AK2 - Seminar 4

Zadatak 1.

A: $a = 418\ pm$

$\rho = 5{,}68\ g\,cm^{-3}$

$V = a^3 = (4{,}18 \cdot 10^{-8}\ cm)^3 = 7{,}30 \cdot 10^{-23}\ cm^3$

$M = \frac{N_A \cdot V \cdot \rho}{Z} = \frac{6{,}022 \cdot 10^{23}\ mol^{-1} \cdot 7{,}30 \cdot 10^{-23}\ cm^3 \cdot 5{,}68\ g\,cm^{-3}}{4}$

$= 62{,}42\ g\,mol^{-1}$ $TiO_{0,9}$

→ nestehiometrijski TiO_x $(x = 0{,}7 - 1{,}3)$

$TiO_2(s) + H_2(g) \xrightarrow{2000\,^\circ C} TiO(s) + H_2O(g)$

$Ti(IV) \rightarrow Ti(II) \mid 2e^-$

$H_2(nula) \rightarrow 2H(I) \mid 2e^-$

B $w(Ti) = 66{,}66\,\%$

$w(O) = 33{,}34\,\%$

$\frac{66{,}66\ g}{47{,}867\ g\,mol^{-1}} : \frac{33{,}34\ g}{15{,}999\ g} = 1{,}3926\ mol : 2{,}0839\ mol \;/ : 1{,}3926\ mol$

$= 1 : 1{,}5 \;/ \cdot 2$

$= 2 : 3$

Ti_2O_3

$O_2(g) + 2TiO(s) \xrightarrow{200\,^\circ C} Ti_2O_3(s)$

$2Ti(II) \rightarrow 2Ti(III) \mid 2e^-$

$O_2(nula) \rightarrow 2O(-II) \mid 2e^-$

$3TiO_2(s) + Ti(s) \xrightarrow{1600\,^\circ C} 2Ti_2O_3(s)$

$Ti(IV) \rightarrow Ti(III) \mid 1e^- \;/ \cdot 3$

$Ti(nula) \rightarrow Ti(III) \mid 3e^-$

C: $w(Ti) = 64,22\,\%$

$w(O) = 35,78\,\%$

$\frac{64,22\,g}{47,867\,g\,mol^{-1}} : \frac{35,78\,g}{15,999\,g\,mol^{-1}} = 1,3416\,mol : 2,2364\,mol$

$= 1 : 1,67 \;/\cdot 3$

$= 3 : 5 \quad Ti_3O_5$

$a = 975,0\,pm$

$b = 380,0\,pm$

$c = 952,0\,pm$

$\beta = 91,92°$

$Z = 4$

$\rho = 4,21\,g\,cm^{-3}$

$V = 9,75 \cdot 10^{-8}\,cm \cdot 3,80 \cdot 10^{-8}\,cm \cdot 9,52 \cdot 10^{-8}\,cm \cdot \sin 91,92$

$= 3,525 \cdot 10^{-22}\,cm^3$

$M = \frac{N_A \cdot \rho \cdot V}{2} = \frac{6,022 \cdot 10^{23}\,mol^{-1} \cdot 4,21\,g\,cm^{-3} \cdot 3,525 \cdot 10^{-22}\,cm^3}{4}$

$= 223,42\,g\,mol^{-1}$

$3\,TiO(s) + O_2(g) \xrightarrow{250-350\,°C} Ti_3O_5(s) \qquad Ti_3O_5 = TiO \cdot 2TiO_2$

