

## Keemia lahtise võistluse ülesannete lahendused

Noorem rühm (9. ja 10. klass)

10. november 2001. a.

1.

Eeldame, et poest ostetud turvast on 100 g, siis on selles 28 g vett, 1,2 g vävliit ja 18 g tuhka.

Veevaba turvast on  $100\text{ g} - 28\text{ g} = 72\text{ g}$

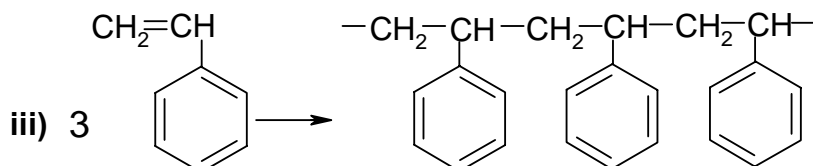
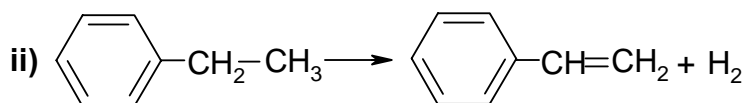
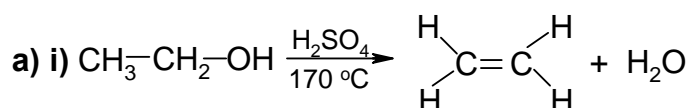
$$\text{a) \%(\text{tuhk})} = \frac{18\text{ g}}{72\text{ g}} \cdot 100 = \mathbf{25}$$

$$\text{b) \%(\text{väävel})} = \frac{1,2\text{ g}}{72\text{ g}} \cdot 100 = \mathbf{1,7}$$

c) Põlevat ainet on  $72\text{ g} - 18\text{ g} = 54\text{ g}$ . Väavlist moodustub põlemisel  $\text{SO}_2$ , mistõttu see on ka põlev aine.

$$\text{\%(\text{väävel})} = \frac{1,2\text{ g}}{54\text{ g}} \cdot 100 = \mathbf{2,2}$$

2.



b) 11,5 g

etanool  $\Leftrightarrow$  eteen  $\Leftrightarrow$  fenüületaan  $\Leftrightarrow$  stüreen  
46,0 g/mol

$$\text{n(\text{stüreen})} = \frac{1}{1} \cdot 11,5\text{ g} \cdot \frac{1\text{ mol}}{46,0\text{ g}} = \mathbf{0,250\text{ mol}}$$

c)  $M_r(\text{stüreen}) = 8 \cdot 12 + 8 \cdot 1 = 104$

$$\text{N(\text{stüreen})} = \frac{52000}{104} = \mathbf{500}$$

$$\text{d) } \text{n(\text{PS})} = 0,250\text{ mol} \cdot \frac{1}{500} = \mathbf{5,00 \cdot 10^{-4}\text{ mol}}$$

3.

a) i) X – P, fosfor

ii) A –  $\text{Ca}_3(\text{PO}_4)_2$ , kaltsiumortofosfaat

B –  $\text{CaSiO}_3$ , kaltsiummetasilikaat

C – CO, süsinikmonooksiid

D –  $\text{H}_2$ , vesinik

L –  $\text{PCl}_5$ , fosforpentakloriid

G – HCl, vesinikkloriidhape

I –  $\text{H}_3\text{PO}_4$ , ortofosforhape

J – NO, lämmastikmonooksiid

iii) E –  $\text{PH}_3$  (fosfiin – ei olnud nõutud)

Y – valge fosfor,  $\text{P}_4$  (ei nõutud)

b) i)  $2\text{Ca}_3(\text{PO}_4)_2 + 10\text{C} + 6\text{SiO}_2 = 6\text{CaSiO}_3 + 4\text{P} + 10\text{CO}$

õige on kirjutada  $\text{P}_4$

ii)  $8\text{P} + 7\text{KOH} + 7\text{H}_2\text{O} = 2\text{H}_2 + \text{PH}_3 + 7\text{KH}_2\text{PO}_2$

iii)  $2\text{P} + 5\text{Cl}_2 = 2\text{PCl}_5$

iv)  $\text{PCl}_5 + 4\text{H}_2\text{O} = 5\text{HCl} + \text{H}_3\text{PO}_4$

v)  $3\text{P} + 5\text{HNO}_3 + 2\text{H}_2\text{O} = 3\text{H}_3\text{PO}_4 + 5\text{NO}$

4.

