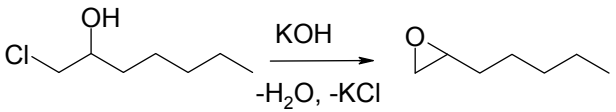
2008/2009 õ.a. keemiaolümpiaadi piirkonnavooru ülesannete lahendused

11. klass

1. a)



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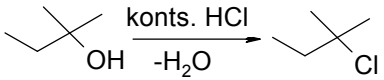
b)



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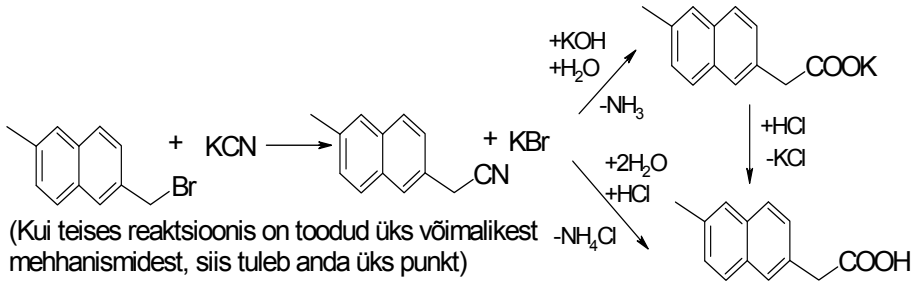
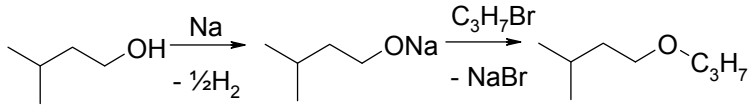
c)



(Kui teises reaktsioonis on toodud üks võimalikest mehhanismidest, siis tuleb anda üks punkt)

(1·2) **2**

d)



(1·2) **2**

6 p

2. a) $NaHCO_3 + HNO_3 = NaNO_3 + H_2O + CO_2\uparrow$ (1)

$NaOH + HNO_3 = NaNO_3 + H_2O$ (1)

$Ca(OH)_2 + 2HNO_3 = Ca(NO_3)_2 + 2H_2O$ (1)

Kuna $NaHCO_3$, NaOH ja $Ca(OH)_2$ vesilahused annavad leeliselise keskkonna, siis **pH > 7** (1) **4**

b) Kui neutraliseerida on vaja 1 mool lämmastikhapet, siis

$$m(NaHCO_3) = \frac{1}{1}\cdot 1\,\text{mol}\cdot\frac{84\ \text{g}}{1\,\text{mol}} = 84\ \text{g} \quad (0{,}5)$$

$$m(NaOH) = \frac{1}{1}\cdot 1\,\text{mol}\cdot\frac{40\ \text{g}}{1\,\text{mol}} = 40\ \text{g} \quad (0{,}5)$$

$$m(Ca(OH)_2) = \frac{1}{2}\cdot 1\,\text{mol}\cdot\frac{74\ \text{g}}{1\,\text{mol}} = 37\ \text{g} \quad (0{,}5)$$

$m(Ca(OH)_2) < m(NaOH) < m(NaHCO_3)$

Happe neutraliseerimiseks kulub kõige vähem **$Ca(OH)_2$**. (1) **2,5**

c) $n(H_2O) = 5{,}73\ \text{m}^3\cdot\frac{1}{0{,}0203}\cdot\frac{1000\ \text{dm}^3}{1\,\text{m}^3}\cdot\frac{1\,\text{mol}}{22{,}4\ \text{dm}^3} = 12600\ \text{mol}$ (2)

