1999/2000 õa keemiaolümpiaadi III vooru ülesannete lahendused
9. klass

1. a) H_2SO_4 – väävelhape
b) HNO_3 – lämmastikhape
c) H_2SO_3 – väävlishape
d) HIO – hüpojoodishape
e) HClO – hüpokloorishape
f) HBrO – hüpobroomishape
g) H_2CO_2 – metaanhape (HCOOH)

2. a) **m'($FeSO_4$)** = 250 g·(1,00-0,82) = **45 g**

b) **i) m'($FeSO_4 \cdot 7H_2O$)** = 45 g· $\frac{278}{152}$ = 82,3 g ≈ **82 g**

ii) m(H_2O) = 250 g - 82 g = **168 g**

c) m"($FeSO_4$) = 103 g · 0,136 = 14 g
m($FeSO_4$) = 45 g - 14 g = 31 g
m($FeSO_4 \cdot 7H_2O$) = 31 g · $\frac{278}{152}$ = 56,7 g ≈ **57 g**

3. a) Me + 2HCl = $MeCl_2$ + $H_2\uparrow$
Me Y H_2

b) **n(H_2)** = 3,136 dm^3· $\frac{1\ mol}{22,4\ dm^3}$ = **0,14 mol**

c) 4 : 2 : 1
n(A) + n(B) + n(C) = 0,14 mol
i) n(A) = $\frac{4}{7}$·0,14 = **0,08 mol**
ii) n(B) = $\frac{2}{7}$·0,14= **0,04 mol**
iii) n(C) = $\frac{1}{7}$·0,14 = **0,02 mol**

d) 0,08 mol·3x g/mol + 0,04 mol·5x g/mol + 0,02 mol·7x g/mol = 4,64 g; **x = 8**

e) **i)** M(A) = 3 g/mol·8 = 24 g/mol — **A** – Mg, magneesium
ii) M(B) = 5 g/mol·8 = 40 g/mol — **B** – Ca, kaltsium
iii) M(C) = 7 g/mol·8 = 56 g/mol — **C** – Fe, raud

4. a) **i)** $Ba(OH)_2$ + H_2SO_4 = $BaSO_4\varnothing$+ $2H_2O$
ii) 2NaOH + H_2SO_4 = Na_2SO_4 + $2H_2O$

b) $Ba(OH)_2$ Y $BaSO_4$
171 g/mol 233 g/mol
m[$Ba(OH)_2$] = $\frac{1}{1}$·14,0 g· $\frac{1\ mol}{233\ g}$·171 g/mol = **10,3 g**
m(leelised) = 250 g · 0,105 = 26,3 g
m(NaOH) = 26,3 g - 10,3 g = **16,0 g**

c) **n(H_2SO_4)** = 250 g · 0,100 · $\frac{1\ mol}{98,1\ g}$ = **0,255 mol**

d) $Ba(OH)_2$ Y H_2SO_4
171 g/mol
n'(H_2SO_4) = 10,3 g · $\frac{1\ mol}{171\ g}$ = 0,0602 mol ≈ 0,060 mol
NaOH neutraliseerimiseks jääb

n”(H_2SO_4) = 0,255 mol - 0,060 mol = 0,195 mol
NaOH neutraliseerimiseks kuluks
2NaOH Y H_2SO_4
40,0 g/mol

$$n(H_2SO_4) = \frac{1}{2}\cdot 16{,}0\ \text{g}\cdot\frac{1\ \text{mol}}{40{,}0\ \text{g}} = 0{,}200\ \text{mol}$$

Na_2SO_4 Y H_2SO_4 (n” = 0,195 mol)

n(Na_2SO_4) = $\frac{1}{1}\cdot 0{,}195$ mol = **0,195 mol**

2NaOH Y H_2SO_4 (n = 0,200 mol - 0,195 mol = 0,005 mol)

n(NaOH) = $\frac{2}{1}\cdot 0{,}005$ mol = **0,010 mol**

5. a) **i)** $C_3H_8 + 5O_2 = 3CO_2 + 4H_2O$
ii) $2C_4H_{10} + 13O_2 = 8CO_2 + 10H_2O$

b) **i)** $2NaOH(liias) + CO_2 = Na_2CO_3 + H_2O$
ii) $NaOH + CO_2(liias) = NaHCO_3$
ehk $Na_2CO_3 + CO_2 + H_2O = 2NaHCO_3$

