinate bond.

Q.7 (2)
$K_3[Fe(CN)_6]$ because in it CN^- donats a lone pair of electron.

Q.8 (2)
Al has 6 co-ordination number.

Q.9 (2)
Negative ligands end in $-O$ eg. SO_4^{2-} (sulphato).

Q.10 (2)
Ligand in complex compound generally electron pair donor because ligand contain lone pair and ligand may be neutral, positively charge or negatively charge species.

Q.11 (4)
Ligand has common donor atom usually Nitrogen & Oxygen

Q.12 (4)
$(CH_3CH_2)_3Al + TiCl_4$ is the Ziegler-Natta catalyst.

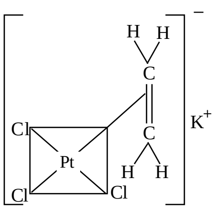
Q.13 (4)
Alum acts as coagulating agent.

Q.14 (2)
C_2H_5Li is an organo-metallic compound.

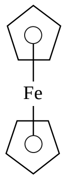
Q.15 (3)
Organometallic compounds are those compounds in which carbon atom is directly linked to metal. But in sodium ethoxide as oxygen is attached to sodium metal so it is not a organometallic compound.

Q.16 (3)
Ziegler Nata catalyst is $[Al_2(C_2H_6)_6] + TiCl_4$ and it is used in high density polythene

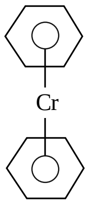
Q.17 (1)



Zeise's salt



Ferrocene



Dibenzene chromium

$(C_2H_5)_4Sn$
Tetraethyl tin

Q.18 (3)
$x + 5 \times 0 - 1 - 3 = 0$
$x = +4$

Q.19 (1)
$x + (-2) \times 2 + 0 \times 2 = -1$
$x = +4 - 1 = +3$
and C.N. = 6
$\Rightarrow$ $C_2O_4^{2} \rightarrow$ Bidentate
$H_2O \rightarrow$ Monodentate

Q.20 (1)
$[Co(NH_3)_5Cl]\,Cl_2 \rightarrow$ Two Ionisible Cl^-

Q.21 (3)
$Co(NH_3)_5NO_2Cl_2$ → Produce 3 ions
$[\ ]\ \ XY \xrightarrow{AgNO_3}$
2AgCl
$[Co(NH_3)_5NO_2]Cl_2$ $\Rightarrow X = Cl^-$
$Y = Cl^-$

Q.22 (4)
In $[Fe(CO)_5]$, Fe has zero oxidation state because all transition elements which are ligate through CO is found in zero oxidation state.

Q.23 (3)
In $[Ni(CO)_4]$
Ni is ligate through carbonyl group and M-CO bond metal is in always zero oxidation state.

Q.24 (1)
$[Co(NCS)(NH_3)_5]Cl_2$
Pentaammine (thiocyanato-N) cobalt (III) chloride.

Q.25 (2)
Zeise's salt is common name of $K[Pt\,Cl_3(\eta^2 = C_2H_4)]$

Q.26 (3)
$[Pt(NH_3)_3(Br)(NO_2)Cl]Cl$

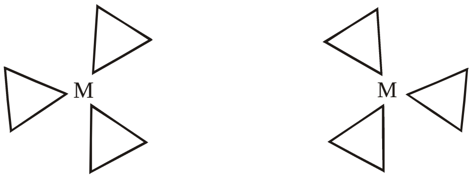
Triamminebromidochloridonitroplatinum (IV) chloride.

Q.27 (1) Follow IUPAC rule.

Q.28 (3) Follow IUPAC rule.

Q.29 (2) In the given ion $[Cr(NH_3)_6]^{3+}$, the oxidation state of chromium is +3 and here 6 NH_3 ligand are attached to the central metal atom. Therefore its IUPAC name is hexamminechromium (III) ion.

Q.30 (1)
$[Co(en)_3]^{3+} \rightarrow [M(AA)_3]$



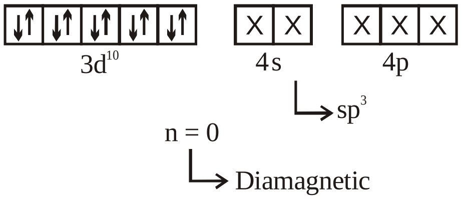
$\Rightarrow$ Optically active but no. G.I.

Q.31 **(3)**

Q.32 (4)
These complex are example of hydrate isomerism it is due to these are exchange the water molecule in their coordination entity.

Q.33 (2) In $[Ag(NH_3)_2]Cl$, Ag^+ contains d^{10} configuration. All others contain unpaired electrons.

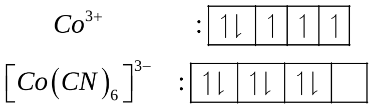
Q.34 (3)
$[ZnBr_4]^{2-} \rightarrow Zn^{2+} \Rightarrow 3d^{10}\,4s^0$



Q.35 (3)
Number of unpaired electrons in central atom
$[Fe(CN)_6]^{4-}$, $[CoCl_4]^{2-}$, $[MnCl_4]^{2-}$
Zero three five

Q.36 (2)

Q.37 (1)

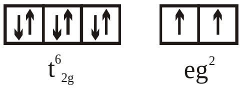


CN– is a strong field ligand and it cause pairing of electrons; as a result number of unpaired electrons in Co^{3+} becomes zero and hence it has lowest value of paramagnetic behaviour.

Q.38 (1)

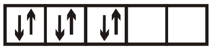
Q.39 **(1)**

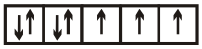
Q.40 (1)

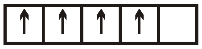


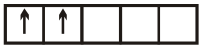
$\mu = \sqrt{2 \times 4} = 2.83\,\text{B.M.}$

Q.41 (3)
$\mu = \sqrt{n(n+2)}$

d^6 SFL

$\Rightarrow n = 0$

d^7 high spin

$\Rightarrow n = 3$

d^4 weak field

$\Rightarrow n = 4\ n\uparrow \Rightarrow \mu\uparrow$

d^2 S.F.