$3\,Ti(II) \rightarrow Ti(II) + 2Ti(IV) \mid 4e^-$

$O_2\,(nula) \rightarrow 2O(-II) \mid 4e^-$

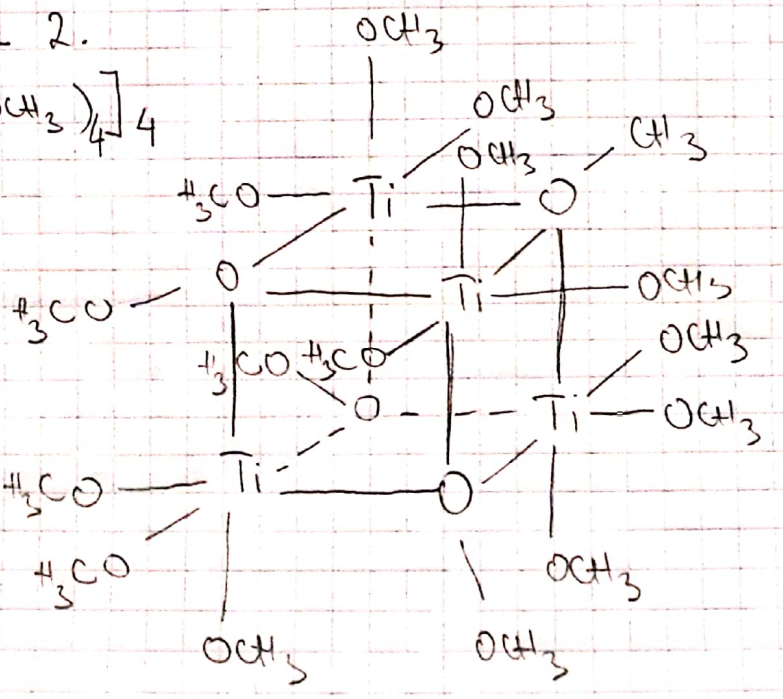
$2\,Ti_3O_5(s) + O_2(g) \xrightarrow{>350\,°C} 6\,TiO_2(s)$

$Ti(II) + 2Ti(IV) \rightarrow 3Ti(IV) \mid 2e^- \;/\cdot 2$

$O_2\,(nula) \rightarrow 2O(-II) \mid 4e^-$

Zadatak 2.

$[Ti(OCH_3)_4]_4$



Zadatak 3.

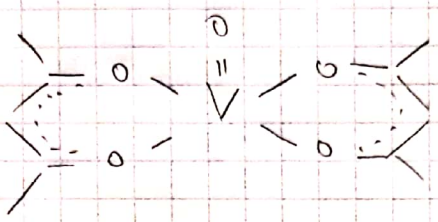
$\omega(V) = 19,22\,\%$
$\omega(C) = 45,29\,\%$
$\omega(H) = 5,32\,\%$
$\omega(O) = 30,17\,\%$

$\frac{19,22\,g}{50,942\,g\,mol^{-1}} : \frac{45,29\,g}{12,011\,g\,mol^{-1}} : \frac{5,32\,g}{1,0079\,g\,mol^{-1}} : \frac{30,17\,g}{15,999\,g\,mol^{-1}}$

$0,3773\,mol : 3,7707\,mol : 5,2783\,mol : 1,8857\,mol$

$1 : 10 : 14 : 5$

$[VO(acac)_2]$



oksobis(pentan-2,4-dionato)vanadij(IV)

$V_2O_5(s) + C_2H_5OH(aq) + 2H_2SO_4(aq) \rightarrow 2VOSO_4(aq) + 3H_2O(l) + CH_3CHO(g)$

$2e^- + V_2O_5 + 6H^+ \rightarrow 2VO^{2+} + 3H_2O$

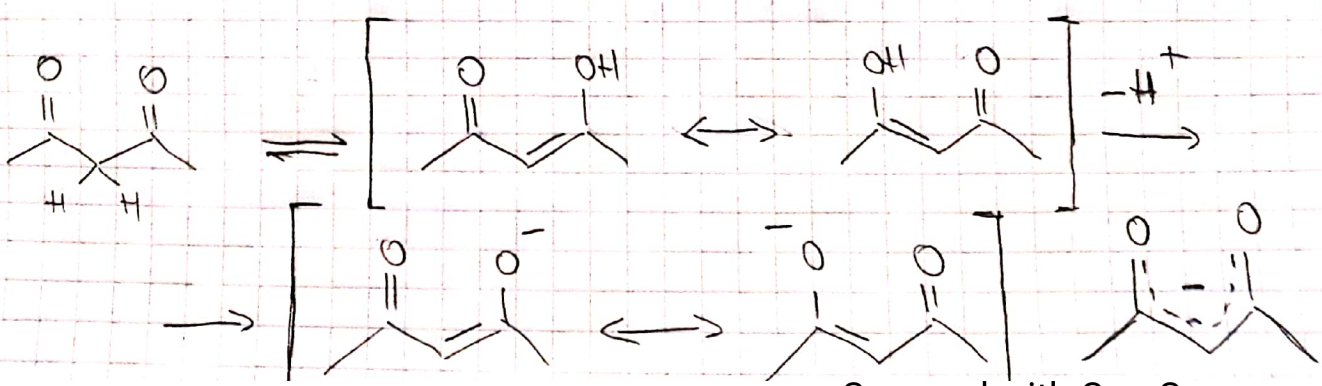
$CH_3CH_2OH \rightarrow CH_3CHO + 2H^+ + 2e^-$