c) $$n'(CO_2) = \frac{1}{1}\cdot 95{,}4\ \text{g}\cdot\frac{1\ \text{mol}}{106\ \text{g}} = 0{,}900\ \text{mol}$$

$$n''(CO_2) = \frac{1}{1}\cdot 84{,}0\ \text{g}\cdot\frac{1\ \text{mol}}{84{,}0\ \text{g}} = 1{,}00\ \text{mol}$$

n(CO_2) = n’ + n” = **1,90 mol**

d) $$n(\text{gaase}) = 11{,}2\ \text{dm}^3\cdot\frac{1\ \text{mol}}{22{,}4\ \text{dm}^3} = 0{,}500\ \text{mol}$$

Olgu butaani moolide arv x
(0,500 mol - x)·3 + x·4 = 1,90 mol
1,50 mol - 3x + 4x = 1,90 mol; x = 0,40 mol
n(C_4H_{10}) = 0,40 mol
n(C_3H_8) = 0,50 mol - 0,40 mol = 0,10 mol
i) m(C_3H_8) = 0,10 mol·44,0 g/mol = **4,4 g**
ii) m(C_4H_{10}) = 0,40 mol·58,0 g/mol = **23,2 g**

6. a) $M(X) = 7{,}87\ \text{g/cm}^3\cdot 7{,}09\ \text{cm}^3/\text{mol} = 55{,}8\ \text{g/mol}$
X – Fe, raud

b) **Y** – Al, alumiinium
A – H_2O, vesi
B – H_2, vesinik
C – Fe_3O_4, raud(II,III)oksiid
D – Al_2O_3, alumiiniumoksiid
E – Cl_2, kloor
F – $FeCl_3$, raud(III)kloriid
G – $FeCl_2$, raud(II)kloriid
H – O_2, hapnik
I – Fe_2O_3, raud(III)oksiid

c) **i)** $3Fe + 4H_2O \xrightarrow{^0t^0t} Fe_3O_4 + 4H_2\uparrow$
ii) $3Fe_3O_4 + 8Al = 9Fe + 4Al_2O_3$
iii) $2Fe + 3Cl_2 = 2FeCl_3$
iv) $Fe + 2HCl = FeCl_2 + H_2\uparrow$
v) $4Fe + 12HCl + 3O_2 = 4FeCl_3 + 6H_2O$
vi) $4Fe + 3O_2 = 2Fe_2O_3$

1999/2000 õa keemiaolümpiaadi III vooru ülesannete lahendused
10. klass

1. a) H_4SiO_4, H_3PO_4, H_2SO_4, $HClO_4$

b) $S + Hg = HgS$

c) **i)** Kui **L** on **Hg**, siis **X** saab olla ainult Tl, sest see on peaalarühma element, mille oksüdatsiooniaste peaks olema III. Au ei sobi, sest see pole peaalarühma element ega reageeri veega.

ii) Ühend **A** saab olla **Tl_2SO_4**, sest Tl oksüdatsiooniaste on tavaliselt I. Kahe talliumiooni sisaldusele soolas (sulfaadis) viitab ka talliumi erakordselt kõrge protsendiline sisaldus ühendis **A**.

d) **i)** $4Tl + 2H_2O + O_2 = 4TlOH$

ii) $2TlOH + H_2SO_4 = Tl_2SO_4 + 2H_2O$

e) amalgaam

f) **%(Tl)** = $\frac{2 \cdot 204{,}4}{504{,}9} \cdot 100$ = **80,97**

2. a) **X** – HNO_3, lämmastikhape; **Y**– HCl, vesinikkloriidhape; **Z** – H_2SO_4, väävelhape

b) **A**– $Cu(NO_3)_2$, vask(II)nitraat; **B** – $CuCl_2$, vask(II)kloriid**;** **C** – $CuSO_4$, vask(II)sulfaat

c) $Cu + 4HNO_3 = Cu(NO_3)_2 + 2NO_2 + 2H_2O$
ühend **A**

d) **i)** segamisel osaleb reaktsioonis hapnik

ii) $2Cu + 4HCl + O_2 = 2CuCl_2 + 2H_2O$
ühend **B**

iii) $2Cu + 2H_2SO_4 + O_2 = 2CuSO_4 + 2H_2O$
ühend **C**

e) **i)** $CuCl_2 + 2AgNO_3 = Cu(NO_3)_2 + 2AgCl\varnothing$
ühend **G**, hõbekloriid