$\Rightarrow n = 2$

Q.42 (1)
$\Delta_0 \Rightarrow CN^- \longrightarrow$ Strongest field Ligand.

Q.43 (4)
$[PtCl_4]^{2-} \rightarrow dsp^2 \Rightarrow$ square planer.

Q.44 (1)
$[MnO_4]^- \rightarrow Mn^{7+} \rightarrow 3d^{10}45^o$

Q.45 (1)
$[Fe(CN_6)]^{3-}$ has d^2sp^3 hybridisation
it is due to cyanide is a strong field ligand and it forms a low spin complex or spin paired complex.

Q.46 (4)

Q.47 (3)
$B_{12} \rightarrow Co$
Haemoglobin $\rightarrow$ Fe
Chlorophyll $\rightarrow$ Mg

EXERCISE-III (JEE MAIN LEVEL)

Q.1 **(2)**

$\ddot{N}H_2 - CH_2 - CH_2 - \ddot{N}H_2$. It contains two donor atoms i.e. nitrogen. So it is a bidentate ligand.

Q.2 **(1)**

$Fe(CN)_2 + 4KCN \longrightarrow Fe(CN)_2.4\,KCN \rightleftharpoons 4K^+ + [Fe(CN)_6]^{4-}$

It gives test of K^+ but does not give test of Fe^{2+}. These type of salts which do not lose their identity when dissolved in water are called complexes.

Q.3 **(2)**

All ligands are Lewis bases as they donate lone pair of electrons to the metal ion to form coordinate covalent bonds.

Q.4 **(2)**

(1) Let x be the oxidation state of Mo in $[Mo_2O_4(C_2H_4)_2(H_2O)_2]^{2-}$. So $2x - 8 = -2$ or $x = +3$.

Q.5 **(4)**

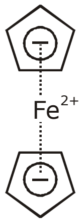
Ca^{2+} & Mg^{2+} ions forms complex with Na_2H_2EDTA.

Q.6 Formula of ferrocene is :

(1) $[Fe(CN)_6]^{4-}$
(2) $Fe_4[Fe(CN)_6]_3$
(3) $[Fe(CO)_5]$
(4) $[Fe(C_5H_5)_2]$

Ans. **(4)**

Sol.



Q.7 **(2)**

$Al(C_2H_5)_3$	σ - complex
$Fe(C_5H_5)_2$	π - complex
$Zn(C_2H_5)_2$	σ - complex
$[Ni(CO)_4]$	σ - complex

Q.8 **(2)**

$[Fe(CO)_5]$ TBP
CO is strong field ligand
Fe - $3d^6 4s^2$

Pairing

↑↓ ↑ ↑ ↑ ↑ ↑↓ _ _ _
4s 4p
↑↓ ↑↓ ↑↓ ↑ ↑ ↑↓ _ _ _
4s 4p
↑↓ ↑↓ ↑↓ ↑↓ _ _ _ _ _ _
dsp^3 hybridisation

Q.9 **(4)**

$[Cu^{2+}(NH_3)_4]^{2+}$ $Cu^{2+} = d^9$
NH_3 is strong field ligand electration

excitation
↑↓ ↑↓ ↑↓ ↑↓ ↑
_ _ _ _ 3d
4s 4p
↑↓ ↑↓ ↑↓ ↑ _
_ _ _ ↑

_ _ _ _

dsp^2 hybrid
1 unpaired electron

$\mu = \sqrt{1(1+2)} = \sqrt{3} = 1.73$ B.M.

Q.10 **(1)**

Consider werner's theroy

Q.11 **(2)**

$K_2[PtCl_6]$; Platinum is in + 4 oxidation state. Atomic number of Pt = 78.
So EAN Pt(IV) = 78 – 4 + 12 = 86

Q.12 **(2)**

$PtCl_4.2KCl \equiv K_2[PtCl_6] \xrightleftharpoons{aq.} 2K^+ + [PtCl_6]^{2-}$.

So, it has three ions per formula unit. The Cl^- is present in coordination sphere so it will not give white precipitate with silver nitrate solution. So in the compound the coordination number of platinum is 6.

Q.13 **(3)**

$K_2[Ni^{2+}(CN)_4]$	$EAN = 28 - 2 + 4 \times 2 = 34$
$[Cu^{2+}(NH_3)_4]SO_4$	$EAN = 29 - 2 + 8 = 35$
$K_2[Pt^{4+}Cl_6]$	$EAN = 78 - 4 + 6 \times 2 = 86$

Q.14 **(4)**

$[Cu(NH_3)_4]SO_4$	$EAN = 35$
$K_3[Fe(CN)_6]$	$EAN = 35$
$K_4[Fe^{2+}(CN)_6]$	$EAN = 36$
$[Co^{3+}(NH_3)_6]Cl_3$	$EAN = 36$
$K_3[Cr^{3+}(C_2O_4)_3]$	$EAN = 33$
$Cr^{3+}(NH_3)_6]Cl(NO_2)_2$	$EAN = 33$

Q.15 **(3)**

$A \rightarrow K_4[Fe(CN)_6]$ EAN = 36
$B \rightarrow [Co(NH_3)_6]Cl_3$ EAN = 36
$C \rightarrow [Cu(NH_3)_4]SO_4$ EAN = 35
$D \rightarrow K_3[CoCl_2(C_2O_4)_2]$ EAN = 36

Q.16 **(4)**

Assuming complex follows EAN rule
EAN of Co = 27 + 4 × 2 + x = 36
x = 1
EAN of Fe = 26 – 2 + 2x + 6 = 36
x = 3

Q.17 **(2)**

It O.N. of CO = x
NH^{2-}

OH^-
$2x + 0 \times 4 + (-2) + (-1) = +3$
en = charge less
x = + 3

Q.18 **(1)**

$[Cr(NH_3)_5C\ell]\ so_4$ will form
$BaSO_4$ (white ppt) on treatment with $BaCl_2$.