<sup>o</sup>t

a) i)  $x\text{CuCO}_3 \cdot y\text{Cu}(\text{OH})_2 = (x + y)\text{CuO} + x\text{CO}_2 + y\text{H}_2\text{O}$

ii)  $\text{CO}_2 + \text{Ca}(\text{OH})_2 = \text{CaCO}_3 + \text{H}_2\text{O}$

5,00 g

b)  $x(\text{CuO}) \Leftrightarrow x(\text{CO}_2) \Leftrightarrow x(\text{CaCO}_3)$

100 g/mol

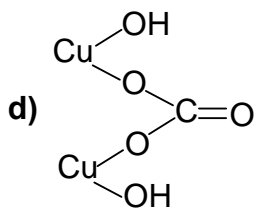
$$x(\text{CuO}) = \frac{1}{1} \cdot 5,00 \text{ g} \cdot \frac{1 \text{ mol}}{100 \text{ g}} = 0,0500 \text{ mol}$$

$$n(\text{CuO}) = 7,95 \text{ g} \cdot \frac{1 \text{ mol}}{79,5 \text{ g}} = 0,100 \text{ mol}$$

$$y(\text{CuO}) = 0,100 \text{ mol} - 0,0500 \text{ mol} = 0,050 \text{ mol}$$

$x = y$ , seega  $\text{CuCO}_3$  ja  $\text{Cu}(\text{OH})_2$  suhe on **1 : 1**

c)  $m(\mathbf{A}) = 0,0500 \text{ mol} \cdot 123,5 \text{ g/mol} + 0,050 \text{ mol} \cdot 97,5 \text{ g/mol} \approx 6,18 \text{ g} + 4,9 \text{ g} \approx$   
 **$\approx 11,1 \text{ g}$**



5.

- a) i) Kaaliumdikromaat –  $\text{K}_2\text{Cr}_2\text{O}_7$ ,  
kaaliumnitraat –  $\text{KNO}_3$   
ii) lahus on kollakasoranž

b) Et vett oli täpselt 100 g, siis kristalliseerus välja  
 $m(\text{K}_2\text{Cr}_2\text{O}_7) = 56,7 \text{ g} - 12,6 \text{ g} = 44,1 \text{ g}$

c) i)  $m(\text{segu S}) = 56,7 \text{ g} \cdot \frac{1}{0,9} = 63,0 \text{ g}$

ii)  $m(\text{KNO}_3) = 56,7 \text{ g} \cdot \frac{0,1}{0,9} = 6,30 \text{ g}$

d)  $\%(\text{KNO}_3 \text{ segus P}) = \frac{6,3 \text{ g}}{6,3 \text{ g} + 12,6 \text{ g}} \cdot 100 = 33,3$

e)  $20^\circ\text{C}$   $L(\text{KNO}_3) = 31,7 \text{ g}$   
 $70^\circ\text{C}$   $L(\text{K}_2\text{Cr}_2\text{O}_7) = 56,7 \text{ g}$

$\%(\text{KNO}_3) = \frac{31,7 \text{ g}}{31,7 \text{ g} + 56,7 \text{ g}} \cdot 100 = 35,9$

$\%(\text{KNO}_3) \geq 35,9 \%$

6.

a) Y – S, väävel

A –  $\text{H}_2\text{S}$ , divesiniksulfiid

B –  $\text{SO}_2$ , vääveldioksiid

C –  $\text{SO}_3$ , vääveltrioksiid

$^{\circ}\text{t}$

D –  $\text{H}_2\text{SO}_4$ , väävelhape

E –  $\text{BaSO}_4$ , baariumsulfaat

L –  $\text{H}_2\text{SO}_3$ , väävlishape

b) i)  $\text{S} + \text{H}_2 = \text{H}_2\text{S}$

ii)  $2\text{H}_2\text{S} + 3\text{O}_2 = 2\text{H}_2\text{O} + 2\text{SO}_2$

iii)  $\text{SO}_2 + \text{H}_2\text{O} = \text{H}_2\text{SO}_3$

$^{\circ}\text{t}_1$  kat

iv)  $2\text{SO}_2 + \text{O}_2 = 2\text{SO}_3$

v)  $\text{SO}_3 + \text{H}_2\text{O} = \text{H}_2\text{SO}_4$

vi)  $\text{H}_2\text{SO}_4 + \text{Ba}(\text{OH})_2 = \text{BaSO}_4 \downarrow + 2\text{H}_2\text{O}$

c)  $\% \text{Ba} = \frac{137,3}{233,4} \cdot 100 = 58,8$

$\%(\text{O}) = \frac{64}{233,4} \cdot 100 = 27,4$

$\%(\text{S}) = \frac{32,1}{233,4} \cdot 100 = 13,8$

$58,8\% + 13,8\% + 27,4\% = 100,0\%$

# Keemia lahtise võistluse ülesannete lahendused

Vanem rühm (11. ja 12. klass)

10. november 2001. a.