ii) $CuSO_4 + BaCl_2 = CuCl_2 + BaSO_4\varnothing$
ühend **H**, baariumsulfaat

f) Cu Y $Cu(NO_3)_2$ Y $CuCl_2$ Y $CuSO_4$
63,5 g/mol 188 g/mol 134 g/mol 160 g/mol

i) kristallhüdraat **D** – $Cu(NO_3)_2 \cdot n'H_2O$

$$n'(H_2O) = 1\,\text{mol} \cdot \frac{63{,}5\ \text{g/mol}}{0{,}496\ \text{g}} \left(1{,}89\ \text{g} - \frac{0{,}496\ \text{g}}{63{,}5\ \text{g/mol}} \cdot 188\ \text{g/mol} \right) \cdot \frac{1\,\text{mol}}{18\ \text{g}} = 3\ \text{mol}$$

D - $Cu(NO_3)_2 \cdot 3H_2O$

ii) kristallhüdraat **E** – $CuCl_2 \cdot n''H_2O$

$$n''(H_2O) = 1\,\text{mol} \cdot \frac{63{,}5\ \text{g/mol}}{0{,}496\ \text{g}} \left(1{,}33\ \text{g} - \frac{0{,}496\ \text{g}}{63{,}5\ \text{g/mol}} \cdot 134\ \text{g/mol} \right) \cdot \frac{1\,\text{mol}}{18\ \text{g}} = 2\ \text{mol}$$

E – $CuCl_2 \cdot 2H_2O$

iii) kristallhüdraat **F** – $CuSO_4 \cdot n'''H_2O$

$$n'''(H_2O) = 1\,\text{mol} \cdot \frac{63{,}5\ \text{g/mol}}{0{,}248\ \text{g}} \left(0{,}98\ \text{g} - \frac{0{,}248\ \text{g}}{63{,}5\ \text{g/mol}} \cdot 160\ \text{g/mol} \right) \cdot \frac{1\,\text{mol}}{18\ \text{g}} = 5\ \text{mol}$$

F – $CuSO_4 \cdot 5H_2O$

g) **i)** $[Cu(H_2O)_2Cl_2]$

ii) $[Cu(H_2O)_3NO_3]NO_3$

iii) $[Cu(H_2O)_4]SO_4(H_2O)$

3. a) **i)** $C_3H_8 + 5O_2 = 3CO_2 + 4H_2O$

ii) D**$H_c(C_3H_8)$** = 3·(-394kJ/mol) + 4·(-242kJ/mol)-1·(-104kJ/mol) -5·0=**-2046kJ/mol**

Märkus: Kõikide kordajate dimensiooniks on mol/mol, mis taandub.

b) **i)** $4C + 5H_2 = C_4H_{10}$

ii) D**$H_f(C_4H_{10})$** = 4·(-394kJ/mol) + 5·(-242kJ/mol) - 1·(-2655kJ/mol) = **-131kJ/mol**

c) $\Delta H(C_4H_{10}) = 21{,}0\ \text{kg} \cdot \frac{1000\ \text{g}}{1\ \text{kg}} \cdot \frac{1\ \text{mol}}{58{,}1\ \text{g}} \cdot (-2655\ \text{kJ/mol}) = -9{,}60 \cdot 10^5\ \text{kJ}$

m(C_3H_8) = $-9{,}60\cdot10^5$ kJ$\cdot\frac{1\text{ mol}}{-2046\text{ kJ}}\cdot\frac{0{,}0440\text{ kg}}{\text{mol}}$ = **20,6 kg**

d) Rohkem, sest auru kondenseerumine on eksotermiline protsess.

4. a) **A** - $KMnO_4$, kaaliumpermanganaat
B – K_2MnO_4, kaaliummanganaat
C – MnO_2, mangaandioksiid e mangaan(IV)oksiid
D – O_2, hapnik
E – $MnSO_4$, mangaansulfaat

b) **i)** $2KMnO_4 \xrightarrow{t^o} K_2MnO_4 + MnO_2 + O_2\uparrow$

ii) $2K_2MnO_4 + Cl_2 = 2KMnO_4 + 2KCl$
ühend **A**

iii) $2MnO_2 + 4KOH + O_2 = 2K_2MnO_4 + 2H_2O$
ühend **B**

iv) $2MnO_2 + 2H_2SO_4 = 2MnSO_4 + O_2\uparrow + 2H_2O$
ühend **E** gaas **D**

v) $3K_2MnO_4 + 2H_2O = 2KMnO_4 + MnO_2 + 4KOH$
ühend **A** ühend **C**

vi) $10KCl + 8H_2SO_4 + 2KMnO_4 = 2MnSO_4 + 5Cl_2\uparrow + 6K_2SO_4 + 8H_2O$
ühend **E**