$VOSO_4(aq) + 2C_2H_3O_2(aq) + Na_2CO_3(aq) \rightarrow [VO(C_5H_7O_2)_2](s) + Na_2SO_4(aq) + H_2O(l) + CO_2(g)$

$Na_2CO_3(s) \rightarrow 2Na^+(aq) + CO_3^{2-}(aq)$

$CO_3^{2-}(aq) + 2H_2O(l) \rightarrow H_2CO_3(aq) + 2OH^-(aq)$

$C_5H_8O_2(aq) + OH^-(aq) \rightarrow C_5H_7O_2^-(aq) + H_2O(l)$



Zadatak 4

$m(\text{uzorak}) = 0{,}1534\ g$

$m(V_2O_5) = 0{,}0358\ g$

$$n(V) = 2n(V_2O_5) = 2 \cdot \frac{0{,}0358\ g}{181{,}879\ g\,mol^{-1}} = 3{,}9367 \cdot 10^{-4}\ mol$$

$$w(V) = \frac{3{,}9367 \cdot 10^{-4}\ mol \cdot 50{,}942\ g\,mol^{-1}}{0{,}1534\ g} = 13{,}07\,\%$$

$w(C) = 61{,}81\,\%$

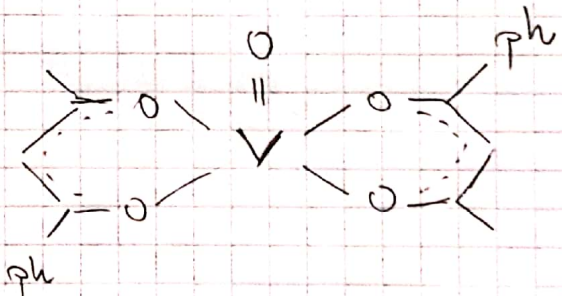
$w(H) = 4{,}65\,\%$

$w(O) = 20{,}47\,\%$

$$\frac{13{,}07\ g}{50{,}942\ g\,mol^{-1}} : \frac{61{,}81\ g}{12{,}011\ g\,mol^{-1}} : \frac{4{,}65\ g}{1{,}0079\ g\,mol^{-1}} : \frac{20{,}47\ g}{15{,}999\ g\,mol^{-1}}$$

$0{,}2565\ mol : 5{,}1461\ mol : 4{,}6135\ mol : 1{,}2791\ mol$

$1 : 20 : 18 : 5$



deso bis(1-fenilbutan-1,3-dionato)vanadij(IV)

žut

$$V_2O_5(s) + H_2SO_4(aq) \rightarrow 2VO_2^+(aq) + SO_4^{2-}(aq) + H_2O(l)$$

$$2VO_2^+(aq) + 2H^+(aq) + CH_3CH_2OH(aq) \rightarrow 2VO^{2+}(aq) + CH_3CHO(aq) + 2H_2O(l)$$

plav

$$1e^- + VO_2^+ + 2H^+ \rightarrow VO^{2+} + H_2O \quad /\cdot 2$$

$$CH_3CH_2OH \rightarrow CH_3CHO + 2H^+ + 2e^-$$

$$V_2O_5(s) + 6OH^-(aq) \rightarrow 2VO_4^{3-}(s) + 3H_2O(l)$$

Zadatak 5.