1. a) Et metallplaat ja atmosfäär on inertsed, siis peavad kõik ained koosnema süsinikust.

$$\text{aine } X_I \quad N(C) = 432 \text{ amü/osake} \cdot \frac{1 \text{ aatom}}{12 \text{ amü}} = 36 \frac{\text{aatom}}{\text{osake}} \quad \mathbf{C_{36}}$$

$$\text{aine } X_{II} \quad N(C) = \frac{720}{12} = 60 \frac{\text{aatom}}{\text{osake}} \quad \mathbf{C_{60}}$$

$$\text{aine } X_{III} \quad N(C) = \frac{840}{12} = 70 \frac{\text{aatom}}{\text{osake}} \quad \mathbf{C_{70}}$$

b)  $C_{36}$ ,  $C_{60}$  ja  $C_{70}$  on **fullereenid**

c)  $n(X_I) = n(X_{II})$

$$n(X_{III}) = 0,1n(X_I)$$

d)  $V = 10 \text{ cm} \cdot 10 \text{ cm} \cdot 1,0 \cdot 10^{-3} \text{ cm} = 0,10 \text{ cm}^3$

$$m = 0,10 \text{ cm}^3 \cdot 2,3 \text{ g/cm}^3 = 0,23 \text{ g}$$

Olgu ainete hulgad vastavalt  $n$ ,  $n$  ja  $0,1n$ ,

siis  $432 \cdot n + 720 \cdot n + 840 \cdot 0,1n = 0,23$

$$n = 1,86 \cdot 10^{-4} \text{ mol (vahetehtena üks lisa tüvenumber)}$$

$$m(\mathbf{C_{36}}) = 1,86 \cdot 10^{-4} \text{ mol} \cdot 432 \text{ g/mol} = \mathbf{0,080 \text{ g}}$$

$$m(\mathbf{C_{60}}) = 1,86 \cdot 10^{-4} \cdot 720 = 0,134 \text{ g} \approx \mathbf{0,13 \text{ g}}$$

$$m(\mathbf{C_{70}}) = 1,86 \cdot 10^{-4} \cdot 0,1 \cdot 840 = \mathbf{0,016 \text{ g}}$$

2.

$$\% \text{mol}(\text{H}_2\text{SO}_4) = \frac{n(\text{H}_2\text{SO}_4)}{n(\text{H}_2\text{SO}_4) + n(\text{H}_2\text{O})} \cdot 100$$

$$0,02 = \frac{n(\text{H}_2\text{SO}_4)}{\frac{490 - [n(\text{H}_2\text{SO}_4) \cdot 98,0]}{18,0} + n(\text{H}_2\text{SO}_4)}$$

$$n(\text{H}_2\text{SO}_4) = 0,5 \text{ mol}$$

$$0,01 = \frac{0,5}{n(\text{H}_2\text{O}) + 0,5}$$

$$n(\text{H}_2\text{O l\oopp\lahuses}) = 49,5 \text{ mol}$$

$$0,02 = \frac{0,5}{n(\text{H}_2\text{O}) + 0,5}$$

$$n(\text{H}_2\text{O alglahuses}) = 24,5 \text{ mol}$$

$$n(\text{H}_2\text{O lisatud}) = 49,5 - 24,5 = 25,0 \text{ mol}$$

$$m(\mathbf{H_2O lisatud}) = 25,0 \cdot 18,0 = \mathbf{450 \text{ g}}$$

3.

a) **A** – Au, kuld

**B** – NO, lämmastik(II)oksiid

**C** – H[AuCl<sub>4</sub>], vesiniktetrakloroauraat(III)

**D** – AgCl, hõbekloriid

**E** – H[AgCl<sub>2</sub>], vesinikdikloroargentaat(I)

**F** – [Cu(NH<sub>3</sub>)<sub>4</sub>](OH)<sub>2</sub>, tetraammiinvask(II)hüdrosiid

b) i)  $\text{Ag} + 2\text{HNO}_3 = \text{AgNO}_3 + \text{NO}_2 + \text{H}_2\text{O}$

$\text{Cu} + 4\text{HNO}_3 = \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$

ii)  $\text{AgNO}_3 + \text{NaCl} = \text{NaNO}_3 + \text{AgCl}$  (ühend **D**)

iii)  $\text{AgCl} + \text{HCl} = \text{H}[\text{AgCl}_2]$  (ühend **E**)

iv)  $\text{Cu}(\text{NO}_3)_2 + 6\text{NH}_3 \cdot \text{H}_2\text{O} = [\text{Cu}(\text{NH}_3)_4](\text{OH})_2$  (ühend **F**) +  $2\text{NH}_4\text{NO}_3 + 4\text{H}_2\text{O}$

v)  $\text{Au} + 4\text{HCl} + \text{HNO}_3 = \text{H}[\text{AuCl}_4]$  (ühend **C**) +  $\text{NO} + 2\text{H}_2\text{O}$