5. a) **c(gaas)** = $\frac{n(\text{gaas})}{1\,dm^3}$ $\frac{1}{dm^3}\cdot1\,dm^3\cdot\frac{1\text{ mol}}{0{,}05\,dm^3}$ = **20 mol/dm^3**

b) **i)** $N_2 + 3H_2 \rightleftharpoons 2NH_3$

ii) **K_{tasak}** = $\frac{[NH_3]^2}{[N_2][H_2]^3}$ $\frac{(2M)^2}{3M\cdot(5M)^3}=\frac{4M^2}{3M\cdot125M^3}=0{,}0107\cdot\frac{1}{M^2}\approx$ **$1\times10^{-2}\times\frac{1}{M^2}$**

c) **i)** **c(H_2)** = $5M+\frac{3}{2}\cdot2M$ = **8M**

ii) **c(N_2)** = $3M+\frac{1}{2}\cdot2M$ = **4M**

6. **a)** **M** – Mg, magneesium
X – CO_2, süsinikdioksiid
Y–O_2, hapnik
Z – N_2, lämmastik
A – MgO, magneesiumoksiid
B – C, süsinik
C – Mg_3N_2, magneesiumnitriid
D – $Mg(OH)_2$, magneesiumhüdroksiid
E – NH_3, ammoniaak
F - $MgCO_3$, magneesiumkarbonaat

b) **i)** $2Mg + CO_2 = 2MgO + C$
aine **A** aine **B**

ii) $2Mg + O_2 = 2MgO$
aine **A**

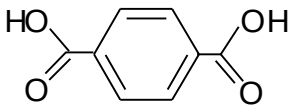
iii) $3Mg + N_2 = Mg_3N_2$
aine **C**

c) **i)** $Mg_3N_2 + 6H_2O = 3Mg(OH)_2 + 2NH_3$
aine **D** aine **E**

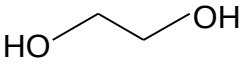
ii) $Mg(OH)_2 \xrightarrow{t^o} H_2O + MgO$
aine **A**

iii) $MgCO_3 \xrightarrow{t^o} MgO + CO_2\uparrow$
aine **A** gaas **X**

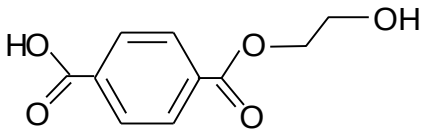
1999/2000 õa keemiaolümpiaadi III vooru ülesannete lahendused
11. klass

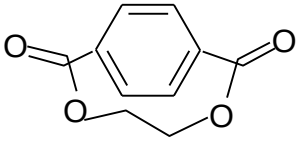
1. a) 

1,4–benseendikarboksüülhape, para–benseendikarboksüülhape

b) 

1,2–etaandiool

c) 

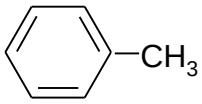
d) 

e) $p_1 \cdot V_1 = p_2 \cdot V_2$

$6\ \text{atm} \cdot 530\ \text{ml} = 1\ \text{atm} \cdot V$

$$V = 530\ \text{ml} \cdot \frac{6\ \text{atm}}{1\ \text{at}} \cdot \frac{1\ \text{dm}^3}{1000\ \text{ml}} = 3{,}18\ \text{dm}^3$$

$$\textbf{n(õhk)} = 3{,}18\ \text{dm}^3 \cdot \frac{1\ \text{mol}}{22{,}4\ \text{dm}^3} = \textbf{0,142 mol}$$

2. a) i) 

ii) $C(CH_3)_3OOH$

iii) $C(CH_3)_3OH$

b) i) $C(CH_3)_3OOH + 2KI + 2HCl = C(CH_3)_3OH + I_2 + 2KCl + H_2O$

ii) $2Na_2S_2O_3 + I_2 = Na_2S_4O_6 + 2NaI$

c) $25{,}0\ \text{cm}^3$ $\qquad$ $10{,}20\ \text{cm}^3 \cdot 0{,}2039\ \text{mol/dm}^3$

