2005/2006 õa keemiaolümpiaadi lõppvooru ülesannete lahendused
9. klass

1. a) i) $Zn + 2HCl = ZnCl_2 + H_2\uparrow$

ii) $2Na + 2H_2O = 2NaOH + H_2\uparrow$

iii) $2Al + 6NaOH + 6H_2O = 2Na_3[Al(OH)_6] + 3H_2\uparrow$

b) i) HNO_3

ii) sool, oksiid ja vesi

c) $2H_2 + O_2 = 2H_2O$

d) Vesinikku on $\frac{2}{3} \cdot 300\ cm^3 = 200\ cm^3$

Hapnikku on $\frac{1}{3} \cdot 300\ cm^3 = 100\ cm^3$

i) $\mathbf{m(O_2)} = 0{,}100\ dm^3 \cdot \frac{1\,mol}{22{,}4\ dm^3} \cdot 32{,}0\ g/mol = 0{,}1429\ g \approx \mathbf{0{,}143\ g}$

ii)

	m		0,200 dm³
	Zn	⇔	H_2
	65,39 g/mol		22,4 dm³/mol

$\mathbf{m(Zn)} = \frac{1}{1} \cdot 0{,}200\ dm^3 \cdot \frac{1\,mol}{22{,}4\ dm^3} \cdot 65{,}39\ g/mol = 0{,}5838\ g \approx \mathbf{0{,}584\ g}$

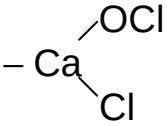
2. a) i) $\mathbf{M(A)} = 29\ g/mol \cdot 2{,}45 = \mathbf{71\ g/mol}$

ii) $\mathbf{M(C)} = 16{,}0\ g/mol \div \frac{1}{0{,}305} = \mathbf{52{,}5\ g/mol}$

b) **A** – Cl_2, kloor

B – HCl, soolhape

C – HClO, hüpokloorishape

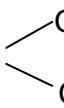
D –  , kloorlubi

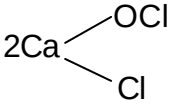
F – $CaCO_3$, kaltsiumkarbonaat

G – $CaCl_2$, kaltsiumkloriid

H – O, atomaarne hapnik

c) i) $Cl_2 + H_2O = HCl + HClO$

ii) $Cl_2 + Ca(OH)_2 =$  $+ H_2O$

iii)  $+ CO_2 + H_2O = CaCO_3 + CaCl_2 + 2HClO$

iv) $HClO = HCl + O$

3. a) A – C, süsinik, grafiit

B - $CaSO_4 \cdot 2H_2O$, kaltsiumsulfaat-vesi(1/2), kips

C – $CaCO_3$, kaltsiumkarbonaat, kaltsiit

$$\%(Ca) = \frac{40{,}08\ g/mol}{136{,}14\ g/mol} \cdot 100 = 29{,}44$$

D – FeS_2, püriit

E - Fe_2O_3, raud(III)oksiid, pruun rauamaak

b) X – CO_2, süsinikdioksiid

Y – H_2O, vesi

Z – H_2CO_3, süsihape

S – CaO, kaltsiumoksiid

T – $Ca(OH)_2$, kaltsiumhüdroksiid

U – SO_2, vääveldioksiid

c) i) $C + O_2 = CO_2$

ii) $CaSO_4 \cdot 2H_2O \xrightarrow{^0t} CaSO_4 + 2H_2O$

iii) $H_2O + CO_2 = H_2CO_3$

iv) $CaSO_4 + BaCl_2 = BaSO_4\downarrow + CaCl_2$

v) $CaCO_3 \xrightarrow{^0t} CaO + CO_2$

vi) $CaO + H_2O = Ca(OH)_2$

vii) $Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$

viii) $4FeS_2 + 11O_2 = 2Fe_2O_3 + 8SO_2$

ix) $Fe_2O_3 + 3C = 2Fe + 3CO$

4. a) $Ca(HCO_3)_2 + Mg(HCO_3)_2 = CaCO_3\downarrow + MgCO_3\downarrow + 2H_2O + 2CO_2\uparrow$

b) n(vesinikkarbonaadid) = n(karbonaadid)

n(karbonaadid) = 3,39 mmol/l · 3,6 l/päevas · 14 päeva = 171 mmol ≈

≈ **0,17 mol**

c) Ca^{2+} moolprotsendiline sisaldus on 2 korda suurem kui Mg^{2+} sisaldus, järelikult moodustab katlakivi karbonaatidest 2 moolosa $CaCO_3$ ja 1 moolosa $MgCO_3$.

$$n(CaCO_3) = \frac{0{,}171}{2+1} \cdot 2 = 0{,}114\ mol$$

$$n(MgCO_3) = \frac{0{,}171}{2+1} \cdot 1 = 0{,}0570\ mol$$

$m(CaCO_3) = n \cdot M = 0{,}114\ mol \cdot 100\ g/mol = 11{,}4\ g$

$m(MgCO_3) = n \cdot M = 0{,}0570\ mol \cdot 84{,}1\ g/mol = 4{,}79\ g$

$m(karbonaadid) = 11{,}4\ g + 4{,}79\ g = 16{,}19\ g \approx 16{,}2\ g$

$$V(karbonaadid) = \frac{m}{?} = \frac{16{,}2\ g}{2{,}7\ g/cm^3} = 6{,}00\ cm^3 \approx 6{,}0\ cm^3$$

