AK2 Seminar 5

Zadatak 1.

A: $w(Fe) = 31,05\ \%$.

$Fe(C_2O_4) \cdot 2H_2O$ $\quad w(Fe) = \frac{55,845\ g}{175,861\ g} = 31,7\ \%$.

B: $m(uzorak) = 0,2455\ g$

$c(KMnO_4) = 0,02\ mol\,dm^{-3}$

$V(KMnO_4) = 30\ mL$

$16H^+(aq) + 2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O \quad /\cdot 2$

$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^- \quad /\cdot 5$

$n(C_2O_4^{2-}) = \frac{5}{2} n(MnO_4^-) = \frac{5}{2} \cdot 0,02\ mol\,dm^{-3} \cdot 30 \cdot 10^{-3}\ dm^3 = 1,5 \cdot 10^{-3}\ mol$

$w(C_2O_4^{2-}) = \frac{1,5 \cdot 10^{-3}\ mol \cdot 88,018\ g\,mol^{-1}}{0,2455\ g} = 53,78\ \%$

$V_2(KMnO_4) = 5\ mL$

$8H^+(aq) + 5Fe^{2+}(aq) + MnO_4^-(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

$Fe^{2+} \rightarrow Fe^{3+} + 1e^- \quad /\cdot 5$

$n(Fe^{3+}) = 5\, n(MnO_4^-) = 5 \cdot 0,02\ mol\,dm^{-3} \cdot 5 \cdot 10^{-3}\ dm^3 = 5 \cdot 10^{-4}\ mol$

$w(Fe^{3+}) = \frac{5 \cdot 10^{-4}\ mol \cdot 55,845\ g\,mol^{-1}}{0,2455\ g} = 11,37\ \%$

$w(H_2O) = 11,00\ \%$ $\quad w(K) = 23,85\ \%$.

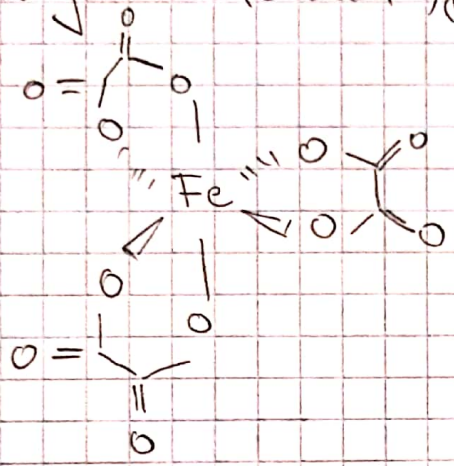
$\frac{23,85\,g}{39,09\,g\,mol^{-1}} : \frac{11,37\,g}{55,845\,g\,mol^{-1}} : \frac{53,78\,g}{88,018\,g\,mol^{-1}} : \frac{11,00\,g}{18,015\,g\,mol^{-1}}$

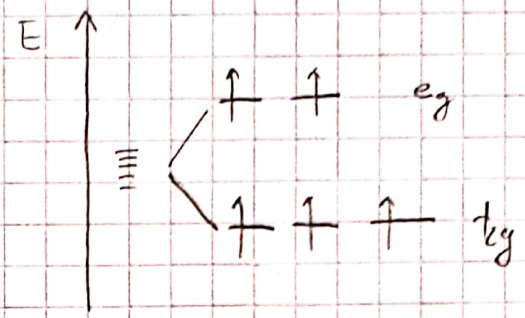
$0,6101\,mol : 0,2036\,mol : 0,6110\,mol : 0,6106\,mol \;/: 0,2036\,mol$

$3 : 1 : 3 : 3$

$K_3[Fe(C_2O_4)_3] \cdot 3H_2O$

kalijev tris(oksalato)ferat(III) trihidrat





Kompleks je paramagnetičan!

Sadržaj kalija se može odrediti gravimetrijski. Kompleks se otopi u razrjeđenoj sumpornoj kiselini te se u otopinu doda natrijev tetrafenilborat pri čemu taloži kalijev tetrafenilborat koji se odfiltrira i suši do konstantne mase i važe.

Zadatak 2.

$a = 1330\ pm$

$b = 1270\ pm$

$c = 844\ pm$

$\beta = 118{,}70°$

$Z = 4$

$\rho = 1{,}875\ g\,cm^{-3}$

$V = abc \cdot \sin\beta = 13{,}30 \cdot 10^{-8}\ cm \cdot 12{,}70 \cdot 10^{-8}\ cm \cdot 8{,}44 \cdot 10^{-8}\ cm \cdot \sin 118{,}70°$