$C(CH_3)_3OOH$ U $2Na_2S_2O_3$

90,1 g/mol

m[$C(CH_3)_3OOH$] = $\frac{1}{2} \cdot 10{,}20\ cm^3 \cdot 0{,}2039\ mol/dm^3 \cdot \frac{1}{25{,}0\ cm^3} \cdot 1\ dm^3 \cdot 90{,}1\ g/mol$ = **3,74 g**

3. a) M(X) = 2,0 g/mol·22 = 44 g/mol

b) **1)** $3H_2 + N_2 \xrightarrow[Pt]{p,\ t^o} 2NH_3$ (ühend **A** on ammoniaak)
2) $4NH_3 + 5O_2 = 4NO + 6H_2O$ (ühend **B** on lämmastikoksiid)
3) $2NO + O_2 = 2NO_2$ (ühend **C** on lämmastikdioksiid)
4) $4NO_2 + O_2 + 2H_2O = 4HNO_3$ (ühend **D** on lämmastikhape)
5) $HNO_3 + NH_3 = NH_4NO_3$ (ühend **E** on ammooniumnitraat)
6) $NH_4NO_3 \xrightarrow{t^o} N_2O\uparrow + 2H_2O$

c) $10HNO_3$ lahj. + 4Mg = $4Mg(NO_3)_2$ + **N_2O**$\uparrow$ + $5H_2O$
ühend **X** - dilämmastikoksiid

d) **i)** $2NH_3 + 2Na = 2NaNH_2 + H_2$
ii) $NaNH_2 + N_2O = NaN_3 + H_2O$
iii) $2NaN_3 + Pb^{2+} = Pb(N_3)_2\varnothing + 2Na^+$

e) H–N–N ρ N ⇌ H–N=N=N

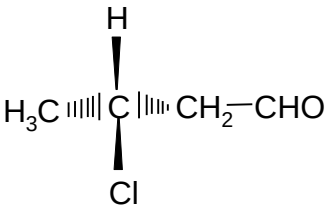
4. a) **i) M(A)** = 1,1607 g/dm^3·22,4 dm^3/mol = **26,0 g/mol**
ii) n(C) = 26,0 g·0,923·$\frac{1\ mol}{12\ g}$ = 2 mol
n(H) = 26,0 g·0,077·$\frac{1\ mol}{1\ g}$ = 2 mol
C_2H_2

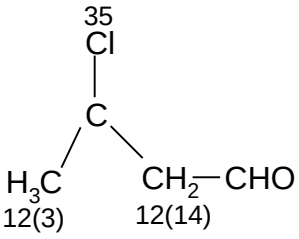
iii) HC r CH

b) **i)** $HC \equiv CH + H_2O \xrightarrow[OH^-]{katal} CH_3CHO$ (ühend **B**)
ii) $2CH_3CHO = CH_3CH(OH)CH_2CHO$ (ühend **X**)
iii) $CH_3CH(OH)CH_2CHO \xrightarrow{t^o} CH_3CH=CHCHO$ (krotoonaldehüüd)
ühend **E**

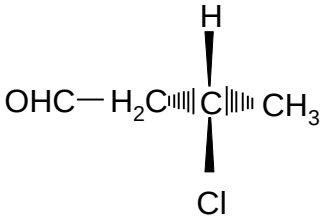
+σ -σ
iv) $CH_3CH=CHCHO + HCl = CH_3CHClCH_2CHO$ (3–klorobutanaal–1)

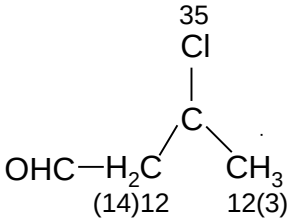
c)





R,3-klorobutanaal-1





S,3-klorobutanaal-1

5. a) **i)** $Zn = Zn^{2+} + 2e^-$

ii) $Cu^{2+} + 2e^- = Cu$

b) $Zn \mid ZnSO_4 \mid\mid CuSO_4 \mid Cu$

c) $E = E^o(Cu^{2+}/Cu) - E^o(Zn^{2+}/Zn) + \frac{0{,}0591}{2}\left[\lg c(Cu^{2+}) - \lg c(Zn^{2+})\right] =$