Karbonaatide kihi paksus **l** = $\frac{V}{s} = \frac{6{,}0\ cm^3}{94{,}2\ cm^2}$ = 0,0637 cm ≈ **0,64 mm**

d) $\mathbf{t} = 14\ \text{päeva} \cdot \frac{0{,}5\ \text{mm}}{0{,}64\ \text{mm}} = 10{,}9\ \text{päeva} \approx \mathbf{11\ päeva}$

e) i) happed

ii) $4HCl + CaCO_3 + MgCO_3 = CaCl_2 + MgCl_2 + 2H_2O + 2CO_2\uparrow$

5. a) i) $CaCl_2 + 6H_2O = CaCl_2 \cdot 6H_2O$

ii) $MgSO_4 + 7H_2O = MgSO_4 \cdot 7H_2O$

iii) $P_4O_{10} + 6H_2O = 4H_3PO_4$

b) i)

$$\begin{array}{ccc} 50{,}0\ \text{g} & & m \\ CaCl_2 & \Leftrightarrow & 6H_2O \\ 111\ \text{g/mol} & & 18{,}0\ \text{g/mol} \end{array}$$

$$\mathbf{m(H_2O)} = \frac{6}{1} \cdot 50{,}0\ \text{g} \cdot \frac{1\,\text{mol}}{111\,\text{g}} \cdot 18{,}0\ \text{g/mol} = \mathbf{48{,}6\ g}$$

ii)

$$\begin{array}{ccc} 50{,}0\ \text{g} & & m \\ MgSO_4 & \Leftrightarrow & 7H_2O \\ 12\underline{0}\ \text{g/mol} & & 18{,}0\ \text{g/mol} \end{array}$$

$$\mathbf{m(H_2O)} = \frac{7}{1} \cdot 50{,}0\ \text{g} \cdot \frac{1\,\text{mol}}{120\,\text{g}} \cdot 18{,}0\ \text{g/mol} = \mathbf{52{,}5\ g}$$

c) $m(H_2O, \text{õhus}) = 48{,}6\ \text{g} \cdot \frac{1}{0{,}75} = 64{,}8\ \text{g}$

$m(\text{õhk}) = 64{,}8\ \text{g} \cdot \frac{1}{0{,}001} = 64800\ \text{g}$

$$\mathbf{V(\text{õhk})} = 64800\ \text{g} \cdot \frac{1\,\text{dm}^3}{1{,}29\ \text{g}} \cdot \frac{1\,\text{m}^3}{1000\,\text{dm}^3} = 50{,}23\ \text{m}^3 \approx \mathbf{50{,}2\ m^3}$$

d) $\mathbf{\%(H_2O\ \text{peale kuivatamist})} = 0{,}1 \cdot 0{,}25 = \mathbf{0{,}025}$

e) $$\mathbf{\%(H_2SO_4)} = \frac{1{,}10\ \text{dm}^3 \cdot 1{,}820\ \text{kg/dm}^3 \cdot 0{,}9}{1{,}10\ \text{dm}^3 \cdot 1{,}820\ \text{kg/dm}^3 + 0{,}05\ \text{kg}} \cdot 100 = \mathbf{87{,}8}$$

6. a) $m(\text{lahus}) = 1\,\text{dm}^3 \cdot 1{,}070\ \text{g/cm}^3 \cdot \frac{1000\,\text{cm}^3}{1\,\text{dm}^3} = 107\underline{0}\ \text{g}$

i) $$\mathbf{m(H_2O)} = 1070\ \text{g} \cdot \frac{100\ \text{g}}{111{,}1\ \text{g}} = \mathbf{963{,}1\ g}$$

ii) $$\mathbf{m(K_2Cr_2O_7)} = 1070\ \text{g} \cdot \frac{11{,}10\ \text{g}}{111{,}1\ \text{g}} = \mathbf{106{,}9\ g}$$

b) $$\mathbf{m(\text{lahus})} = 100{,}0\ \text{g} \cdot \frac{111{,}1\ \text{g}}{11{,}10\ \text{g}} = 1000{,}9\ \text{g} \approx \mathbf{1001\ g}$$

c) $$\mathbf{c(K_2Cr_2O_7)} = 106{,}9\ \text{g} \cdot \frac{1\,\text{mol}}{294{,}2\ \text{g}} \cdot \frac{1}{\text{dm}^3} = \mathbf{0{,}3634\ mol/dm^3}$$

2005/2006 õa keemiaolümpiaadi lõppvooru ülesannete lahendused

10. klass

1. a) **X** – $FeSO_4$, raud(II)sulfaat
Y – $KMnO_4$, kaaliumpermanganaat
Z – SiO_2, ränidioksiid

b) **i)** $10FeSO_4+2KMnO_4+8H_2SO_4=5Fe_2(SO_4)_3+2MnSO_4+K_2SO_4+8H_2O$
ii) $2KMnO_4 + 3Na_2SO_3 + H_2O = 2MnO_2 + 3Na_2SO_4 + 2KOH$
iii) $2KMnO_4 + Na_2SO_3 + 2KOH = 2K_2MnO_4 + Na_2SO_4 + H_2O$
iv) $FeSO_4 + BaCl_2 = BaSO_4\downarrow + FeCl_2$
v) $3FeSO_4 + 2K_3[Fe(CN)_6] \rightarrow Fe_3[Fe(CN)_6]_2 + 3K_2SO_4$
vi) $SiO_2 + 6HF = H_2SiF_6 + 2H_2O$
vii) $SiO_2 + 2NaOH = Na_2SiO_3 + H_2O$
viii) $6SiO_2 + 2Ca_3(PO_4)_2 + 10C = 6CaSiO_3 + P_4 + 10CO$