Q.19 **(2)**

Q.20 **(3)**

O. N. of Al = +3
O. N. of B = + 3
$[BF_4]^-$
$[Al(C_2O_3)_3]^{3-}$

Q.21 **(1)**

Correct name is dichloridodimethylglyoximatecobalt (II)

Q.22 **(3)**

$Co(NO_2)_3 + 3KNO_2 \longrightarrow K_3[Co(NO_2)_6] \underset{}{\overset{aq.}{\rightleftharpoons}} 3K^+ +$
$[Co(NO_2)_6]^{3-}$ (total six electric charge)
3 : 1
electrolyte.

Q.23 **(2)**

O. N of Br = x $\Rightarrow +2 + 2x - 8 = 0$
$\Rightarrow x = +3$

Q.24 **(3)**

Q.25 **(2)**

Let the O. N. of Fe = x $\Rightarrow 4 + x + (-1) \times 5 + (-1) = 0 \Rightarrow x = +2$

Q.26 **(3)**

$[PtBrCl\ NH_3\ Py]$ Pt^{2+} is dsp^2 hybridised & hence geometry is square planner & sq. planner complex with four different ligands shows geometrical isomerism.

Q.27 **(3)**

$[Cu^{2+}(NH_3)_4]$	$[PtCl_4]$
$[Cu(NH_3)_3Cl]^+$	$[PtCl_3NH_3]^-$
$[Cu(NH_3)_2Cl_2]^0$]	$[PtCl_2(NH_3)_2]^0$ [it is not
$[Cu(NH_3)Cl_3]^-$	$[PtCl(NH_3)_3]^+$
$[CuCl_4]^{2-}$	$[Pt(NH_3)_4]^{2+}$

Total four

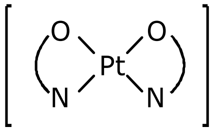
Q.28 **(2)**

NO_2^- is an ambidentate ligand and thus it can linkage to metal ion through O as well as through N. Hence show linkage isomerism.

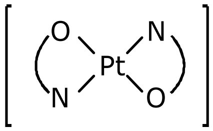
Q.29 **(4)**

Geometrical isomerism arises in heteroleptic complexes due to different possible geometric arrangements of the ligands. Geometrical isomerism is common among coordination compounds with coordination numbers 4 having square planar geometry and 6 having octahedral geometry.

Q.30 **(4)**

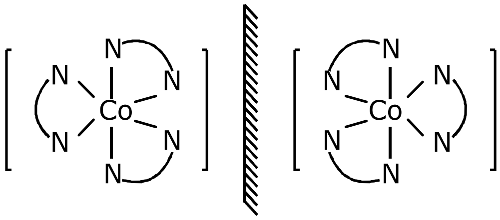


cis



Trans

Q.31 **(1)**



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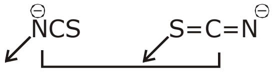
Q.32 **(4)**



Ambident ligand

Since both cation & anion constitute coordination sphere so it exhibit coordination isomerism and contains ambident ligand so, it shows linkage isomerism.

Q.33 **(4)**

$[Ag^{+}F_4]^{-}$ sp^3 sp^3
T.H.
$[Hg^{2+}T_4]^{2-}$ sp^3
T.H.
$[Ni^{2+}Cl_4]^{2-}$ sp^3
T.H.(weak field ligand)
$[Ni(CN)_4]^{2-}$ dsp^2
Square planer

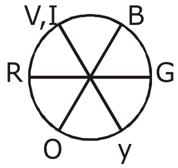
Q.34 **(2)**

Order of strength of lighand en > H_2O > Br

$\therefore$ Order of Δ_0 is $\Delta_{en} > \Delta_{H_2O} > \Delta_{Br}$

$$\Delta = \frac{hc}{\lambda_{absorbed}}$$

Using munsheel wheel the ralation between absorbed wavelength & colour peresived by observer is



Q.35 **(1)**

H_2O is weak field ligand

Fe^{2+} $3d^6$

↑ ↓ ↑ ↑ ↑ ↑ _   _ _ _   _ _ _ _ _

3d 4s 4p 4d

4 unpaired electron

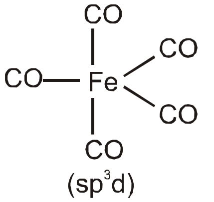
_ _ _ _ _ _

sp^3d^2

Q.36 **(1)**

exception

Q.37 **(3)**



Trigonalbipyramidal ;

being symmetrical molecule $\mu = 0$.

As it is symmetrical molecule, therefore, its dipole moment (μ) is zero.

Q.38 **(4)**

In d^6, 'low spin' octahedral complex all electron will be paired because of higher CFSE.

Q.39 **(3)**

(3) Mn^{2+}, $3d^5$ configuration has 5 unpaired electrons.

In (4) Fe^{2+} ($3d^6$) has no unpaired electrons because of strong field ligand (CN^-), all electrons are paired.

In (1) and (2) Cu^{2+}($3d^9$) has one unpaired electron.

Q.40 **(3)**

$[Fe^0(CO)_5]^0$

Co is strong field ligand

Fe $3d^8$

Refer. Q.28

EXERCISE-IV

Q.1 2

Q.2 **+3**

$2x + 4 \times (-2) = -2$

$2x = 6$

$x = +3$

Q.3 6

Al has 6 co-ordination number.

Q.4 4

$x + 5 \times 0 - 1 - 3 = 0$

$x = +4$

Q.5 **35**

EAN = 26 + 1 + 8 = 35.

gy- çHkkoh ijek.kq Øekad (EAN) = 26 + 1 + 8 = 35.