$= 1{,}25 \cdot 10^{-21}\ cm^3$

$M = \frac{V \cdot N_A \cdot \rho}{Z} = 352{,}98\ g\,mol^{-1}$

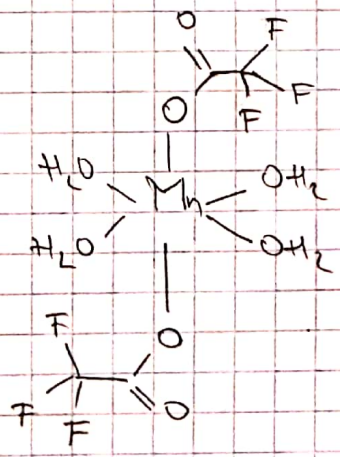
$- 54{,}938\ g\,mol^{-1} \rightarrow Mn$

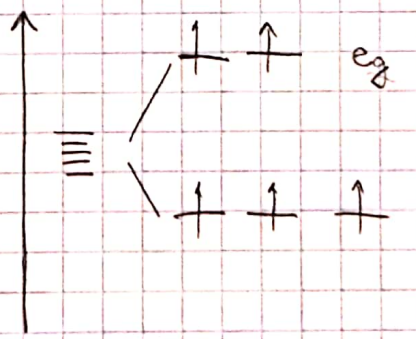
$- 72{,}059\ g\,mol^{-1} \rightarrow 4 \cdot H_2O$

$225{,}983\ g\,mol \rightarrow 2 \cdot CF_3COO$

$[Mn(CF_3COO)_2(H_2O)_4]$

$MnCO_3(s) + 2CF_3COOH(aq) + 3H_2O(l) \rightarrow [Mn(CF_3COO)_2(H_2O)_4](s) + CO_2(g)\uparrow$





Kompleks je paramagnetičan

Zadatak 3.

A: $CoCl_2 \cdot 6H_2O(aq) + KCN(aq) \rightarrow Co(CN)_2(s)$

$2Co(CN)_2(aq) + 2KCN(aq) \rightarrow K_2Co[Co(CN)_6](s)$

kalijev kobaltov(II) heksacianokobaltat(II)

B: $m(\text{uzorak}) = 0,6873\ g$

$m(Co_2(SO_4)_3) = 0,41792\ g$

$n(Co) = 2n(Co_2(SO_4)_3) = 2 \cdot \frac{0,41792\ g}{406,04\ g\,mol^{-1}} = 2,06 \cdot 10^{-3}\ mol$

$w(Co) = \frac{2,06 \cdot 10^{-3}\ mol \cdot 58,933\ g\,mol^{-1}}{0,6873\ g} = 17,65\ \%$

$m(KB(ph)_4) = 2,220\ g$

$n(K) = n(KB(ph)_4) = \frac{2,220\ g}{358,328\ g\,mol^{-1}} = 6,14 \cdot 10^{-3}\ mol$

$w(K) = \frac{6,14 \cdot 10^{-3}\ mol \cdot 39,098\ g\,mol}{0,6873\ g} = 34,93\ \%$

$m(\text{uzorak}) = 0,6745\ g$

$m(CO_2) = 536,5\ mg$

$n(C) = n(CO_2) = \frac{536,5 \cdot 10^{-3}\ g}{44,009\ g\,mol^{-1}} = 1,22 \cdot 10^{-2}\ mol$

$w(C) = \frac{1,22 \cdot 10^{-2}\ mol \cdot 12,011\ g\,mol^{-1}}{0,6745\ g} = 21,72\ \%$

$w(N) = 25,70\ \%$

$\frac{34,93\,g}{39,098\,g\,mol^{-1}} : \frac{17,65\,g}{58,933\,g\,mol^{-1}} : \frac{21,72\,g}{12,011\,g} : \frac{25,70\,g}{14,007\,g\,mol^{-1}}$

$0,8934\,mol : 0,2995\,mol : 1,8083\,mol : 1,8348\,mol \;/\cdot 0,2995\,mol$

3 : 1 : 6 : 6

$K_3[Co(CN)_6]$ žuljev heksacianokobaltat(III)

tamnocrveno
žuljev heksacianokobaltat(II)

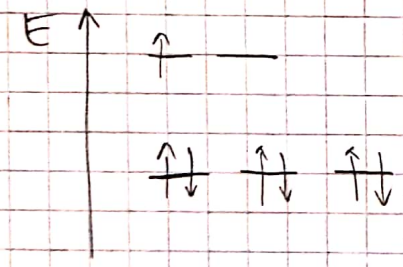
$Co(CN)_2(aq) + 4KCN(aq) \rightarrow K_4[Co(CN)_6](aq)$ 5

$2K_4[Co(CN)_6](aq) + 2H^+(aq) \rightarrow 2K_3[Co(CN)_6](aq) + 2K^+(aq) + H_2(g)$

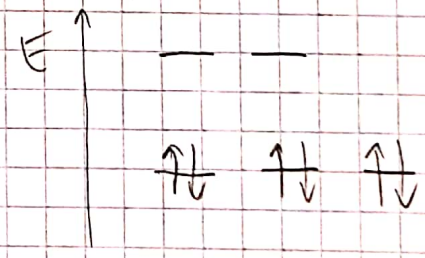
$K_4[Co(CN)_6] \rightarrow K_3[Co(CN)_6] + K^+ + 1e^- \;/\cdot 2$

$2H^+ + 2e^- \rightarrow H_2$

Co(II):



Co(III):



Δ_o je veći za kompleks u kojem je metalni ion većeg naboja, tj valna duljina emitirane svjetlosti pobitkom povratka elektrona na osnovnu razinu će biti manje valne duljine (Co(III) - žuto , Co(II) - crveno)

Zadatak 4.