2. a) hüdroksüülamiin

b) **i)** NH_2OH **x** = -I
x+2-2+1 = 0
ii) $(NH_3OH)Cl$ **x** = -I
x+3-2+1-1 = 0
iii) NH_3 **x**= -III
x+3 = 0
iv) NH_4^+ **x** = -III
x+4 = 1

c) $NH_2OH + H_2O = NH_3OH^+ + OH^-$

d) **i)** $NH_2OH + HCl = (NH_3OH)Cl$
ii) $3NH_2OH = N_2\uparrow + NH_3\uparrow + 3H_2O$
iii) $NH_2OH + H_2S = S\downarrow + NH_3\uparrow + H_2O$
iv) $NH_2OH + O_2 = HNO_2 + H_2O$
v) $NH_2OH + SO_2 + H_2O = NH_4HSO_4$
vi) $2NH_2OH + I_2 = N_2\uparrow + 2HI + 2H_2O$
vii) $NH_2OH + 3KI + 3HCl = NH_4I + I_2 + 3KCl + H_2O$

3. a) $BaCl_2 + Na_2SO_4 = BaSO_4\downarrow + 2NaCl$

b) i) $\mathbf{n(BaCl_2)} = 100\,\text{g} \cdot 0{,}1 \cdot \frac{1\,\text{mol}}{208\,\text{g}} = \mathbf{0{,}0481\ mol}$

n(Na_2SO_4) = $100\,g \cdot 0{,}1 \cdot \frac{1\,mol}{142\,g}$ = **0,0704 mol**

ii) n($BaSO_4$)= $\frac{1}{1} \cdot 0{,}0481\,mol$ = **0,0481 mol**

n'(Na_2SO_4) = $0{,}0704\ mol - \frac{1}{1} \cdot 0{,}0481\ mol$ = **0,0223 mol**

n(NaCl) = $\frac{2}{1} \cdot 0{,}0481\,mol$ = **0,0962 mol**

c) m($BaSO_4$) = 0,0481 mol · 233 g/mol = 11,2 g

m'(Na_2SO_4) = 0,0223 mol · 142 g/mol = 3,17 g

m(NaCl) = 0,0962 mol · 58,5 g/mol = 5,63 g

%(Na_2SO_4) = $\frac{3{,}17\,g}{100\,g + 100\,g - 11{,}2\,g} \cdot 100$ = **1,68**

%(NaCl) = $\frac{5{,}63\,g}{188{,}8\,g} \cdot 100$ = **2,98**

4. a) **X** – N, lämmastik

A - NO, lämmastikoksiid

B – NO_2, lämmastikdioksiid

C – N_2O_4, dilämmastiktetraoksiid

D – N_2O_3, dilämmastiktrioksiid

E – HNO_2, lämmastikushape

F – N_2O_5, dilämmastikpentaoksiid

G – HNO_3, lämmastikhape

H – N_2O, dilämmastikmonooksiid

b)

i) $N_2 + O_2 \xrightarrow{\text{elektrikaar}} 2NO$

ii) $2NO + O_2 = 2NO_2$

iii) $NO + NO_2 = N_2O_3$

iv) $2NO_2 + O_3 = N_2O_5 + O_2$

v) $N_2O_3 + H_2O = 2HNO_2$

vi) $N_2O_5 + H_2O = 2HNO_3$

vii) $2NO_2 + H_2O = HNO_3 + HNO_2$ või $3NO_2 + H_2O = 2HNO_3 + NO$

viii) $4NO_2 + O_2 + 2H_2O = 4HNO_3$

ix) $2N_2O \xrightarrow{^0t} 2N_2 + O_2$

c) Kõrgemal temperatuuril on ülekaalus NO_2, madalamal temperatuuril on ülekaalus N_2O_4.

5. a) $2{,}4 \cdot 10^{-4} = [Pb^{2+}] \cdot [Cl^-]^2$

$[Cl^-] = 2[Pb^{2+}]$

$4[Pb^{2+}]^3 = 2{,}4 \cdot 10^{-4}\ mol^3/l^3$

$[\mathbf{Pb^{2+}}] = \sqrt[3]{\frac{2{,}4 \cdot 10^{-4}}{4}} = 3{,}915 \cdot 10^{-2}$ mol/l $\approx$ **$3{,}9 \cdot 10^{-2}$ mol/l**

b) $[Br^-]^2 \cdot 3{,}915 \cdot 10^{-2}$ mol/l $= 7{,}4 \cdot 10^{-5}$ mol^3/l^3

$[\mathbf{Br^-}] = \sqrt{\frac{7{,}4 \cdot 10^{-5}}{3{,}915 \cdot 10^{-2}}} = 4{,}35 \cdot 10^{-2}$ mol/l $\approx$ **$4{,}4 \cdot 10^{-2}$ mol/l**

c) $\mathbf{n(CaBr_2)} = \frac{0{,}0435 \text{ mol/l} \cdot 1{,}5 \text{ l}}{2} = 0{,}0326$ mol $\approx$ **0,033 mol**