4.

a) i)  $k = \frac{\ln 2}{\tau} = \frac{0,6931}{30,17 \text{ a}} = 0,02297 \approx \mathbf{0,0230 \text{ a}^{-1}}$

ii)  $k = 0,02297 \text{ a}^{-1} \cdot \frac{1 \text{ a}}{365,25 \text{ päeva}} \cdot \frac{1 \text{ päev}}{24 \text{ tundi}} \cdot \frac{1 \text{ tund}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ s}} = \mathbf{7,28 \cdot 10^{-10} \text{ s}^{-1}}$

b)  $t = \frac{\ln a_0/a}{k} = \frac{1}{0,0230 \text{ a}^{-1}} \cdot \ln \frac{100\%}{0,1\%} = 300,7 \text{ aastat} \sim 301 \text{ aastat}$

1986 + 301 = **2286. aastaks**

c)  $m(\text{Cs}) = \frac{N_o}{N_A} \cdot M(\text{Cs}) = \frac{a_o}{k \cdot N_A} \cdot M(\text{Cs}) = 137 \text{ g/mol} \cdot \frac{3,8 \cdot 10^{16} \text{ s}^{-1}}{7,28 \cdot 10^{-10} \text{ s}^{-1} \cdot 6,02 \cdot 10^{23} \text{ mol}^{-1}} =$   
 $= 11860 \text{ g} \approx \mathbf{12 \text{ kg}}$

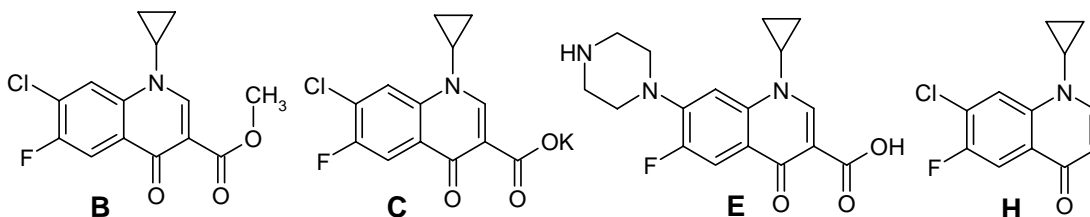
(Valemi  $v_o = k \cdot c_o$  põhjal  $a_o = k \cdot N_o$  ja  $N_o = a_o/k$ )

5.

a.  $M(\text{F})=367.8 \text{ g/mol}$ . Siis  $386-368=18 \text{ g/mol}$ , tähendab et saadusaineks on ühendi **F** monohüdraat.

b) Ciprofloxacini on amiin ning annab vesinikkloriidiga vastava soola. Selle molekulis on kolm lämmastikuaatomit aga kaks neist on seotud aromaatses tuumaga ning tugeva konjugatsiooni tõttu ei ilmu neil aluselisi omadusi. Jäeb järele ainult üks NH lämmastik.

c), d) Gaas **G** on CO<sub>2</sub>

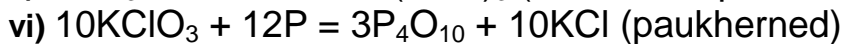
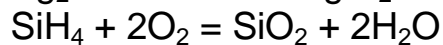
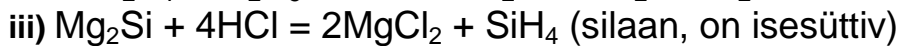
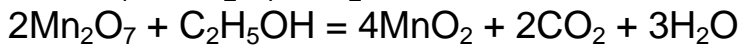
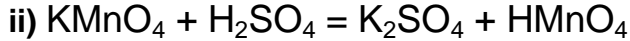
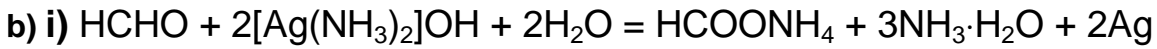


6.

a) Juhan õppis bioloogiat, sest tema kätele oli jäänud praktikumist vere jäljed, mis luminooli toimel hakkasid helenduma.

Kaarel "mängis" tulnukat, sest nii tema kui Peeter määrisid oma kaela raud(III)kloriidi lahusega.

Peetri kätel olev  $K_4[Fe(CN)_6]$  andis Kaarli kaelale "sinise vere" ja Kaarli kätel olev KSCN andis Peetri kaelale "punase vere".



Dispergeerunud  $P_4O_{10}$  ühineb õhuniiskusega, moodustades  $H_3PO_4$  valge suitsu

