**1.** Which one of the following ions exhibits *d*-*d* transition and paramagnetism as well?

(a) $CrO_4^{2-}$ (b) $Cr_2O_7^{2-}$

(c) $MnO_4^-$ (d) $MnO_4^{2-}$ ***(2018)***

$CrO_4^{2-}$ $Cr^{+6}$ $n = 0$

$Cr_2O_7^{2-}$ $Cr^{+6}$ $n = 0$

} diamagnetic

$MnO_4^-$ $Mn^{+7}$ $n = 0$

$MnO_4^{2-}$ $Mn^{+6}$ $n = 1$

} Paramagnetic

**2.** Match the metal ions given in column I with the spin magnetic moments of the ions given in column II and assign the correct code.

| Column I | | Column II | |
|---|---|---|---|
| A. | $Co^{3+}$ $n = 4$ | (i) | $\sqrt{8}$ B.M. |
| B. | $Cr^{3+}$ $n = 3$ | (ii) | $\sqrt{35}$ B.M. |
| C. | $Fe^{3+}$ $n = 5$ | (iii) | $\sqrt{3}$ B.M. |
| D. | $Ni^{2+}$ $n = 2$ | (iv) | $\sqrt{24}$ B.M. |
| | | (v) | $\sqrt{15}$ B.M. |

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

↓,

(BM) Bohr Magneton

| | A | B | C | D |
|---|---|---|---|---|
| (a) | (iv) | (v) | (ii) | (i) |
| (b) | (i) | (ii) | (iii) | (iv) |
| (c) | (iv) | (i) | (ii) | (iii) |
| (d) | (iii) | (v) | (i) | (ii) |

***(2018)***

3. Name the gas that can readily decolourise acidified $KMnO_4$ solution.

(a) $SO_2$ (b) $NO_2$

(c) $P_2O_5$ (d) $CO_2$ *(2017)*

$2KMnO_4 + SO_2 + H_2O \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2SO_4$

(Pink violet) (Colourless)

**9.** Assuming complete ionisation, same moles of which of the following compounds will require the least amount of acidified $KMnO_4$ for complete oxidation?

(a) $FeSO_3$ (b) $FeC_2O_4$

(c) $Fe(NO_2)_2$ (d) $FeSO_4$ ***(2015)***

$MnO_4^- + Fe^{2+} + SO_3^{2-} \rightarrow Fe^{3+} + Mn^{+2} + SO_4^{2-}$

(+4 → +6, ③)

$MnO_4^- + Fe^{2+} + C_2O_4^{2-} \rightarrow Fe^{3+} + CO_2 + Mn^{2+}$

$n : 3$

$MnO_4^- + Fe^{2+} + NO_2^- \rightarrow Fe^{3+} + NO_3^- + Mn^{2+}$

(① +3 → +5, ③)

**12.** The reaction of aqueous $KMnO_4$ with $H_2O_2$ in acidic conditions gives

(a) $Mn^{4+}$ and $O_2$ (b) $Mn^{2+}$ and $O_2$

(c) $Mn^{2+}$ and $O_3$ (d) $Mn^{4+}$ and $MnO_2$.

$$2KMnO_4 + 3H_2SO_4 + 5H_2O_2 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$$

$$2MnO_4^- + 5H_2O_2 + 6H^+ \longrightarrow 2Mn^{2+} + 8H_2O + 5O_2$$

**13.** Magnetic moment 2.83 BM is given by which of the following ions?
(At. nos. Ti = 22, Cr = 24, Mn = 25, Ni = 28)

(a) $Ti^{3+}$ (n = 1) (b) $Ni^{2+}$ (n = 2)

(c) $Cr^{3+}$ (n = 3) (d) $Mn^{2+}$ (n = 5) ***(2014)***

2.83 BM (n = 2)

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

$\mu = 2.83 BM$

**25.** Which of the following ions will exhibit colour in aqueous solutions?

(a) $La^{3+}$ $(Z = 57)$ (b) $Ti^{3+}$ $(Z = 22)$

(c) $Lu^{3+}$ $(Z = 71)$ (d) $Sc^{3+}$ $(Z = 21)$ ***(2010)***

$Ti^{+3}$ $(n = 1)$

31. Copper sulphate dissolves in excess of KCN to give

(a) $Cu(CN)_2$ (b) CuCN

(c) $[Cu(CN)_4]^{3-}$ (d) $[Cu(CN)_4]^{2-}$ **(2006)**

$$\left[CuSO_4 + 2KCN \longrightarrow \underset{\text{Cupric cyanide}}{Cu(CN)_2} + K_2SO_4\right] 2$$