$= 0{,}340V - (-0{,}763\ V) + 0{,}0296\ [-1 - (-1)]\ V =$ **1,103 V**

d) Galvaanielement töötab kuni kogu Cu^{2+} on redutseerunud

Cu^{2+} Y $2e^-$

Q = $\frac{2}{1} \cdot 1{,}00\ dm^3 \cdot 0{,}100\ mol/dm^3 \cdot 96500\ A \cdot s/mol \cdot \frac{1\ h}{3600\ s}$ = **5,36 A×h**

6. a) **i)** $n(Cu) = 10{,}20 \cdot 10^{-3}\ dm^3 \cdot 0{,}0100\ mol/dm^3 \cdot 10 = 1{,}02 \cdot 10^{-3}\ mol$

$m(Cu) = 1{,}02 \cdot 10^{-3}\ mol \cdot 63{,}5\ g/mol = 0{,}0648\ g$

%(Cu) = $\frac{0{,}0648}{0{,}2317} \cdot 100$ = **28,0**

ii) $n(Y+Cu) = 13{,}70 \cdot 10^{-3}\ dm^3 \cdot 0{,}0100\ mol/dm^3 \cdot 10 = 1{,}36 \cdot 10^{-3}\ mol$

$n(Y) = 1{,}36 \cdot 10^{-3}\ mol - 1{,}02 \cdot 10^{-3}\ mol = 3{,}4 \cdot 10^{-4}\ mol$

$m(Y) = 3{,}4 \cdot 10^{-4}\ mol \cdot 88{,}9\ g/mol = 0{,}0302\ g \approx 0{,}030\ g$

%(Y) = $\frac{0{,}0302}{0{,}2317} \cdot 100$ = **13**

iii) $n(Ba) = (20{,}00 \cdot 10^{-3}\ dm^3 \cdot 0{,}0100\ mol/dm^3 -$

$- 8{,}80 \cdot 10^3 dm^3 \cdot 0{,}0150\ mol/dm^3) \cdot 10 = 6{,}8 \cdot 10^{-4}\ mol$

$m(Ba) = 6{,}8 \cdot 10^{-4}\ mol \cdot 137\ g/mol = 0{,}0932\ g \approx 0{,}093\ g$

%(Ba) = $\frac{0{,}0932}{0{,}2317} \cdot 100$ = **40**

iv) m(O) = 0,2317 g - 0,0648 g - 0,0302 g - 0,0932 g=0,0434 g ≈ 0,043 g

%(O) = $\frac{0,0434}{0,2317} \cdot 100$ = **19**

b)

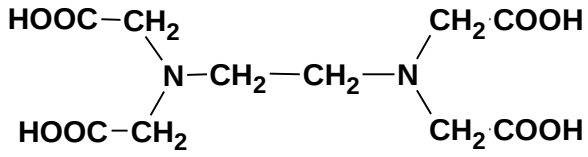
Cu	Y	Ba	O
$1,02 \cdot 10^{-3}$ mol	$3,4 \cdot 10^{-4}$ mol	$6,8 \cdot 10^{-4}$ mol	$\frac{0,0434\ g}{16 g/mol} = 2,71 \cdot 10^{-3}$ mol

$\frac{1\ mol}{3,4 \cdot 10^{-4}\ mol}$ = 2941

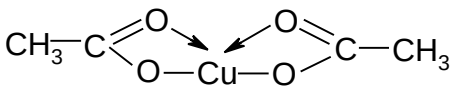
n(Cu) = $2941 \cdot 1,02 \cdot 10^{-3}$ mol = 3 mol
n(Ba) = $2941 \cdot 6,8 \cdot 10^{-4}$ mol = 2 mol
n(O) = $2941 \cdot 2,71 \cdot 10^{-3}$ mol = 8 mol

$Cu_3Y_1Ba_2O_8$

c) i)



ii)

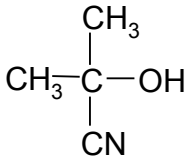


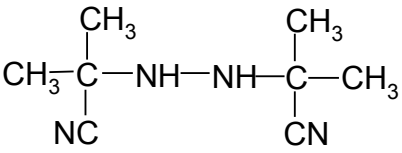
1999/2000 õa keemiaolümpiaadi III vooru ülesannete lahendused
12. klass