Q.6 **2**

$$[Co(H_2O)_6]Cl_2 \rightleftharpoons [Co(H_2O)_6]^+ + 2Cl^-.$$

Q.7 36

EAN =Atomic number – Oxidation state + 2 × number of Ligands = $26 - 2 + 2\,(6) = 36$.

Q.8 **34**

EAN = (atomic no)- (oxidation state) + (2 × number of Ligands) = $28 - 2 + 2 \times 4 = 34$

Q.9 **35**

EAN of a central metal ion=(atomic no. of central atom) – oxidation state + no. of ligands × 2

$= 26 - 3 + (6 \times 2) = 23 + 12 = 35$

Q.10 **–2**

$[Ni(CN)_4]^x$, $(Ni = +2)$ $(CN = -1)$

$x = 2 + 4(-1) \Rightarrow x = -2$.

Q.11 (4) **Q.12** (4) **Q.13** (1) **Q.14** (3)
Q.15 (2) **Q.16** (1)

PREVIOUS YEAR'S

MHT

Q.1 (1)

Q.2 (2)

Q.3 (1)

Q.4 (3)

Q.5 (1)

Q.6 (1)

Q.7 (4)

Q.8 (2)

Q.9 (2)

Q.10 (3)

Q.11 (1)

Q.12 (3)

Q.13 (3)

Q.14 (2)

Q.15 (3)

Q.16 (2)

Q.17 (1)

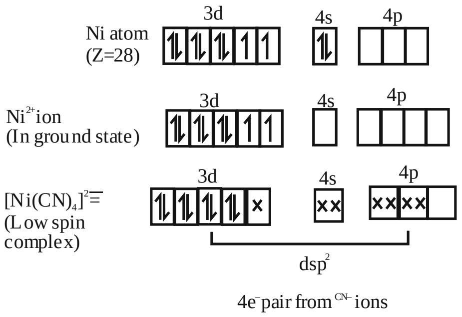
Q.18 (2)

Q.19 (4)

Q.20 (1)
The IUPAC name of the corrdination compound $[Co(H_2O)_2(NH_3)_4]Cl_3$ is tetraamminediaquacobalt (III) chloride.

Q.21 (1)
The IUPAC name of the complex ion $[Cr(NH_3)_4Cl_2]^+$ is teraaminedichloridochromium (III) ion

Q.22 (4)
$[Ni(CN)_4]^{2-}$ is diamagentic not paramangetic Ni atom (Z= 28) (ground sate) = [Ar] $3d^8$, $4S^2$, $4P^0$



CN⁻ is a strong field ligand due to which pairing of electron takes place.

Q.23 (3)

Q.24 (2)

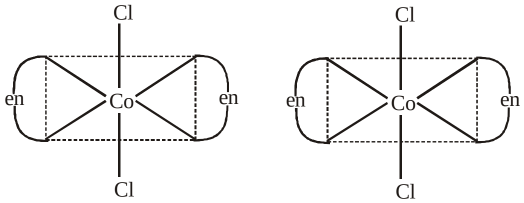
Q.25 (2)

Q.26 (4)

NEET

Q.1 (2)
Based on the number of metal atoms present in a complex, they are classified into mononuclear, dinuclear, trinuclear and so on.
eg: $Fe(CO)_5$: mononuclear
$Co_2(CO)_8$: dinuclear
$Fe_3(CO)_{12}$: trinuclear
Hence, option (2) should be the right

Q.2 (3)
In $[CoCl_2(en)]$, Coordination number of Co is 6 and this compound has octahedral geometry.

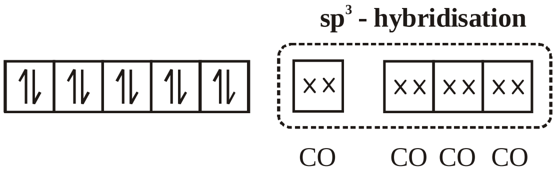


Trans-form (optically inactive)

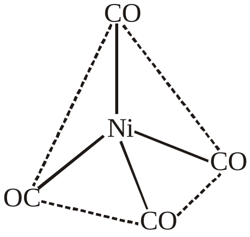
cis-form (optically active)

As per given option, type of isomerism is geometrical isomerism

Q.3 (2)
Ni(28) : [Ar] $3d^8 4s^2$
$\therefore$ CO is a strong field ligand.
Configuration would be :

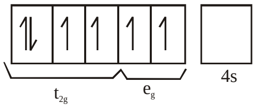


For, four 'CO'-ligands hybridisation would be sp^3 and thus the complex would be diamagnetic and of tetrahedral geometry.



Q.4 (4)
$[SiCl_6]^{2-}$ is not stable due to steric hinderence develop by large size Cl atom on small size Si atom

Q.5 (2)
$K_4[Fe(CN)_6]$
$4(+1) + \times + 6(-1) = 0$
$x = +2$



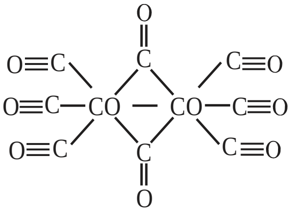
$Fe^{2+} = [Ar]3d^6 4s^0$

Q.6 (1)
Q.7 (4)
Q.8 (3)
Q.9 (4)
Q.10 (2)
(A) $[Ni(H_2O)_2(en)_2]^{2+}$
(B) $[Ni(H_2O)_4(en)]^{2+}$
(C) $[Ni(en)_3]^{2+}$
en is SFL (strong field ligand)
As the number of en (strong ligand) increase splitting also increases.
So, Δ_0 increases.
i.e. maximum energy will be absorbed in case of opton C.
So the order is C > A > B

Q.11 (3)
IUPAC
$[Ag(H_2O)_2][Ag(CN)_2]$
Coordination number = 2,
Oxidation state = Ag^{+1}
Diaquasilver (I) dicyanidoargenate (I)

JEE MAIN

Q.1 (7)