$m(\text{uzorak}) = 0{,}2167\,g$

$\Delta m = 0{,}0059\,g - m(H_2O, k.r.)$

$w(H_2O, k.r.) = 2{,}72\,\%$ (ako 5,46 % odgovara 2 molekule vode, onda 2,72 % 1 molekula vode)

$\Delta m_2 = 0{,}01183\,g - m(H_2O)$

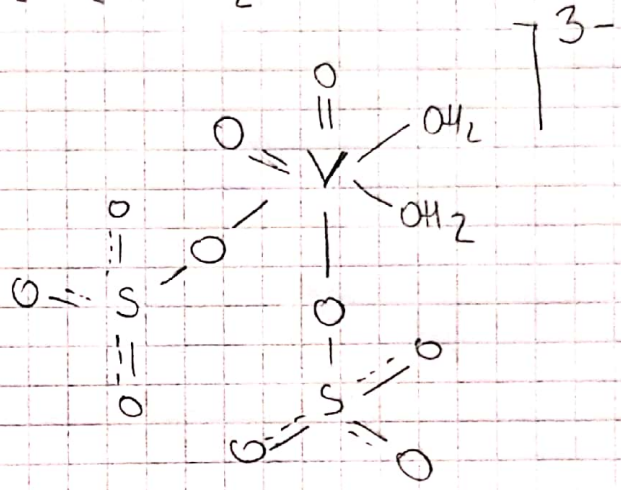
$w(H_2O) = 5{,}46\,\%$

$KB(V) = 6 \rightarrow 2H_2O, 2O, 2O$ (ligandi)

$(NH_4)_3[VO_2(SO_4)_2(H_2O)_2] \cdot H_2O$

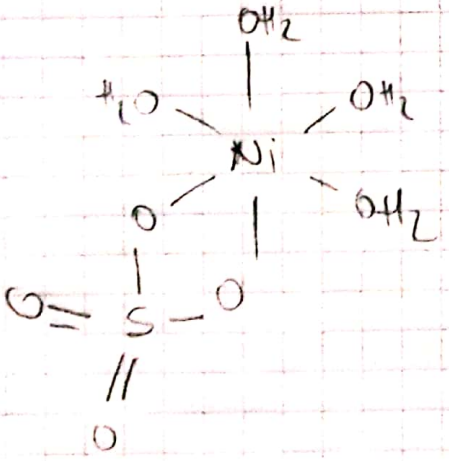
↑

3:1 elektrolit



amonijev diakvadioksodisulfatovanadat(V) monohidrat

Primjer spoja u kojem se SO_4^{2-} veže didentatno:



Zadatak 6.

$\omega(C) = 37,52\%$

$\omega(H) = 4,41\%$

$\omega(Cl) = 22,15\%$

$\omega(V) = 15,32\%$

$\omega(O) = 19,99\%$

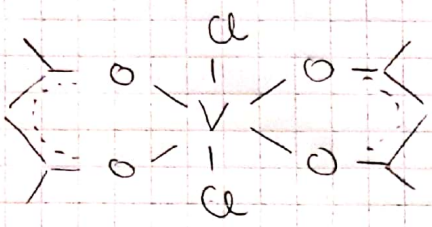
$\frac{37,53\ g}{12,011\ g\,mol^{-1}} : \frac{4,41\ g}{1,0079\ g\,mol^{-1}} : \frac{22,15\ g}{35,45\ g\,mol^{-1}} : \frac{15,32\ g}{50,942\ g\,mol} : \frac{19,99\ g}{15,999\ g\,mol^{-1}}$

$3,1246\ mol : 4,3754\ mol : 0,6248\ mol : 0,3125\ mol : 1,2494\ mol$

$10 : 14 : 2 : 1 : 4$

$[VCl_2(C_5H_7O_2)_2]$

$[VO(C_5H_7O_2)_2](sln) + SOCl_2(sln) \rightarrow [VCl_2(C_5H_7O_2)_2](s) + SO_2(g)$



trans-dikloro bis(pentan-2,4-dionato) vanadij(IV)