6. a) i) $M_r(\mathbf{E}) = \frac{1{,}01}{0{,}0045} = 224{,}44$

$M_r(\mathbf{XY_2}) = 224{,}44 - 1{,}01 = 223{,}43$

$\mathbf{A_r(X)} = 223{,}43 \cdot 0{,}2845 \approx$ **63,5**

ii) $M_r(\mathbf{Y_2}) = 223{,}43 \cdot (1 - 0{,}2845) = 159{,}86$

$\mathbf{A_r(Y)} = \frac{159{,}86}{2} \approx$ **79,9**

b) **X** – Cu, vask
Y – Br, broom
A – HPO_3
B – P_4O_{10}
C – PH_3
D – H_3PO_4
E – $HCuBr_2$

c) $NaF + H_2SO_4(konts) = NaHSO_4 + HF$
$NaCl + H_2SO_4(konts) = NaHSO_4 + HCl$

d) i) $2NaBr + 3H_2SO_4(konts) = 2NaHSO_4 + Br_2 + SO_2 + 2H_2O$
ii) $2Cu + 4HBr(konts) = 2HCuBr_2 + H_2\uparrow$
iii) $4PH_3 + 8O_2 = P_4O_{10} + 6H_2O$
iv) $P_4 + 10Br_2 + 12H_2O = 4HPO_3 + 20HBr$
v) $P_4O_{10} + 6H_2O = 4H_3PO_4$

2005/2006 õa keemiaolümpiaadi lõppvooru ülesannete lahendused
11. klass

1. a) i) $p \cdot V = n \cdot R \cdot T$

$$\mathbf{V}=0{,}06\ \text{mol} \cdot 0{,}08205 \frac{\text{atm} \cdot \text{dm}^3}{\text{mol} \cdot \text{K}} \cdot 323\,\text{K} \cdot \frac{1}{1\text{atm}} = 1{,}590\ \text{dm}^3 \approx \mathbf{1{,}59\ dm^3}$$

ii) Limiteerivaks reagendiks on SO_2

b) $n(SO_2) = 0$

$n(O_2) = \frac{1}{2} \cdot 0{,}03\ \text{mol} = 0{,}015\ \text{mol}$

$n(SO_3) = 0{,}03\ \text{mol}$

$\Sigma n = 0{,}045\ \text{mol}$

$$\mathbf{V_{(lõpus)}} = \frac{0{,}045}{0{,}06} \cdot 1{,}590\ \text{dm}^3 = 1{,}193\ \text{dm}^3 \approx \mathbf{1{,}19\ dm^3}$$

c) i) $w = -p \cdot \Delta V$

$\mathbf{w} = -101325\ \text{N/m}^2 \cdot (0{,}00119\ \text{m}^3 - 0{,}00159\ \text{m}^3) = +40{,}53\ \text{J} \approx \mathbf{+41\ J}$

ii) Tööd tehti süsteemi suhtes.

d) i) $\Delta \mathbf{H_r} = 0{,}03\ \text{mol}\ [-395\ \text{kJ/mol} - (-296\ \text{kJ/mol}] = \mathbf{-2{,}97\ kJ}$

ii) Soojus lahkub süsteemist.

2. a) $m(\mathbf{Y}, a) = 197{,}39 \cdot 0{,}1796 = 35{,}45$

$m(\mathbf{Y}, b) = 147{,}37 \cdot 0{,}2406 = 35{,}45$

$m(\mathbf{Y}, g) = 480{,}74 \cdot 0{,}4424 = 212{,}7$

$N(\mathbf{Y}) = \frac{212{,}7}{35{,}45} = 6$

Y – Cl, kloor

Eeldusel, et molekulis a on igat elementi üks aatom

$m(\mathbf{X} + \mathbf{Y}) = 197 - (35+31+32) = 99$

$19 + 80 = 99$

X – F, fluor

Z – Br, broom

b) i) $PSFClBr \Leftrightarrow 31 + 32 + 19 + 35 + 80 = 197$

ii) $HCFClBr \Leftrightarrow 1 + 12 + 19 + 35 + 80 = 147$

iii) $N(O) = 480{,}74 \cdot 0{,}1664 \cdot \frac{1\,\text{aatom}}{16} = 5$ aatomit

$N(Cl) = 6$ aatomit

$m(P+S) = 480{,}7 - 212{,}7 - 80 = 188$

$A_r(P) = 31$ ja $A_r(S) = 32$

$188 : 31 = 6{,}06$

Olgu N(P) = x, siis N(O) = 6 – x

$x \cdot 31 + (6 - x) \cdot 32 = 188$

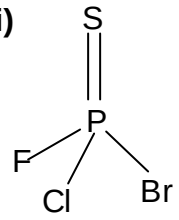
x = 4

N(P) = 4 aatomit

N(S) = 2 aatomit

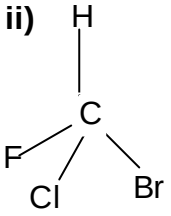
$P_4S_2Cl_6O_5$

c) i)