$$2Cu(CN)_2 \longrightarrow \underset{\text{Cuprous cyanide.}}{Cu_2(CN)_2} + (CN)_2$$

$$Cu_2(CN)_2 + 6KCN \longrightarrow 2K_3[Cu(CN)_4]$$

---

$$2CuSO_4 + 10KCN \longrightarrow 2K_3Cu(CN)_4 + 2K_2SO_4 + (CN)_2$$

35. In acidic medium, which of the following becomes colourless?

(a) $MnO_4^-$ (b) $MnO_4^{2-}$

(c) $CrO_4^{2-}$ (d) $FeO_4^{2-}$ **(2018)**

a) Purple ⟶ colourless

b) stable in acidic

c) $CrO_4^{2-}$ (yellow) ⟶ $Cr_2O_7^{2-}$ (orange)

d) $FeO_4^{2-}$ decomposes

38. Among the following, the compound that is both paramagnetic and coloured is

(a) $K_2Cr_2O_7$ (b) $(NH_4)_2[TiCl_6]$

(c) $VOSO_4$ (d) $K_3[Cu(CN)_4]$ ***(2017)***

a) $Cr^{+6}$ $(d^0)$

b) $Ti^{+4}$ $(d^0)$

c) $V^{+4}$ $(d^1)$ ✓

d) $Cu^{+}$ $(d^{10})$

**63.** When $XO_2$ is fused with an alkali metal hydroxide in presence of an oxidizing agent such as $KNO_3$, a dark green product is formed which disproportionates in acidic solution to afford a dark purple solution. $X$ is

(a) Ti (b) Cr

(c) V (d) Mn ***(Online 2018)***

$X$ (Mn) $MnO_2 \xrightarrow[KNO_3]{\text{Metal hydroxide}} K_2{}^{+6}MnO_4$

$MnO_2 + KOH + KNO_3 \longrightarrow K_2MnO_4 + KNO_2.$

$\downarrow$

$MnO_2 + MnO_4^-$

**84.** The correct option(s) to distinguish nitrate salts of $Mn^{2+}$ and $Cu^{2+}$ taken separately is (are)

(a) $Mn^{2+}$ shows the characteristic green colour in the flame test

(b) only $Cu^{2+}$ shows the formation of precipitate by passing $H_2S$ in acidic medium

(c) only $Mn^{2+}$ shows the formation of precipitate by passing $H_2S$ in faintly basic medium

(d) $Cu^{2+}/Cu$ has higher reduction potential than $Mn^{2+}/Mn$ (measured under similar conditions). **(2018)**

b) $Cu^{2+} \xrightarrow[HCl]{H_2S} CuS$ (black ppt)

c) $Cu^{+2}$ & $Mn^{+2} \xrightarrow{H_2S}$ both form ppt

d) $E_{Cu^{+2}/Cu} = 0.34\,V$

$E_{Mn^{+2}/Mn} = -1.18\,V$

$Zn_2[Fe(CN)_6] + NaOH \longrightarrow Na_2[Zn(OH)_4] + Na_4[Fe(CN)_6]$



**90.** For the given aqueous reactions, which of the statement(s) is(are) true?

Excess KI + $K_3[Fe(CN)_6]$ $\xrightarrow[H_2SO_4]{\text{dilute}}$ brownish-yellow solution

$K_4[Fe^{+2}(CN)_6] + I_2$

$\downarrow ZnSO_4$

$I_2 + KI \longrightarrow KI_3$

white precipitate + brownish yellow filtrate

brownish yellow filtrate

$I_3^- \rightleftharpoons I^- + I_2$

(filtrate)

$\downarrow Na_2S_2O_3$

colourless solution

$K_4[Fe(CN)_6] + ZnSO_4 \rightarrow$

(a) The first reaction is a redox reaction.

(b) White precipitate is $Zn_3[Fe(CN)_6]_2$.

$K_2Zn_3[Fe(CN)_6]_2$ white ppt

(c) Addition of filtrate to starch solution gives blue colour.