$SOCl_2$ → klorirajući agens

$a = 14,167\ Å$

$b = 18,774\ Å$

$c = 19,670\ Å$

$Z = 8$

$\rho = 1,734\ g\,cm^{-3}$

$V = abc = 14,167 \cdot 10^{-8}\ cm \cdot 18,774 \cdot 10^{-8}\ cm \cdot 19,670\ 10^{-8}\ cm$

$= 5,231 \cdot 10^{-21}\ cm^3$

$M = \frac{6,022 \cdot 10^{23}\ mol^{-1} \cdot 5,231 \cdot 10^{-21}\ cm^3 \cdot 1,734\ g\,cm^{-3}}{8}$

$M = 682,78\ g\,mol^{-1}$

$\omega(C) = 26,4\%$

$\omega(H) = 3,1\%$

$\omega(Cl) = 31,2\%$

$\omega(Sb) = 17,8\%$

$\omega(V) = 7,5\%$

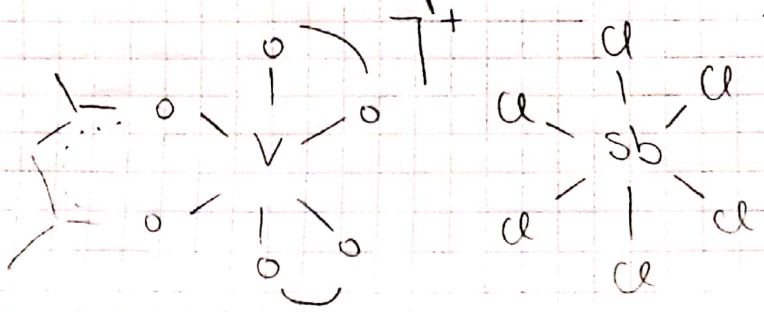
$\frac{26,4\ g}{12,011\ g\,mol^{-1}} : \frac{3,1\ g}{1,007\ g\,mol^{-1}} : \frac{31,2\ g}{35,45\ g\,mol^{-1}} : \frac{17,8\ g}{121,76\ g\,mol^{-1}} : \frac{7,5\ g}{50,942\ g\,mol^{-1}}$

$2,1979\ mol : 3,0751\ mol : 0,8801\ mol : 0,1462\ mol : 0,1472\ mol$

$15 : 21 : 6 : 1 : 1$

$[V(C_5H_7O_2)_3][SbCl_6]$

tris(pentan-2,4-dionato) vanadiju(IV) heksakloroantimonat(V)



Zadatak 7

A: $\omega(Cr) = 31,33\%$ $\quad \frac{31,33\ g}{51,996\ g\,mol^{-1}} : \frac{68,67\ g}{18,998\ g\,mol^{-1}}$

$\omega(F) = 68,67\%$.

$0,6025\ mol : 3,6146\ mol$

$1 : 6$

$[CrF_6]^{3-}$

B: $\omega(C) = 12,77\%$ $\quad \frac{12,77\ g}{12,011\ g\,mol} : \frac{4,25\ g}{1,0079\ g\,mol^{-1}} : \frac{27,64\ g}{51,996\ g\,mol^{-1}} : \frac{14,90\ g}{14,007\ g\,mol} : \frac{40,40\ g}{18,998\ g\,mol}$

$\omega(H) = 4,29\%$.

$\omega(Cr) = 27,64\%$. $\quad 1,0632\ mol : 4,2564\ mol : 0,5316\ mol : 1,0637\ mol : 2,1265\ mol$

$\omega(N) = 14,90\%$. $\quad 2 : 8 : 1 : 2 : 4$

$\omega(F) = 40,40\%$.