A: $a = 17,73\,Å$ $\quad V = abc\sin\beta = 17,73\cdot10^{-8}\,cm \cdot 16,43\cdot10^{-8}\,cm \cdot 19,74\cdot10^{-8}\,cm \cdot \sin 122,13^\circ$

$b = 16,43\,Å$ $\quad = 4,87\cdot10^{-21}\,cm^3$

$c = 19,74\,Å$ $\quad M = \dfrac{4,87\cdot10^{-21}\,cm^3 \cdot 6,022\cdot10^{23}\,mol^{-1} \cdot 1,52\,g\,cm^{-3}}{4}$

$\beta = 122,13^\circ$

$Z = 4$ $\quad = 1114,35\,g\,mol^{-1}$

$\rho = 1,52\,g\,cm^{-3}$

paramagnetično → Co(II)

Sastav A i B identičan

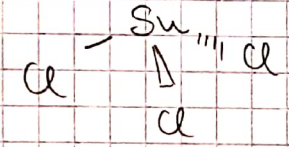
B:

anion: $w(Sn) = 52,74\%$ $\quad \dfrac{52,74\,g}{118,71\,g\,mol^{-1}} : \dfrac{47,25\,g}{35,45\,g\,mol^{-1}}$

$w(Cl) = 47,25\%$ $\quad 0,4443\,mol : 1,3328\,mol$

$1 : 3$

$[SnCl_3]^-$



kation: $w(Co) = 6,64\%$ $\quad \dfrac{6,64\,g}{58,933\,g\,mol^{-1}} : \dfrac{3,99\,g}{35,45\,g\,mol^{-1}} : \dfrac{70,39\,g}{12,011\,g\,mol^{-1}} : \dfrac{4,99\,g}{1,0079\,g\,mol^{-1}} : \dfrac{13,95\,g}{30,974\,g\,mol^{-1}}$

$w(Cl) = 3,99\%$

$w(C) = 70,39\%$

$w(H) = 4,99\%$

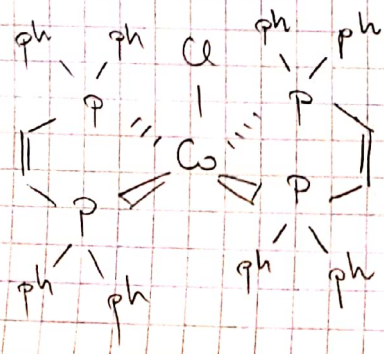
$w(P) = 13,96\%$

$0,1127\,mol : 0,1125\,mol : 5,8605\,mol : 4,9508\,mol : 0,4507\,mol$

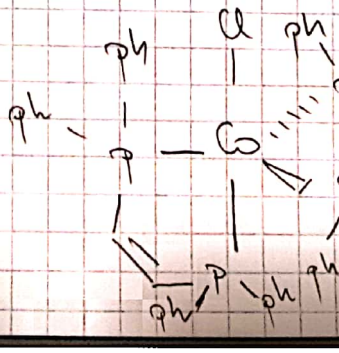
$1 : 1 : 52 : 44 : 4$

$[CoCl\{(C_6H_5)_2PCH=CHP(C_6H_5)_2\}_2]^+$

kvadratna piramida



trigonska bipiramida



Zadatak 5.

$CoCl_3 \cdot 5NH_3 \cdot H_2O \xrightarrow{+AgNO_3} 2\,AgCl$ ($2\,Cl^-$ iona ionska)

$\downarrow \Delta\,(-H_2O)$

$CoCl_3 \cdot 5NH_3$

(1 molekula vode u kristalnoj rešetki)

$\downarrow$

$[Co^{III}Cl(NH_3)_5]Cl_2 \cdot H_2O$

pentaamminklorokobaltov(III) klorid monohidrat

Ako se kompleks otopi te se otopini doda $AgNO_3$, istaloženi AgCl će sadržavati samo Cl^- ione koji su u kompleksu bili vezani ionski.

Da bi dodatkom $AgNO_3$ istaložio ukupni klor sadržan u kompleksu, kompleks je potrebno razoriti npr. s HNO_3. Primjerice ako se u otopinu $[CoCl(NH_3)_5]Cl_2 \cdot H_2O$ doda dušična kiselina, zatim $AgNO_3$, istaložit će 3 mola AgCl.