(d) White precipitate is soluble in NaOH solution.

**(2012)**

$KI_3 + Na_2S_2O_3 \longrightarrow Na_2S_4O_6 + 2NaI + KI$

(colourless)

$Zn_2[Fe(CN)_6]$ $\xrightarrow{\text{soluble in NaOH}}$

**96.** The oxidation number of Mn in the product of alkaline oxidative fusion of $MnO_2$ is *(2009)*

$MnO_2 + KOH + O_2 \longrightarrow K_2\overset{+6}{Mn}O_4 + 2H_2O$

+4

(6) ✓

**100.** $(NH_4)_2Cr_2O_7$ on heating liberates a gas. The same gas will be obtained by

(a) heating $NH_4NO_2$

(b) heating $NH_4NO_3$

(c) treating $H_2O_2$ with $NaO_2$

(d) treating $Mg_3N_2$ with $H_2O$ **(2004)**

$(NH_4)_2Cr_2O_7 \longrightarrow N_2 + Cr_2O_3 + 4H_2O$ (Intra molecular Redox)

(a) $NH_4NO_2 \longrightarrow N_2 + 2H_2O$

(b) $NH_4NO_3 \longrightarrow N_2O + 2H_2O$

(c) $NaO_2 + H_2O_2 \longrightarrow Na_2O_2.$

(d) $Mg_3N_2 \xleftarrow{H_2O} Mg(OH)_2 + NH_3$

52. A student accidentally added conc. $H_2SO_4$ to potassium permanganate and it exploded due to the formation of an explosive which is

(a) MnO
(b) $Mn_2O_3$
(c) $Mn_2O_5$
(d) $Mn_2O_7$

$KMnO_4 + H_2SO_4 \longrightarrow KHSO_4 + (MnO_3)_2SO_4$ (Permanganyl Sulphate)

$(MnO_3)_2SO_4 + H_2O \longrightarrow Mn_2O_7$

$Mn_2O_7 \downarrow$

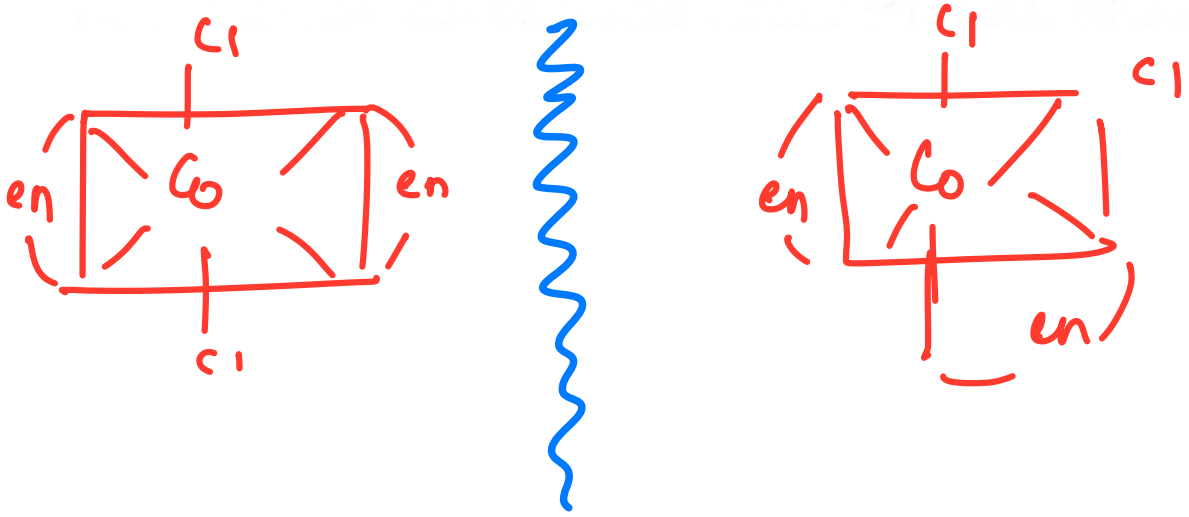
$MnO_2 + O_2$

**1.** The type of isomerism shown by the complex $[CoCl_2(en)_2]$ is

(a) geometrical isomerism (b) coordination isomerism

(c) ionization isomerism (d) linkage isomerism.