$[CrF_4(en)]^-$

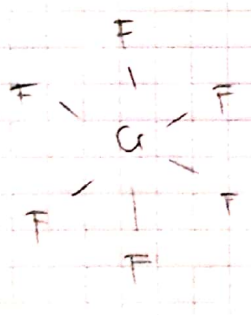
$$10H^+_{(aq)} + NO_3^-_{(aq)} + 4Zn_{(s)} \longrightarrow 4Zn^{2+}_{(aq)} + NH_4^+_{(aq)} + 3H_2O_{(l)}$$

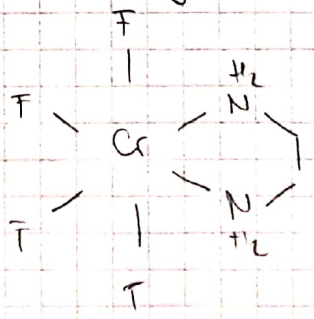
$$Zn \longrightarrow Zn^{2+} + 2e \quad / \cdot 4e^-$$

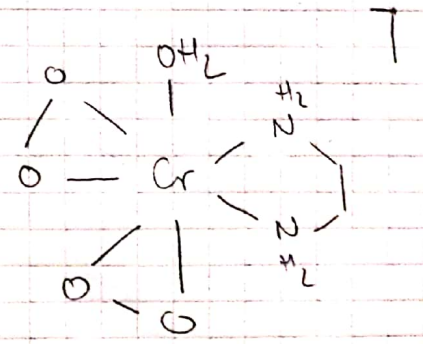
$$8e^- + NO_3^- + 10H^+ \Rightarrow NH_4^+ + 3H_2O$$

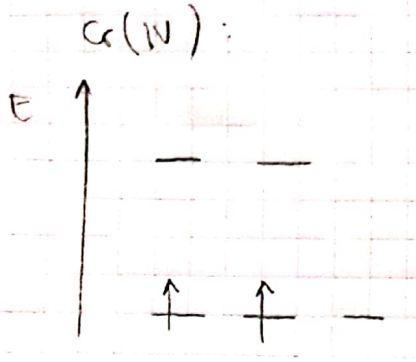
A: $(NH_4)_3[CrF_6]$ amonijev heksafluorokromat(III)

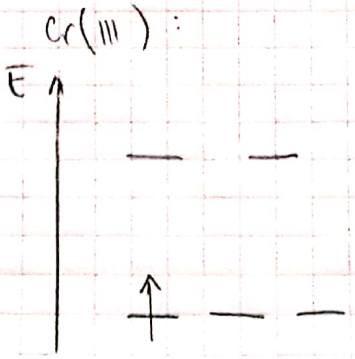
B: $(NH_4)[CrF_4(en)]$ amonijev etilendiaminotetrafluorokromat(III)











$\mu(Cr^{4+}) = \sqrt{2(2+2)} = 2,83$

$\mu(Cr^{3+}) = \sqrt{1(1+2)} = 1,73$

Razlika u magnetskom momentu.

Zadatak 8.

A: $w(N) = 17,95\,\%$ $\quad \frac{17,95\ g}{14,007\ g\,mol^{-1}} : \frac{5,19\ g}{1,0079\ g\,mol^{-1}} : \frac{22,1\ g}{51,996\ g\,mol^{-1}} : \frac{54,76\ g}{15,999\ g\,mol^{-1}}$

$w(H) = 5,19\,\%$

$w(Cr) = 22,1\,\%$ $\quad 1,2815\ mol : 5,1493\ mol : 0,4250\ mol : 3,4227\ mol$

$w(O) = 54,76\,\%$ $\quad 3 : 12 : 1 : 8$

$(NH_4)_3[Cr(O_2)_4]$ amonijev tetraperoksokromat(V)

3: $w(N) = 25,15\,\%$ $\quad \frac{25,15\ g}{14,007\ g\,mol^{-1}} : \frac{5,43\ g}{1,0079\ g\,mol^{-1}} : \frac{31,1\ g}{51,996\ g\,mol^{-1}} : \frac{38,29\ g}{15,999\ g\,mol^{-1}}$