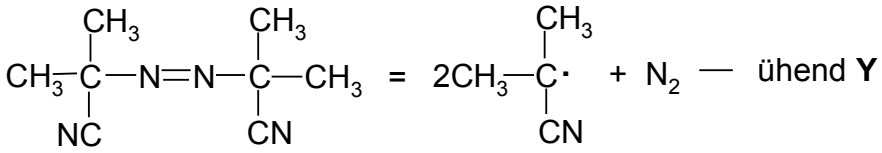
1. a) $Cl_2 + H_2O = HCl + HClO$ HClO on oksüdeerija

b) i) CH_3COCH_3
ii) $H_2N–NH_2$

c) i) HCN (vesiniktsüaniid) – ühend **X**

ii)  – ühend **A**

iii)  – ühend **B**

d) 

e) i) **M(Y)** = 32 g/mol·0,875 = **28,0 g/mol**
ii) Sama molaarmass on lämmastikul (N_2), süsinikmonooksiidil (CO) ja eteenil ($CH_2=CH_2$). CO ei saa tekkida, kuna ühendis 1,1′–ditsüano–1,1′–dimetüülasoetaanis puudub hapnik, etüülrühm ei lagune eteeniks.

2. a) i) **M(X)** = $\frac{1}{2}\left(\frac{32{,}1}{0{,}226} - 32{,}1 - 4\cdot 16{,}0\right)\text{g/mol}$ = **23,0 g/mol**

ii) **M(Y)** = $\frac{1}{2}\left(\frac{32{,}1}{0{,}254} - 32{,}1 - 4\cdot 16{,}0\right)\text{g/mol}$ = **15,1 g/mol**

b) **A** – Na_2SO_4, naatriumsulfaat
B – $(CH_3)_2SO_4$, dimetüülsulfaat
C – NaOH, naatriumhüdroksiid
D – CH_3NaSO_4, naatriummetüülsulfaat
E – CH_3OH, metanool
F – Na, naatrium
G – CH_3ONa, metoksünaatrium, naatriummetanolaat

c) **i)** $(CH_3)_2SO_4 + NaOH = CH_3NaSO_4 + CH_3OH$
ii) $(CH_3)_2SO_4 + 2NaOH = Na_2SO_4 + 2CH_3OH$
iii) $2CH_3OH + 2Na = 2CH_3ONa + H_2\uparrow$
iv) $CH_3ONa + H_2O = CH_3OH + NaOH$

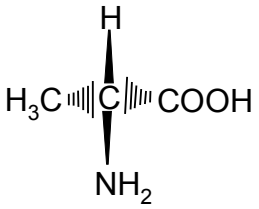
d) dimetüülsulfaat on ester $CH_3–O–SO_2–O–CH_3$

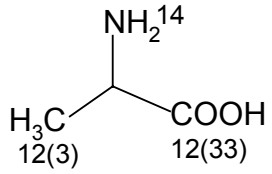
3. a) **A** – CH_3CHO
B – $CH_3–CH=NH$
C – $CH_3CH(NH_2)–C\equiv N$
X – $CH_3CH(NH_2)COOH$

b) **i)** $CH_3CHO + NH_3 = CH_3CH=NH + H_2O$
ii) $CH_3CH=NH + HCN = CH_3–CH(NH_2)–C\equiv N$
iii) $CH_3–CH(NH_2)–C\equiv N + 2H_2O = CH_3–CH(NH_2)COOH + NH_3$

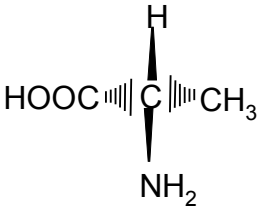
c) **i)** α–aminopropaanhape, alaniin

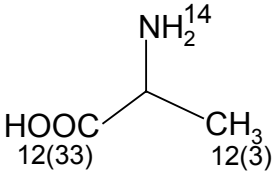
ii)





R

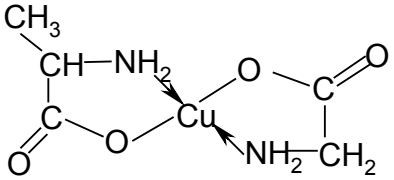




S

d) $2CH_3CH(NH_2)COOH + Cu^{2+} = [CH_3CH(NH_2)COO]_2Cu + 2H^+$

e)