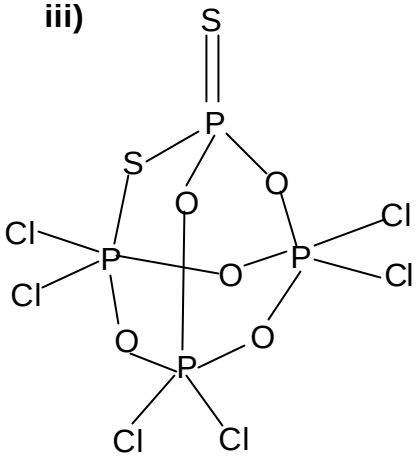
a

ii)



b

iii)



g

iv) bromofluorokloorometaan

3. a) i) $^{14}_{7}N + ^{1}_{0}n \rightarrow ^{14}_{6}C + ^{1}_{1}H$ (prootonit võib tähistada ka p või $^{1}_{1}p$)

ii) $^{14}_{6}C \rightarrow ^{14}_{7}N + ^{0}_{-1}e$ (beetaosakest võib ka tähistada β või β^-)

b) Kiiruskonstant on esimest järku kineetika korral seotud poolestusajaga järgmiselt:

k = $\frac{\ln 2}{\tau} = \frac{0{,}6931}{5715\ \text{a}} \cdot \frac{1\ \text{a}}{8766\ \text{h}}$ = **$1{,}384 \times 10^{-8}\ \text{h}^{-1}$**

c) Radioaktiivne lagunemine allub esimest järku kineetikale, kus mingil hetkel lagunemata osakeste arv N sõltub radioaktiivsete osakeste alghulgast N_o järgmiselt:

$N = N_0 \cdot e^{-kt}$, kust avaldades $t = -\frac{1}{k}\ln\left(\frac{N}{N_0}\right) = -\frac{\tau}{\ln 2}\ln\left(\frac{N}{N_0}\right)$.

Eelduste kohaselt N/N_0 vastab vanaaegse ja kaasaegse proovi radioaktiivse kiirguse intensiivsuste suhtele ehk

t = $-\frac{5715\ \text{a}}{\ln 2} \cdot \ln\left(\frac{14000}{18400}\right)$ = **2300 aastat**

4. a) $4s^2 3d^6 4p^0$

b) Ühendis **G** on Fe oa –II. Seega on molekulis 2 vesiniku aatomit. Ühendis **H** on Fe oa II, sest molekulis on 2 joodi aatomit.

G – H_2FeLig_x $M_r(\mathbf{G}) = 55{,}85/0{,}3287 = 169{,}91$

H - I_2FeLig_y $M_r(\mathbf{H}) = 2 \cdot 126{,}9/0{,}6019 = 421{,}66$

$M_r(Lig_x,\mathbf{G}) = 169{,}91 - 55{,}85 - 2 \cdot 1{,}01 = 112{,}0$

$M_r(Lig_y,\mathbf{H}) = 421{,}66 - 2 \cdot 126{,}9 - 55{,}85 = 112{,}0$

$\mathbf{X} \approx \mathbf{Y}$

Elektronide arvust leiame

$$x = \frac{18-8-2}{2} = 4$$

$$M_r(Lig) = \frac{112}{4} = 28$$

B = Lig – CO, süsinikmonooksiid

c) **A** – $Fe(CO)_5$, (18-8)/2 = 5

$$N(CO,\mathbf{C}) = \left(\frac{2 \cdot 55{,}85}{0{,}3070} - 2 \cdot 55{,}85\right)\frac{1\ \text{molek}}{28} = 9\ \text{molekuli}$$

$$N(Lig) = \frac{2 \cdot 18 - 2 \cdot 8 - 2}{2} = 9$$

C – $Fe_2(CO)_9$

D – $NaH[Fe(CO)_4]$ $N(Lig) = \frac{18-8-2}{2} = 4$

$Na_2[Fe(CO)_4]$

E – Na_2CO_3 **G** – $H_2[Fe(CO)_4]$ Σ 18 elektroni

F – NaCl **H** – $I_2[Fe(CO)_4]$ Σ 18 elektroni

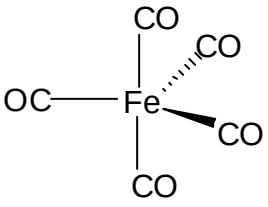
d) **i)** $2Fe(CO)_5 = Fe_2(CO)_9 + CO$

ii) $Fe(CO)_5 + 4NaOH = Na_2[Fe(CO)_4] + Na_2CO_3 + 2H_2O$

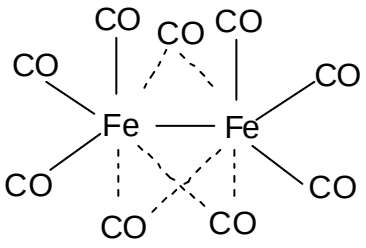
iii) $Na_2[Fe(CO)_4] + 2HCl = H_2[Fe(CO)_4] + 2NaCl$

iv) $Fe(CO)_5 + I_2 = I_2[Fe(CO)_4] + CO$

e)



A



C

5. a) m(ioone) = $\left(\frac{0{,}32}{23{,}0}+\frac{0{,}04}{24{,}3}+\frac{0{,}01}{40{,}1}+\frac{0{,}57}{35{,}5}+\frac{0{,}06}{96{,}0}\right)\frac{\text{mol}}{\text{g}}\cdot 34\,\frac{\text{g}}{\text{kg}}\cdot\frac{1\,\text{kg}}{0{,}966\,\text{kg}}=$

1,14 mol/kg = **1,1 mol/kg**

b) $\Delta T = 1{,}86\,\frac{\text{K}\cdot\text{kg}}{\text{mol}}\cdot 1{,}10\,\frac{\text{mol}}{\text{kg}}$ = 2,1 K