***(2018)***



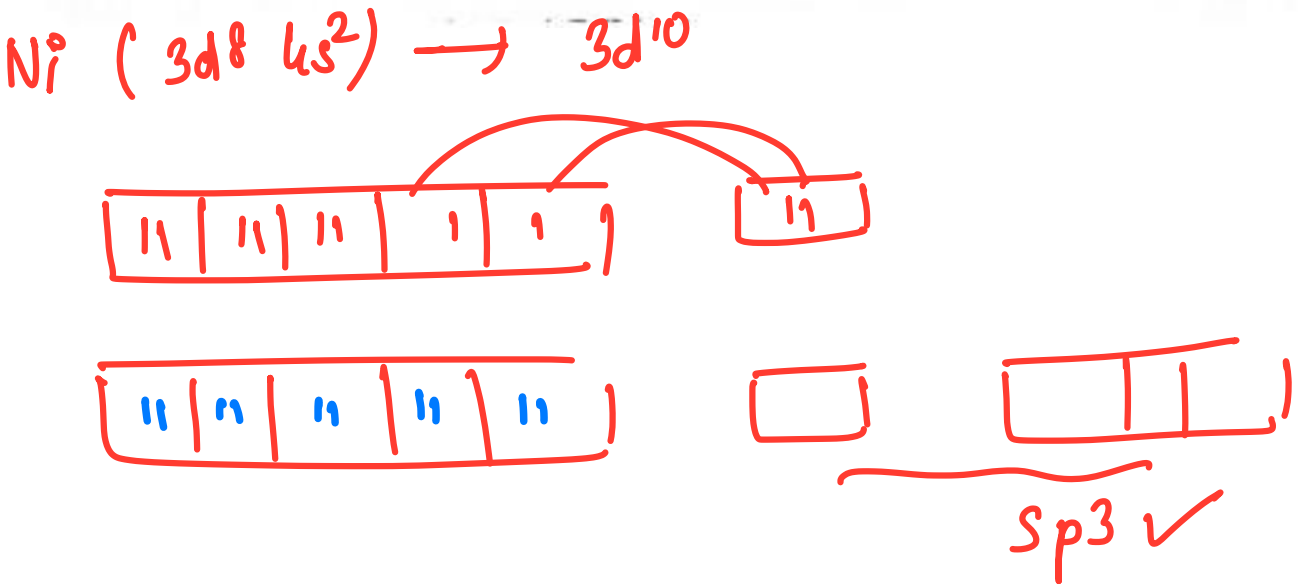
2. The geometry and magnetic behaviour of the complex $[Ni(CO)_4]$ are

(a) square planar geometry and diamagnetic

(b) tetrahedral geometry and diamagnetic

(c) square planar geometry and paramagnetic

(d) tetrahedral geometry and paramagnetic. *(2018)*



3. Iron carbonyl, $Fe(CO)_5$ is

(a) tetranuclear (b) mononuclear

(c) trinuclear (d) dinuclear. *(2018)*

$Co_2(CO)_8$ dinuclear

$Fe_3(CO)_{12}$ trinuclear

5. Correct increasing order for the wavelengths of absorption in the visible region for the complexes of $Co^{3+}$ is

(a) $[Co(H_2O)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$

(b) $[Co(H_2O)_6]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$

(c) $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(H_2O)_6]^{3+}$

(d) $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$ *(2017)*

CFSE $H_2O < NH_3 < en$ $E = \frac{hc}{\lambda}$

8. Which of the following has longest C—O bond length? (Free C—O bond length in CO is 1.128 Å.)

(a) $[Fe(CO)_4]^{2-}$ (b) $[Mn(CO)_6]^{+}$

(c) $Ni(CO)_4$ (d) $[Co(CO)_4]^{-}$

***(2016 Phase-I)***

M — C BO↑

C — O BO↓

C ——— O BL↑

**11.** The sum of coordination number and oxidation number of the metal $M$ in the complex $[M(en)_2(C_2O_4)]Cl$ (where $en$ is ethylenediamine) is

(a) 6 (b) 7 (c) 8 (d) 9 **(2015)**

-1

-2

+3

CN = 6
ON = 3
] = 9

**14.** An excess of $AgNO_3$ is added to 100 mL of a 0.01 M solution of dichlorotetraaqua chromium(III) chloride. The number of moles of AgCl precipitated would be