Q. 2 [766]
[1021]

$$\left[Cu\left(CH_2O\right)_6\right]^{2+} \rightarrow Cu^{2+}\left(3d^9\right) \rightarrow t_{2g}^6 e_g^3$$

$$CFSE = \left(6\times\frac{2}{5} - 3\times\frac{3}{5}\right)\Delta_0$$

$$= \frac{3}{5}\times\frac{hc}{\lambda}$$

$$= \frac{3}{5}\times\frac{6.63\times10^{-34}\times3.08\times10^{8}}{600\times10^{-9}}$$

$$= \frac{3\times6.63\times3.08}{6}\times10^{-19}$$

$= 10.21 \times 10^{-19}$
$= 10.21 \times 10^{-2} \times 10^{2} \times 10^{-19}$
$= 1021 \times 10^{-21}$

Q.3 (3)
AgCl +
$NH_4OH \rightarrow [Ag(NH_3)_2Cl]$
White ppt excess
soluble complex

Q.4 (2)
$K_3(Fe(CN)_6)$ due to high spin splitting absorbs light at shortest wavelength
$Fe^{3+}(3d^5) \rightarrow CN^-$ is strong field ligand.
$t_{2g}^5 e_g^0 \rightarrow n = 1$
$\mu = \sqrt{3}$

= 1.73 MB

= 2

Q.5 (4)
(1) $[Cr(H_2O)_6]^{3+} \rightarrow Cr^{3+}(3d^3) \rightarrow t_{2g}^3$

$$CFSE = 3\times\frac{2}{5}\Delta_0$$

(2) $[Mo(H_2O)_6]^{3+} \rightarrow Mo^{3+}(4d^3) \rightarrow t_{2g}^3$

$$\text{CFSE} = 3 \times \frac{2}{5}\Delta_0^{'}$$

$$[Cr(H_2O)_6]^{3+}_{\Delta_0} < [Mo(H_2O)_6]^{3+}_{\Delta_0^{'}}$$

$\Delta_0 < \Delta_0^{'}$ due to higher Z_{eff} value of Mo^{3+} than Cr^{3+}

(3) $[Fe(H_2O)_6]^{3+} \rightarrow Fe^{3+}(3d^5) \rightarrow t_{2g}^3 e_g^2$

$$\text{CFSE} = 3 \times \frac{2}{5}\Delta_0 - 2 \times \frac{3}{5}\Delta_0$$

(4) $[Os(H_2O)_6]^{3+} \rightarrow Os^{3+}(5d^5) = t_{2g}^5 e_g^0$

$$\text{CFSE} = 5 \times \frac{2}{5}\Delta_0^{'} \quad = 2\Delta_0^{'}$$

Q.6 (3)

$PtCl_4.2HCl$

Or

$H_2(PtCl_6) + \underset{\text{Excess}}{AgNO_3} \rightarrow$ No ppt

$CoCl_3.4NH_3$

Or

$\underset{\text{One mole}}{(Co(NH_3)_4Cl_2)Cl} + \underset{\text{Excess}}{AgNO_3} \rightarrow \underset{\text{one moles}}{AgCl}$

$NiCl_2.6H_2O$

$$\left(Ni\left(H_2O\right)_6\right)Cl_2 + \underset{\text{Excess}}{AgNO_3} \rightarrow \underset{\text{Two moles}}{2AgCl}$$

Ni $3d^8$ t_2g^6 eg^2

unpaired e^- (n) = 2

Q.7 (6)

$[Co(H_2O)_6]^{2+} + NH_3(\text{excess}) \rightarrow [Co(NH_3)_6]^{3+} + 6H_2O$

Diamagnetic

↓

Low sping complex

$Co^{3+} \Rightarrow 3d^6 4s^0 \qquad \Rightarrow t_{2g}^6 e_g^0$

Q.8 (C)

Q.9 **(3)**

$[Cr(CO)_6]$, $[Mn(CO)_5]$ and $[Mn_2(CO)_{10}]$ would show synergic bond (Back-bonding).

Q.10 **(B)**

Both statement I and Statement II is true.

Explanation : In $[Ni(CN)_4]^{2-}$, there is Ni^{2+} ion for which the electronic configuration of valence shell is $3d^8 4s^0$. The empty 3d, 3s and two up orbitals undergo dsp^2 hybridization.

Q.11 **(B)**

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

$[FeF_6]^{3-}$

Fe; $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

Fe^+; $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

$3d^5$

W.F.L

1	1	1	1	1

n = 5 $\mu = \sqrt{5(5+2)} = \sqrt{35}$ B.M.

$[Fe(CN)_6]^{3-}$ $\qquad$ Fe^{+3} & S.F.LSo, n = 1

$\mu = \sqrt{1(1+2)} = \sqrt{3}$ B.M.

$[Mn(Cl)_6]^{3-}$ $\qquad$ Mn^{+3} ; $3d^4$ W.F.L n = 4

$\mu = \sqrt{4(4+2)} = \sqrt{24}$ B.M.

$[Mn(CN)_6]^{3-}$ $\qquad$ S.F.L; n = 2

$\mu = \sqrt{2(2+2)} = \sqrt{8}$ B.M.

Q. 12 (1)

(a) $CoCl_3 \cdot 4NH_3 = [Co(NH_3)_4Cl_2]Cl$

Can exhibit G.I.

(b) $CoCl_3 \cdot 5NH_3 = [Co(NH_3)_5Cl_2]Cl_2$

Can't exhibit G.I.

(c) $CoCl_3 \cdot 6NH_3 = [Co(NH_3)]Cl_3$

Can't exhibit G.I.

(d) $CoCl(NO_3)_2 \cdot 5NH_3 = [Co(NH_3)_5Cl](NO_3)_2$

OR = $[Co(NH_3)_5(NO_3)]Cl(NO_3)$

Both can't exhibit G.I.