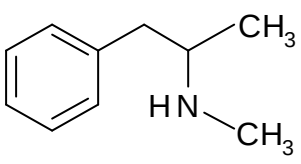
t(külm) = 0 ^{0}C – 2,1 ^{0}C = **-2,1 ^{0}C**

c) Ioonide molaalne kontsentratsioon

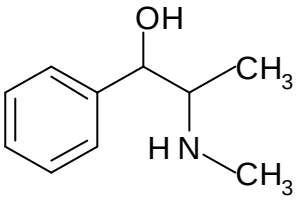
m(ioonid) = $\frac{5{,}0\ \text{K}}{1{,}86\,\frac{\text{K}\cdot\text{kg}}{\text{mol}}}$ = 2,69 mol/kg

m(NaCl) = $\frac{1}{2}\cdot(2{,}69-1{,}14)\frac{\text{mol}}{\text{kg}}\cdot 0{,}966\,\text{kg}\cdot 58{,}5\,\text{g/mol}$ = 43,8 g **~ 44 g**

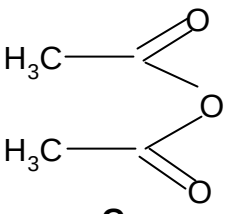
6. a) i)



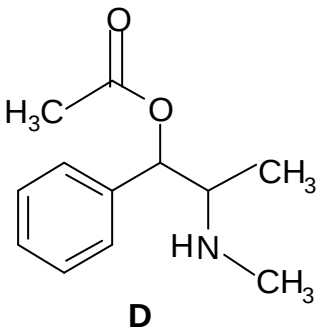
A



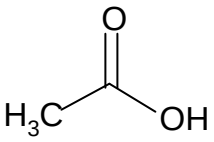
B



C



D



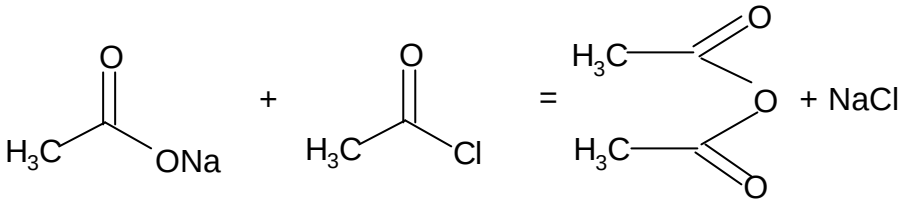
E

ii) B – 2-(N-metüülamino)-1-fenüül-1-hüdroksüpropaan

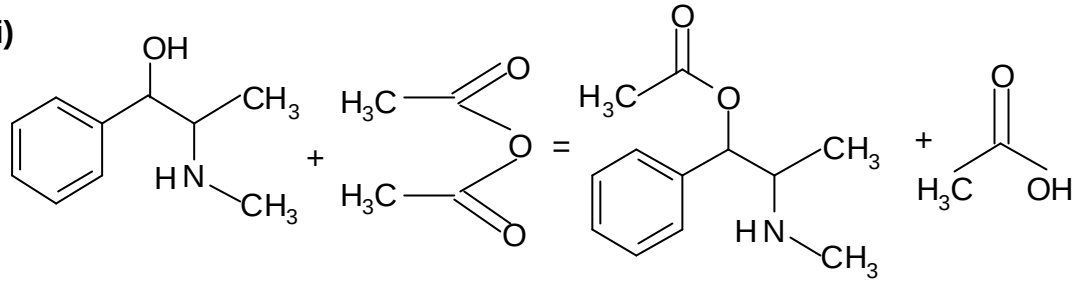
C – äädikhappe e. etaanhappe anhüdriid

E – äädikhape e etaanhape

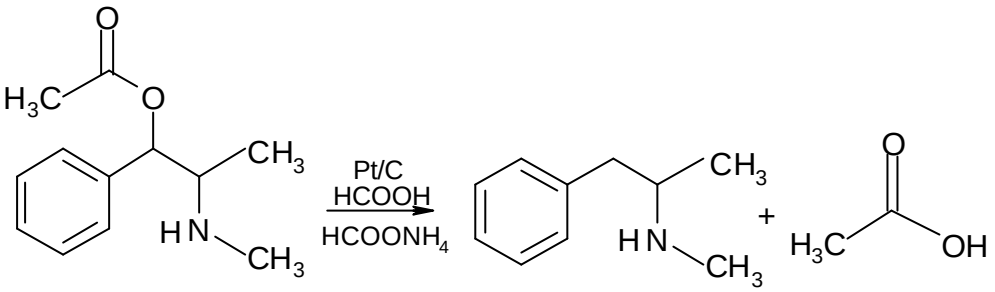
b) i)


O
H3C
ONa
+
O
H3C
Cl
=
O
H3C
O
H3C
O
+ NaCl

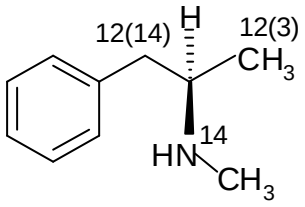
ii)


OH
CH3
HN
CH3
+
O
H3C
O
H3C
O
=
O
H3C
O
CH3
HN
CH3
+
O
H3C
OH

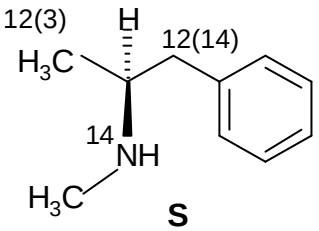
iii)


O
H3C
O
CH3
HN
CH3
Pt/C
HCOOH
HCOONH4
CH3
HN
CH3
+
O
H3C
OH

c)