(a) 0.003 (b) 0.01

(c) 0.001 (d) 0.002 ***(2013)***

$[Cr(H_2O)_4Cl_2]Cl + AgNO_3 \longrightarrow [Cr(H_2O)_4Cl_2]NO_3 + AgCl$ ppt

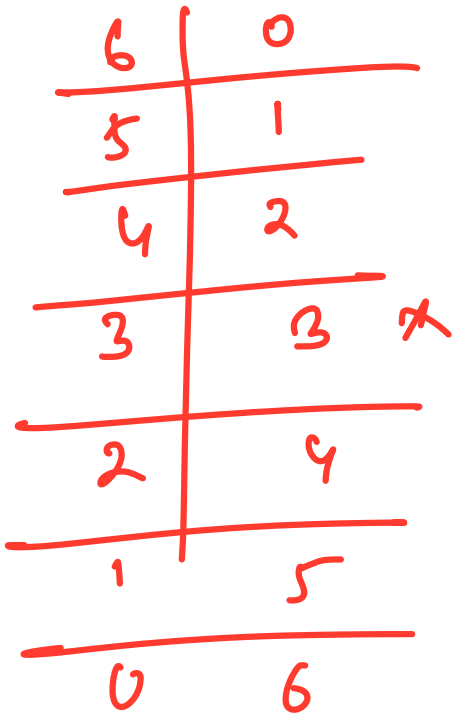
$10^{-3}$ mole

**17.** The complexes $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$ are the examples of which type of isomerism?

(a) Linkage isomerism (b) Ionization isomerism

(c) Coordination isomerism

(d) Geometrical isomerism *(2011)*



**18.** The complex, $[Pt(py)(NH_3)BrCl]$ will have how many geometrical isomers?

(a) 3 (b) 4 (c) 0 (d) 2 ***(2011)***

M $Ma^bc^cd^d$ = 3 ✓

{ AB CD
AC BD
AD BC }

**36.** The wavelength of light absorbed is highest in

(a) $[Co(NH_3)_5Cl]^{2+}$ (b) $[Co(NH_3)_5H_2O]^{3+}$

(c) $[Co(NH_3)_6]^{3+}$ (d) $[Co(en)_3]^{3+}$ *(2011)*

$I^- < Br^- < S^{2-} < SCN^- < Cl^- < N_3^- < F^- \approx$ Urea.

$< OH^- < O^{2-} <$ $H_2O$

47. The oxidation states of Cr in $[Cr(H_2O)_6]Cl_3$, $[Cr(C_6H_6)_2]$ and $K_2[Cr(CN)_2(O)_2(O_2)(NH_3)]$ respectively are

(a) +3, +4 and +6 (b) +3, +2 and +4

(c) +3, 0 and +6 (d) +3, 0 and +4 **(2018)**

0 +3

$2 \times (+1) + x + 2 \times (-1) + 2(-2) + 2(-1) + 0 = 0$

$x = +6.$

**50.** The total number of possible isomers for square planar $[Pt(Cl)(NO_2)(NO_3)(SCN)]^{2-}$ is

(a) 16 (b) 8

(c) 24 (d) 12 *(Online 2018)*

$[Pt(Cl)(NO_2)(NO_3)(NCS)]^{2-}$

$[Pt(Cl)(ONO)(NO_3)(NCS)]^{2-}$

$[Pt(Cl)(ONO)(NO_3)(SCN)]^{2-}$

$[Pt(Cl)(NO_2)(NO_3)(SCN)]^{2-}$

**52.** On treatment of 100 mL of 0.1 M solution of $CoCl_3.6H_2O$ with excess $AgNO_3$, $1.2 \times 10^{22}$ ions are precipitated. The complex is

(a) $[Co(H_2O)_6]Cl_3$

(b) $[Co(H_2O)_5Cl]Cl_2.H_2O$

(c) $[Co(H_2O)_4Cl_2]Cl.2H_2O$

(d) $[Co(H_2O)_3Cl_3].3H_2O$

*(2017)*

$\frac{100 \times 0.1}{1000} = 0.01$

$\frac{1.2 \times 10^{22}}{6.022 \times 10^{23}} = 0.02$

no of $Cl^-$ ions present in ionisation sphere

$= \frac{\text{moles of ions ppt}}{\text{moles of complex}} = \frac{0.02}{0.01} = 2$