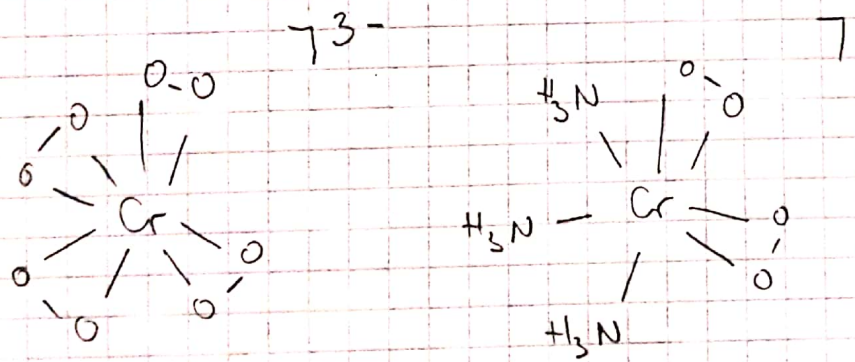
$w(H) = 5,43\,\%$

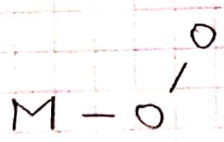
$w(Cr) = 31,11\,\%$ $\quad 1,7955\ mol : 5,3874\ mol : 0,5981\ mol : 2,3933\ mol$

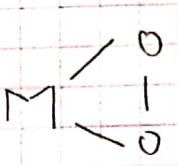
$w(O) = 38,29\,\%$ $\quad 3 : 9 : 1 : 4$

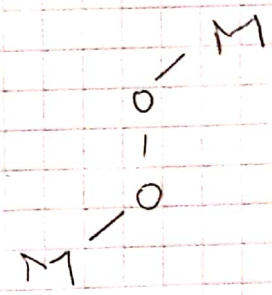
$[Cr(O_2)_2(NH_3)_3]$

triamminotetraperoksokrom(IV)









Zadatak 9.

A

$$K_2Cr_2O_7(s) + 4KCl(s) + 3H_2SO_4(konc.) \rightarrow \underset{\text{kromil-klorid}}{2CrO_2Cl_2(l)} + 3K_2SO_4(s) + 3H_2O(l)$$

Smješak H_2SO_4 (konc.) → dehidratacijsko sredstvo

b: $w(Cr) = 20,27\,\%$

$w(Cl) = 13,82\,\%$

$w(C) = 28,07\,\%$

$w(H) = 6,63\,\%$

$w(O) = 31,21\,\%$

$$\frac{20,27\,g}{51,996\,g\,mol^{-1}} : \frac{13,82\,g}{35,45\,g\,mol^{-1}} : \frac{28,07\,g}{12,011\,g\,mol^{-1}} : \frac{6,63\,g}{1,0079\,g\,mol^{-1}} : \frac{31,21\,g}{15,999\,g\,mol^{-1}}$$

$0,3898\,mol : 0,3898\,mol : 2,3370\,mol : 6,5780\,mol : 1,9507\,mol$

$1 : 1 : 6 : 17 : 5 : 2$

$\frac{0,7760\,mol}{0,3898\,mol} = 2$

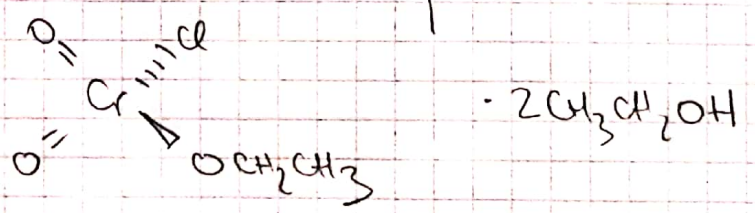
$\frac{35,75\,g}{46,0684\,g\,mol^{-1}} = 0,7760\,mol$

$m(uzorak) = 0,3166\,g$

$\Delta m = 0,1132\,g = m(C_2H_5OH)$

$w(C_2H_5OH) = \frac{0,1132\,g}{0,3166\,g} = 35,75\,\%$

$$[CrO_2Cl(CH_3CH_2O)] \cdot 2\,CH_3CH_2OH$$



$\cdot 2CH_3CH_2OH$

$$2CrO_2Cl_2(l) + 3H_2O(l) \rightarrow 4HCl(aq) + H_2Cr_2O_7(aq)$$