12(14)
H
12(3)
CH3
14
HN
CH3

R


12(3)
H
H3C
12(14)
14
NH
H3C

S

2005/2006 õa keemiaolümpiaadi lõppvooru ülesannete lahendused
12. klass

1. a) **A** – $Mn(OH)_2$, mangaan(II)hüdroksiid
B - K_2MnO_4, kaaliummanganaat
C – $Mn(NO_3)_2$, mangaan(II)nitraat
D – $MnCl_2$, mangaan(II)kloriid
E – $MnSO_4$, mangaan(II)sulfaat
F – $KMnO_4$, kaaliumpermanganaat
G – MnO_2, mangaan(IV)oksiid

b) i) $2MnO_2 + 4KOH + O_2 \overset{^0t\,^0t}{=} 2K_2MnO_4 + 2H_2O$
ii) $MnO_2 + 4HCl = MnCl_2 + Cl_2 + 2H_2O$
iii) $4KMnO_4 + Mn(OH)_2 + 6KOH = 5K_2MnO_4 + 4H_2O$
iv) $MnCl_2 + 2AgNO_3 = Mn(NO_3)_2 + 2AgCl\downarrow$
v) $MnCl_2 + 2KOH = Mn(OH)_2\downarrow + 2KCl$
vi) $MnCl_2 \xrightarrow{\text{elektrolüüs}} Mn + Cl_2$
vii) $2KMnO_4 \xrightarrow{^0t} K_2MnO_4 + MnO_2\downarrow + O_2$
viii) $3MnO_2 + 4Al = 2Al_2O_3 + 3Mn$
ix) $2KMnO_4 + H_2O_2 + 2KOH = 2K_2MnO_4 + O_2 + 2H_2O$
x) $2KMnO_4 + 5H_2O_2 + 3H_2SO_4 = 2MnSO_4 + K_2SO_4 + 5O_2 + 8H_2O$

2. a) i) $\mathbf{c(C_6H_5COOH)_v} = \frac{m(C_6H_5COOH)_v}{M(C_6H_5COOH)\cdot V} = \frac{0{,}0107\ g}{122\ g/mol \cdot 50\ ml \cdot 10^{-3}\ l/ml} \approx$

$\approx$ **0,0018 M**

ii) $\mathbf{c(C_6H_5COOH)_b} = \frac{m(C_6H_5COOH)_b}{M(C_6H_5COOH)\cdot V} = \frac{0{,}0363\ g}{122\ g/mol \cdot 50\ ml \cdot 10^{-3}\ l/ml} \approx$

$\approx$ **0,0060 M**

b) $K_a = \frac{[H^+][C_6H_5COO^-]}{[C_6H_5COOH]}$

c) i) $c(C_6H_5COOH)_v = [C_6H_5COOH]_v + [C_6H_5COO^-]_v$

ii) $[C_6H_5COO^-]_v = [H^+]_v$

d) $[H^+]^2 + K_a\cdot[H^+] - K_a\cdot c(C_6H_5COOH)_v = 0 \Rightarrow$

$$\Rightarrow [H^+] = \frac{-K_a + \sqrt{K_a^2 + 4K_a \cdot c(C_6H_5COOH)_v}}{2}$$

$$[H^+]_v = \frac{-6{,}20\cdot10^{-5} + \sqrt{(6{,}20\cdot10^{-5})^2 + 4\cdot6{,}20\cdot10^{-5}\cdot0{,}0018}}{2} \approx \mathbf{0{,}00030\ M}$$

pH = 3,52

e) $\mathbf{[C_6H_5COO^-]_v} = [H^+]_v = \mathbf{0{,}00030\ M}$

$\mathbf{[C_6H_5COOH]_v} = 0{,}0018\ M - 0{,}0003\ M = \mathbf{0{,}0015\ M}$

$\mathbf{[OH^-]} = \frac{K_v}{[H^+_v]} \approx \mathbf{3{,}33\times10^{-11}\ M}$

f) i) $\mathbf{[C_6H_5COOH]_b} = K\cdot[C_6H_5COOH]_v = 1{,}43\cdot0{,}0015\ M \approx \mathbf{0{,}0021\ M}$

ii) $\mathbf{[(C_6H_5COO)_2]_b} = \frac{0{,}0060\ M - 0{,}0021M}{2} \approx \mathbf{0{,}0020\ M}$

g) i) $2(C_6H_5COOH)_b = (C_6H_5COOH)_{2,b}$

ii) $\mathbf{K_D} = \frac{[(C_6H_5COOH)_2]_b}{[C_6H_5COOH]_b^2} = \frac{0{,}0020}{(0{,}0021)^2} = 453.5 \approx \mathbf{450}$