Q. 13 (2)

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

$[Fe(CN)_6]^{3-}$ Paramagnetic (1 unpaired electron)

$[Ti\ (CN)_6]^{3-}$ Paramagnetic (1 unpaired electron)

$[Ni(CN)_4]^{2-}$ Diamagnetic

$[Co(CN)_6]^{3-}$ Diamagnetic

Q.14 (5)

$CoCl_3.XNH_3 + AgNO_3\,(aq) \rightarrow 2AgCl\downarrow$

$[Co(NH_3)_5Cl]Cl_2$

X = 5

Q.15 **(A)**

$CuSO_4.5H_2O$

$[Cu(H_2O)_5(SO_4)]$

x + 0 - 2 = 0

x = +2

Cu^{+2} is coordinated by H_2O and SO_4

Both statement I and statement II are correct.

Q.16 [0]

$[Co(CN)_6]^{3-}$ absorbes light with shortest wave length bacause CN^- is SFL so more spiliting takes place and t2g and eg orbital have more energy diffence.

Q.17 (1)

Absorption energy $\propto \Delta_0 \propto$ strength of ligand

Strength of ligand $\rightarrow H_2O < NH_3 < en$

Q.18 [0]

$[Co(H_2O)_6]Cl_2 \rightarrow t_2g^5eg^2$

$\mu = \sqrt{3(3+2)} = \sqrt{15} = 3.87$

$[Cr(H_2O)_6]Cl_3 \rightarrow t_2g^3eg^2$

$\mu = \sqrt{3(3+2)} = \sqrt{15} = 3.87$

Q.19 [1]

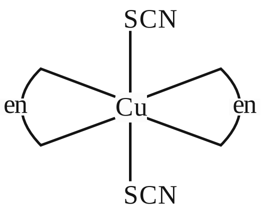
$[Co(NH_3)_4Cl_2]Cl$

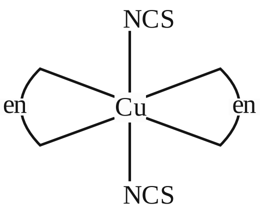
Primary valency = oxidation no. = +3

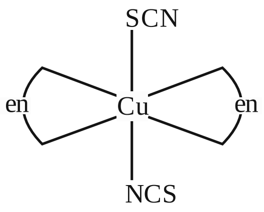
Q.20 (1)

Coordination **Magnetic** **Compound** **Behaviour**	**O.S.**
(1) $K_3[Cu(CN)_4]$ dia	Cu^{+1}
(2) $K_2[Cu(CN)_4]$ Para	Cu^{+2}
(3) $K_3[Fe(CN)_4]$ Para	Fe^{+1}
(4) $K_4[FeCl_6]$ Para	Fe^{+2}

Q.21 (3)







Q.22 (2)

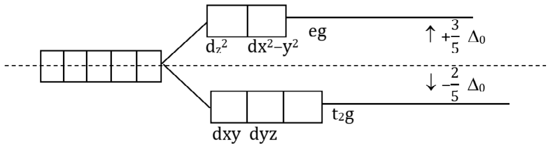
$[Fe(CN)_3]^{3-}$

$\Downarrow$

$\boxed{\text{C.N.} = 6}$ → as in question it is mentioned inner d complex

Means Hybridization is d^2sp^3 (octahedral)

Splitting of octahedral complex



→ as ligand approaches long the axis in octahedral complex; so the orbitals who are along the axis will get repulsion

→ Hence along the axis orbitals i.e. dz^2 & $dx^2 - y^2$ get more energy.

Now, O.N. of Fe here is

$[Fe(CN)_6]^{3-} \qquad \Rightarrow -3 - \{-1 \times 6\}$

$\Rightarrow +3$

Fe $\qquad \Rightarrow [Ar]3d^64s^2$

$Fe^{+3} \qquad \Rightarrow [Ar]3d^54s^0$

⇒ as here S.F.L. so hunds rule will not followed here,

So, $\Delta_0 >$ P.E.

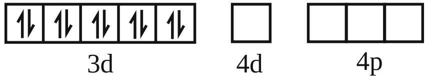
⇒ Hence t_2g will first filled

Q.23 (2)

(1) $Ni(CO)_4$

CO → SFL → Pairing

${}_{28}Ni \rightarrow [Ar]4s^23d^8$

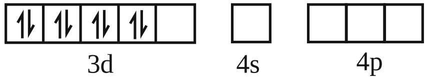


Sp^3 Hybridisation

(2) $[Ni(CN)_4]^{-2}$

CN → SFL → Pairing

${}_{28}Ni^{+2} \rightarrow [Ar]\ 4s^03d^8$

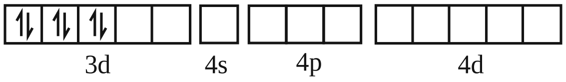


dsp^3 Hybridisation

(3) $[Co(CN)_6]^{-3}$

CN → SFL → Pairing

${}_{27}Co^{+3} \rightarrow [Ar]4s^03d^6$

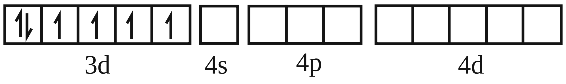


d^2sp^3 hybridisation

(4) $[CoF_6]^{-3}$

F → WFL → Pairing not possible

${}_{27}Co^{+3} \rightarrow [Ar]4s^03d^6$



sp^3d^2 hybridisation

A-I, B-IV, C-III, D-II

Q.24 (9)

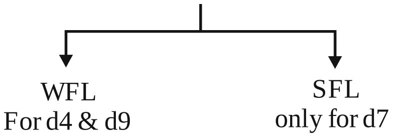
Coordination no. = 6

Oxidation state = 3

6 + 3 = 9

Q.25 (1)

Jahn-Teller distortion is seen in octahedral complex

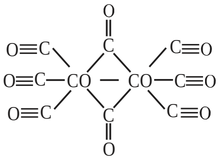


→ Now if we see above, in all option we have cu^{2+}→ which means it has d9

→ So that compound which contains W.F.L will show more distortion

Option (1)