**53.** The pair having the same magnetic moment is
[At. No.: Cr = 24, Mn = 25, Fe = 26, Co = 27]

(a) $[Cr(H_2O)_6]^{2+}$ and $[CoCl_4]^{2-}$

(b) $[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$

(c) $[Mn(H_2O)_6]^{2+}$ and $[Cr(H_2O)_6]^{2+}$

(d) $[CoCl_4]^{2-}$ and $[Fe(H_2O)_6]^{2+}$

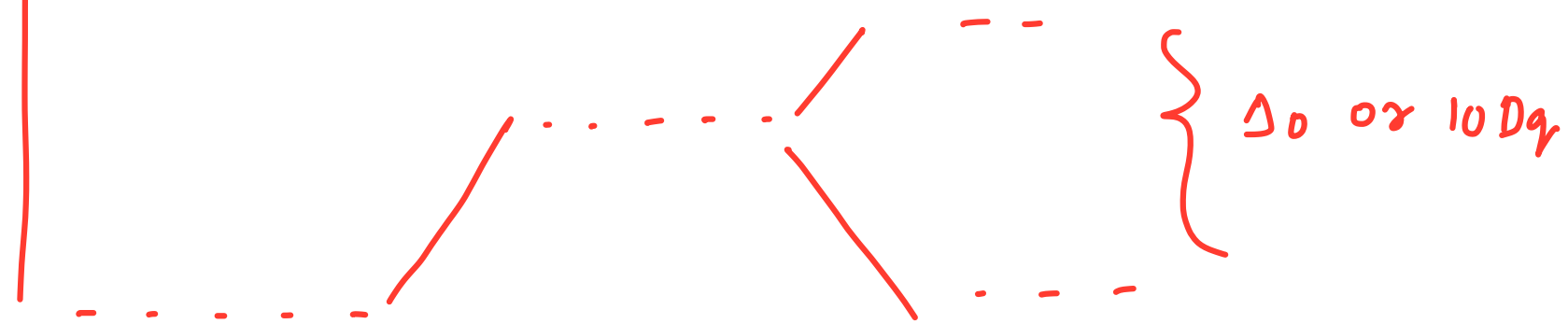
**61.** Which of the following complex ions has electrons that are symmetrically filled in both $t_{2g}$ and $e_g$ orbitals?

(a) $[CoF_6]^{3-}$ (b) $[Co(NH_3)_6]^{2+}$

(c) $[Mn(CN)_6]^{4-}$ (d) $[FeF_6]^{3-}$ ***(Online 2015)***

a) $CoF_6^{3-} \rightarrow t_{2g}^4 e_g^2$ b) $Co^{+2}$ $t_{2g}^6 e_g^1$

c) $Mn^{2+}$ $t_{2g}^5 e_g^0$ d) $Fe^{+3}$ $(3d^5)$ $(t_{2g}^3 e_g^2)$



**73.** The ammonia prepared by treating ammonium sulphate with calcium hydroxide is completely used by $NiCl_2.6H_2O$ to form a stable coordination compound. Assume that both the reactions are 100% complete. If 1584 g of ammonium sulphate and 952 g of $NiCl_2.6H_2O$ are used in the preparation, the combined weight (in grams) of gypsum and the nickel-ammonia coordination compound thus produced is _____.

(Atomic weights in g $mol^{-1}$: H = 1, N = 14, O = 16, S = 32, Cl = 35.5, Ca = 40, Ni = 59) ***(2018)***

**78.** For the octahedral complexes of $Fe^{3+}$ in $SCN^-$ (thiocyanato-S) and in $CN^-$ ligand environments, the difference between the spin-only magnetic moments in Bohr magnetons (when approximated to the nearest integer) is [Atomic number of Fe = 26] ***(2015)***

**88.** As per IUPAC nomenclature, the name of the complex $[Co(H_2O)_4(NH_3)_2]Cl_3$ is

(a) tetraaquadiaminecobalt(III) chloride

(b) tetraaquadiamminecobalt(III) chloride

(c) diaminetetraaquacobalt(III) chloride

(d) diamminetetraaquacobalt(III) chloride. ***(2012)***

**50.** The effective atomic number for $[Rh(H_2O)_6]^{3+}$ (atomic number for Rh is 45) is

(a) 42 (b) 45

(c) 48 (d) 54