3. a) **A** – $[Co(NH_3)_6]SO_4$, heksaammiinkoobalt(II)sulfaat

B – $Co_2SO_4(OH)_2$, koobalt(II)hüdroksiidsulfaat

C – $Co(OH)_2$, koobalt(II)hüdroksiid

D – CoO(OH), koobalt(III)hüdroksiidoksiid

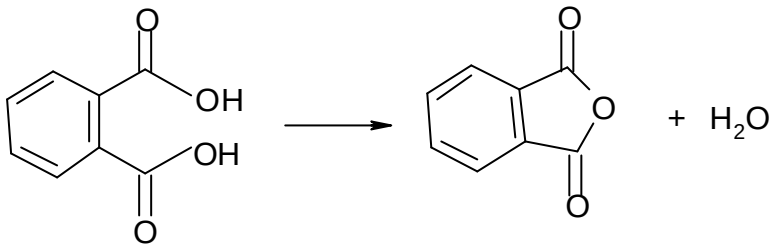
E – $[Co(NH_3)_6](OH)_3$, heksaammiinkoobalt(III)hüdroksiid

b) i) $CoSO_4 + 6NH_3 = [Co(NH_3)_6]SO_4$

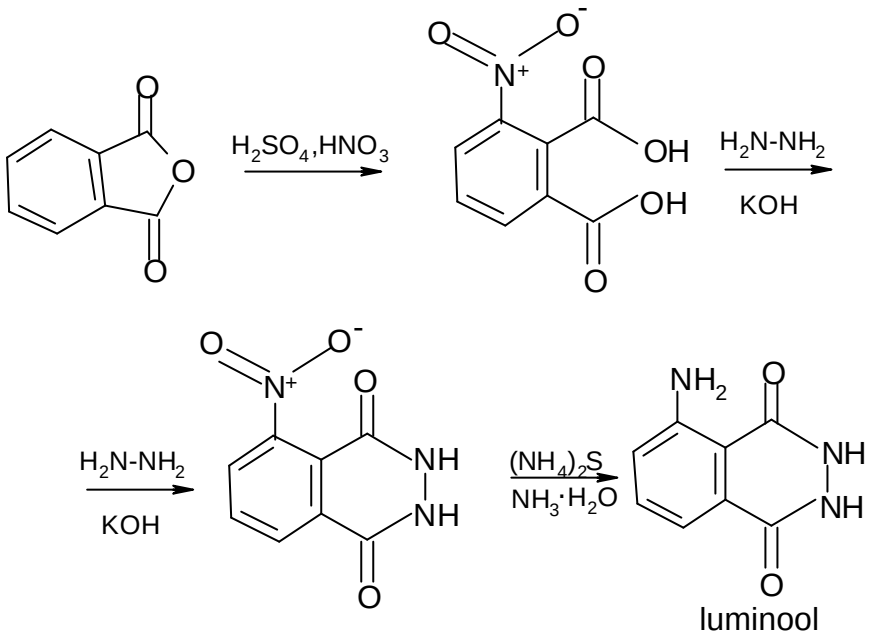
ii) $2CoSO_4 + 2NaOH = Co_2SO_4(OH)_2\downarrow + Na_2SO_4$
iii) $Co_2SO_4(OH)_2 + 2NaOH = 2Co(OH)_2\downarrow + Na_2SO_4$
iv) $4Co(OH)_2 + O_2 = 4CoO(OH)\downarrow + 2H_2O$
v) $2Co(OH)_2 + H_2O_2 = 2CoO(OH)\downarrow + 2H_2O$
vi) $CoO(OH) + 6NH_3 + H_2O = [Co(NH_3)_6](OH)_3$
vii) $[Co(NH_3)_6](OH)_3 = CoO(OH)\downarrow + 6NH_3 + H_2O$

4. a) **A** – benseen-1,2-dikarboksüülhappe anhüdriid e ftaalhappe anhüdriid
B – benseen-1,2-dikarboksüülhape e ftaalhape
C – 3-nitrobenseen-1,2-dikarboksüülhape e 3-nitroftaalhape

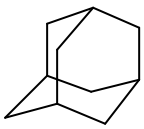
b)



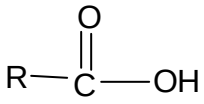
c)

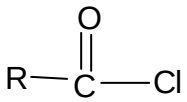


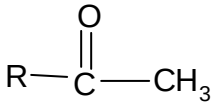
5. a)

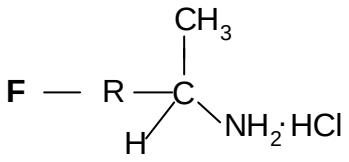


b) B – R–Br

C — 

D — 

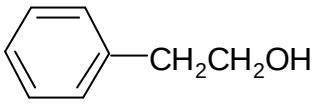
E — 



B - bromoadamantaan
C – adamantaankarboksüülhape
D – adamantaankarboksüülhappeklooranhüdriid

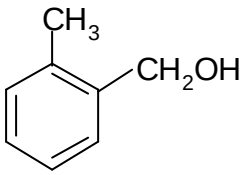
6. a) $PhCH_2Cl + Mg = PhCH_2MgCl$

b)

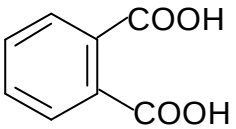


2-fenüületanool

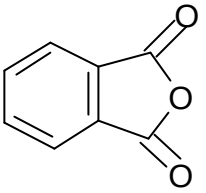
c)



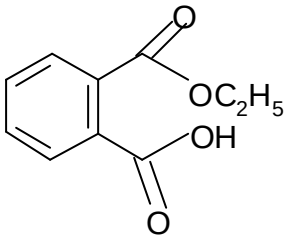
A



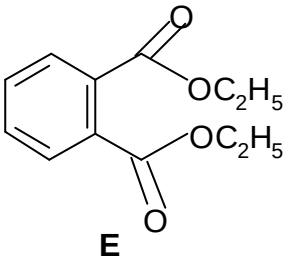
B



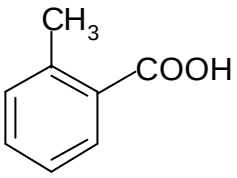
C



D



E



F