Q.1 **(7)**



Q. 2 [745]

[1021]

$$\left[Cu\left(CH_2O\right)_6\right]^{2+} \rightarrow Cu^{2+}\left(3d^9\right) \rightarrow t_{2g}^6 e_g^3$$

$$CFSE = \left(6\times\frac{2}{5} - 3\times\frac{3}{5}\right)\Delta_0$$

$$= \frac{3}{5}\times\frac{hc}{\lambda}$$

$$= \frac{3}{5}\times\frac{6.63\times10^{-34}\times3.08\times10^{8}}{600\times10^{-9}}$$

$$= \frac{3\times6.63\times3.08}{6}\times10^{-19}$$

$= 10.21 \times 10^{-19}$

$= 10.21 \times 10^{-2} \times 10^{2} \times 10^{-19} = 1021 \times 10^{-21}$

Q.3 (3)

Sol. (3)

AgCl +

$NH_4OH \rightarrow [Ag(NH_3)_2Cl]$

White ppt excess

soluble complex

Q.4 (2)

$K_3(Fe(CN)_6)$ due to high spin splitting absorbs light at shortest wavelength

Fe^{3+} $(3d^5)$ → CN^- is strong field ligand.

$$t_{2g}^5 e_g^0 \rightarrow n = 1$$

$$\mu = \sqrt{3}$$

$= 1.73$ MB

$= 2$

Q.5 (4)

(1) $[Cr(H_2O)_6]^{3+} \rightarrow Cr^{3+}\,(3d^3) \rightarrow t_{2g}^3$

$$CFSE = 3\times\frac{2}{5}\Delta_0$$

(2) $[Mo(H_2O)_6]^{3+} \rightarrow Mo^{3+}\,(4d^3) \rightarrow t_{2g}^3$

$$CFSE = 3\times\frac{2}{5}\Delta_0^{'}$$

$$[Cr(H_2O)_6]^{3+}_{\Delta_0} < [Mo(H_2O)_6]^{3+}_{\Delta_0^{'}}$$

$\Delta_0 < \Delta_0^{'}$ due to higher Z_{eff} value of Mo^{3+} than Cr^{3+}

(3) $[Fe(H_2O)_6]^{3+} \rightarrow Fe^{3+}(3d^5) \rightarrow t_{2g}^3 e_g^2$

$$CFSE = 3\times\frac{2}{5}\Delta_0 - 2\times\frac{3}{5}\Delta_0$$

(4) $[Os(H_2O)_6]^{3+} \rightarrow Os^{3+}(5d^5) = t_{2g}^5 e_g^0$

$$CFSE = 5\times\frac{2}{5}\Delta_0^{'}$$

$$= 2\Delta_0^{'}$$

Q.6 (3)

$PtCl_4.2HCl$

Or

$H_2(PtCl_6) + AgNO_3 \rightarrow$ No ppt

Excess

$CoCl_3.4NH_3$

Or

$(Co(NH_3)_4Cl_2)Cl + AgNO_3 \rightarrow AgCl$

One mole Excess one moles

$NiCl_2.6H_2O$

$$\left(Ni\left(H_2O\right)_6\right)Cl_2 + \underset{\text{Excess}}{AgNO_3} \rightarrow \underset{\text{Two moles}}{2AgCl}$$

Ni $3d^8$ t_2g^6 eg^2

unpaired e^- (n) = 2

Q.7 (6)

$[Co(H_2O)_6]^{2+} + NH_3(excess) \rightarrow [Co(NH_3)_6]^{3+} + 6H_2O$

Diamagnetic

↓

Low sping complex

$Co^{3+} \Rightarrow 3d^6 4s^0$

$\Rightarrow t_{2g}^6 e_g^0$

Q.8 (3)

Q.9 **(3)**

$[Cr(CO)_6]$, $[Mn(CO)_5]$ and $[Mn_2(CO)_{10}]$ would show synergic bond (Back-bonding).

Q.10 **(B)**

Both statement I and Statement II is true.

Explanation : In $[Ni(CN)_4]^{2-}$, there is Ni^{2+} ion for which the electronic configuration of valence shell is $3d^8 4s^0$. The empty 3d, 3s and two up orbitals undergo dsp^2 hybridization.

Q.11 **(B)**

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

$[FeF_6]^{3-}$

Fe; $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

Fe^+; $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

$3d^5$

W.F.L

1	1	1	1	1

n = 5 $\mu = \sqrt{5(5+2)} = \sqrt{35}$ B.M.

$[Fe(CN)_6]^{3-}$ Fe^{+3} & S.F.LSo, n = 1

$\mu = \sqrt{1(1+2)} = \sqrt{3}$ B.M.

$[Mn(Cl)_6]^{3-}$ Mn^{+3} ; $3d^4$ W.F.L n = 4

$\mu = \sqrt{4(4+2)} = \sqrt{24}$ B.M.

$[Mn(CN)_6]^{3-}$ S.F.L; n = 2

$\mu = \sqrt{2(2+2)} = \sqrt{8}$ B.M.

Q. 12 (1)

(a) $CoCl_3 \cdot 4NH_3 = [Co(NH_3)_4Cl_2]\,Cl$

Can exhibit G.I.

(b) $CoCl_3 \cdot 5NH_3 = [Co(NH_3)_5Cl_2]Cl_2$

Can't exhibit G.I.

(c) $CoCl_3 \cdot 6NH_3 = [Co(NH_3)]Cl_3$

Can't exhibit G.I.

(d) $CoCl(NO_3)_2 \cdot 5NH_3 = [Co(NH_3)_5Cl](NO_3)_2$

OR = $[Co(NH_3)_5(NO_3)]Cl(NO_3)$

Both can't exhibit G.I.