4. a) **i)** Et atsetoonis on ainult üks hapnik, siis saab ühendi **B** molaarmassi leida hapniku protsendilise sisalduse järgi

$$M(B) = \frac{16{,}0\ g/mol}{0{,}381} = 42{,}0\ g/mol$$

Ühendis **B**: $n(H) = 42{,}0\ g \cdot 0{,}0476 \cdot \frac{1\ mol}{1\ g} = 2\ mol$

$$n(C) = (42 - 16 - 2)\ g \cdot \frac{1\ mol}{12\ g} = 2\ mol$$

Ühendi **B** empiiriline valem on C_2H_2O

ii) M(atsetoon) = 58 g/mol

M(**A**) = M(atsetoon) - m(**B**) = 58 g/mol - 42 g/mol = 16 g/mol

Ühendi **A** empiiriline valem on $C_3H_6O - C_2H_2O = CH_4$

b) **A** – CH_4, metaan

B – $CH_2=C=O$, keteen

C – $CH_3COOC_2H_5$, etüülmetanaat

D – CH_3COOH, etaanhape

E – CH_3COONa, naatriumetanaat

c) **i)** $CH_2=C=O + C_2H_5OH = CH_3COOC_2H_5$ (**C**)

ii) $CH_3COOC_2H_5 + H_2O = C_2H_5OH + CH_3COOH$ (**D**)

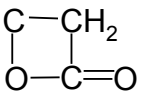
iii) $CH_2=C=O + H_2O = CH_3COOH$ (**D**)

iv) $CH_3COOH + NaOH = H_2O + CH_3COONa$ (**E**)

v) $CH_3COONa + NaOH = Na_2CO_3 + CH_4$ (**A**)

d) $CH_2=C=O + CH_3COOH = CH_3COOCOCH_3$

etaanhappeanhüdriid

e) $2(CH_2=C=O) =$ 

diketeen

5. a) **N(prep)** = $1250\ Ci/mmol \cdot 3{,}700 \cdot 10^{10} \frac{lagunemist}{sek} \cdot \frac{60\ sek}{1\ min}$ = **$2{,}775 \cdot 10^{15}$ dpm/mmol**

b) **N(100%)** = $5{,}41 \cdot 10^{-6} \frac{mmol}{mmol \cdot min} \cdot 6{,}02 \cdot 10^{20} \frac{lagunemist}{mmol}$ = **$3{,}26 \cdot 10^{15}$ dpm/mmol**

c) **n(100%)** = $1\ mmol \cdot \frac{2{,}78 \cdot 10^{15}}{3{,}26 \cdot 10^{15}}$ = **0,853 mmol**

d) **t** = $\frac{89{,}0\ ööpäeva}{\ln 2} \cdot \ln \frac{0{,}853}{0{,}853 - 0{,}100} \Rightarrow 128{,}4\ ööpäeva \cdot 0{,}1249$ = **16,0 ööpäeva**

e) eriaktiivsus (203 ööpäeva) = $1{,}000\ Ci/ml \cdot e^{\frac{-\ln 2}{89{,}0\ ööpäeva}} \cdot 203\ ööpäeva$ = **0,205 Ci/ml**

6. a) **i)** **$[Cl^-]$** = [AgCl] = $\frac{1{,}81\cdot10^{-3}\ g/dm^3}{143\ g/mol}$ = **$1{,}26\cdot10^{-5}$ mol/dm^3**

ii) **$c(Cl^-)$** = $c(H^+) = 10^{-pH} = 10^{-2{,}35}$ mol/dm^3 = **$4{,}47\cdot10^{-3}$ mol/dm^3**

b) **LK(AgCl)** = $[Ag^+][Cl^-] = (1{,}26\cdot10^{-5}\ mol/dm^3)^2$ = **$1{,}59\cdot10^{-10}$ mol^2/dm^6**

c) HCl lahuses [AgCl] = $[Ag^+] = \frac{1{,}59\cdot10^{-10}}{4{,}47\cdot10^{-3}}$ = **$3{,}56\cdot10^{-8}$ mol/dm^3**

L(AgCl) = $3{,}56\cdot10^{-8}$ mol/dm$^3\cdot$143 g/mol = $5{,}09\cdot10^{-6}$ g/dm^3

Lahustuvuste suhe on $\frac{1{,}81\cdot10^{-3}}{5{,}09\cdot10^{-6}}$ = **356**

d) **i)** **m(NaCl)** = $1{,}0\cdot10^4$ dm$^3\cdot1{,}0\cdot10^{-3}$ mol/dm$^3\cdot$58,5 g/mol = **585 g**

ii) **m(Ag)** = $\frac{1{,}59\cdot10^{-10}}{1{,}0\cdot10^{-3}}$ mol/dm$^3\cdot1{,}0\cdot10^4$ dm$^3\cdot$108 g/mol = **0,17 g**