Q. 13 (2)

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

$[Fe(CN)_6]^{3-}$ Paramagnetic (1 unpaired electron)

$[Ti(CN)_6]^{3-}$ Paramagnetic (1 unpaired electron)

$[Ni(CN)_4]^{2-}$ Diamagnetic

$[Co(CN)_6]^{3-}$ Diamagnetic

Q.14 (5)

$CoCl_3.\,XNH_3 + AgNO_3\,(aq) \rightarrow 2AgCl\downarrow$

$[Co(NH_3)_5Cl]\,Cl_2$

X = 5

Q.15 **(A)**

$CuSO_4.5H_2O$

$[Cu(H_2O)_5(SO_4)]$

x + 0 - 2 = 0

x = +2

Cu^{+2} is coordinated by H_2O and SO_4

Both statement I and statement II are correct.

Q.16 [0]

$[Co(CN)_6]^{3-}$ absorbes light with shortest wave length bacause CN^- is SFL so more spiliting takes place and t2g and eg orbital have more energy diffence.

Q.17 (1)

Absorption energy $\propto \Delta_0 \propto$ strength of ligand

Strength of ligand $\rightarrow H_2O < NH_3 <$ en

Q.18 [0]

$[Co(H_2O)_6]Cl_2 \rightarrow t_2g^5eg^2$

$\mu = \sqrt{3(3+2)} = \sqrt{15} = 3.87$

$[Cr(H_2O)_6]Cl_3 \rightarrow t_2g^3eg^2$

$\mu = \sqrt{3(3+2)} = \sqrt{15} = 3.87$

Q.19 [3]

[1]

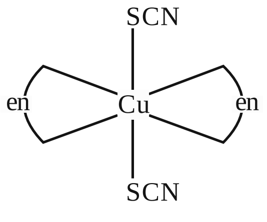
$[Co(NH_3)_4Cl_2]Cl$

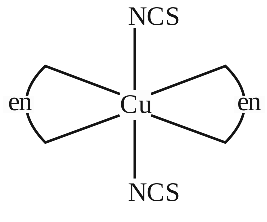
Primary valency = oxidation no. = +3

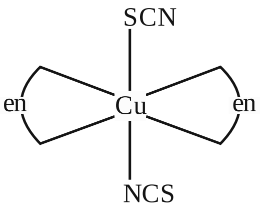
Q.20 (1)

Coordination Magnetic Compound Behaviour	**O.S.**
(1) $K_3[Cu(CN)_4]$ dia	Cu^{+1}
(2) $K_2[Cu(CN)_4]$ Para	Cu^{+2}
(3) $K_3[Fe(CN)_4]$ Para	Fe^{+1}
(4) $K_4[FeCl_6]$ Para	Fe^{+2}

Q.21 (3)







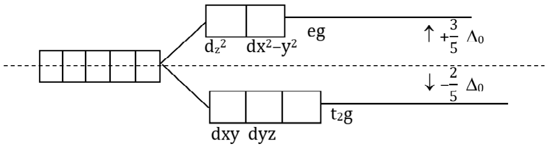
Q.22 (2)

$[Fe(CN)_3]^{3-}$

$\Downarrow$

$\boxed{C.N. = 6}$ → as in question it is mentioned inner d complex

Means Hybridization is d^2sp^3 (octahedral)
Splitting of octahedral complex



→ as ligand approaches long the axis in octahedral complex; so the orbitals who are along the axis will get repulsion

→ Hence along the axis orbitals i.e. dz^2 & $dx^2 - y^2$ get more energy.

Now,O.N. of Fe here is

$[Fe(CN)_6]^{3-}$ $\Rightarrow -3 - \{-1 \times 6\}$

$\Rightarrow +3$

Fe $\Rightarrow [Ar]3d^6 4s^2$

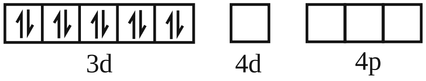
Fe^{+3} $\Rightarrow [Ar]3d^5 4s^0$

⇒ as here S.F.L. so hunds rule will not followed here,
So, $\Delta_0 >$ P.E.

⇒ Hence t_2g will first filled

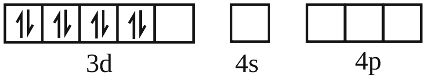
Q.23 (2)

(1) $Ni(CO)_4$
CO → SFL → Pairing
$_{28}Ni \rightarrow [Ar]4s^2 3d^8$



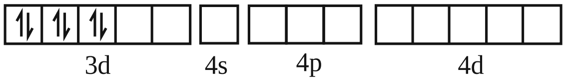
Sp^3 Hybridisation

(2) $[Ni(CN)_4]^{-2}$
CN → SFL → Pairing
$_{28}Ni^{+2} \rightarrow [Ar]\ 4s^0 3d^8$



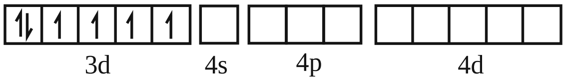
dsp^3 Hybridisation

(3) $[Co(CN)_6]^{-3}$
CN → SFL → Pairing
$_{27}Co^{+3} \rightarrow [Ar]4s^0 3d^6$



d^2sp^3 hybridisation

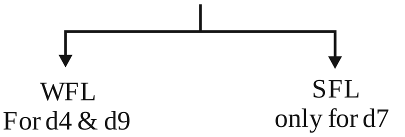
(4) $[CoF_6]^{-3}$
F → WFL → Pairing not possible
$_{27}Co^{+3} \rightarrow [Ar]4s^0 3d^6$



sp^3d^2 hybridisation
A-I, B-IV, C-III, D-II

Q.24 (9)
Coordination no. = 6
Oxidation state = 3
6 + 3 = 9

Q.25 (1)
Jahn-Teller distortion is seen in octahedral complex



→ Now if we see above, in all option we have cu^{2+}→ which means it has d9

→ So that compound which contains W.F.L will show more distortion

Option (1)