Kõikides reaktsioonides suhtuvad HNO_3 ja H_2O üks ühele. (0,5)

$$m(HNO_3) = \frac{1}{1}\cdot 12600\ \text{mol}\cdot\frac{63{,}01\ \text{g}}{1\,\text{mol}}\cdot\frac{1\,\text{kg}}{1000\ \text{g}} = 794{,}0\ \text{kg} \quad (1)$$

$$m_{\text{lahus}} = 0{,}9\ \text{m}^3\cdot\frac{1522\ \text{kg}}{1\,\text{m}^3} = 1369{,}8\ \text{kg} \quad (0{,}5)$$

$$\textbf{\%}(HNO_3) = \frac{794{,}0\ \text{kg}}{1369{,}8\ \text{kg}}\cdot 100 = \mathbf{58{,}0} \quad (0{,}5)$$ **4,5**

11 p

3. a) Peale süsivesiniku **A** (C_xH_y) põlemist

$C_xH_y + O_2 \rightarrow H_2O + CO_2 + CO$

ja veeauru kondenseerimist on võimalikud gaasilised saadused

CO ($M_r = 0{,}97\cdot 29 = 28$) ja CO_2 ($M_r = 1{,}52\cdot 29 = 44$).

Nende gaaside juhtimisel leelise lahusesse jääb järgi ainult CO.

$2MOH + CO_2 = M_2CO_3 + H_2O$

$$n(O_2) = 75\ \text{cm}^3\cdot\frac{1\,\text{mol}}{22{,}4\ \text{dm}^3}\cdot\frac{1\ \text{dm}^3}{1000\ \text{cm}^3}\cdot\frac{1000\ \text{mmol}}{1\,\text{mol}} = 3{,}35\ \text{mmol} \quad (1)$$

$$n(CO) = 17{,}9\ \text{cm}^3\cdot\frac{1\,\text{mmol}}{22{,}4\ \text{cm}^3} = 0{,}800\ \text{mmol} \quad (0{,}5)$$

$$n(CO_2) = (56 - 17{,}9)\ \text{cm}^3\cdot\frac{1\,\text{mmol}}{22{,}4\ \text{cm}^3} = 1{,}70\ \text{mmol} \quad (1)$$

$$x = \frac{n(CO) + n(CO_2)}{n(\mathbf{A})} = \frac{(0{,}8 + 1{,}7)\,\text{mmol}}{0{,}5\ \text{mmol}} = 5{,}0 \quad (1)$$

$$y = \frac{2n(H_2O)}{n(\mathbf{A})}$$

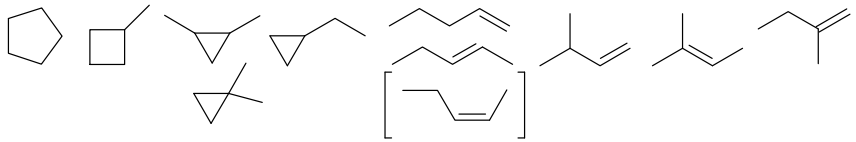
$1CO_2 \Leftrightarrow 1O_2$ $1CO \Leftrightarrow 0{,}5O_2$ $1H_2O \Leftrightarrow 0{,}5O_2$

$$n(H_2O) = 2\cdot\left(3{,}35 - \frac{1}{1}\cdot 1{,}70 - \frac{1}{2}\cdot 0{,}80\right)\text{mmol} = 2{,}50\ \text{mmol}$$

$$y = \frac{2\cdot 2{,}5\ \text{mmol}}{0{,}5\ \text{mmol}} = \underline{10} \quad (2)$$

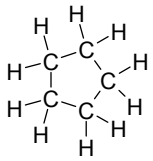
A – C_5H_{10} **5,5**

b)

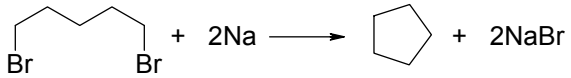


(Kui on toodud 9 isomeeri, siis anda täispunktid) (9·0,5) **4,5**

c)



- tsüklopentaan (0,5+0,5)



(1) **2**

12 p

4. a) **X** – $CuCl_2$, vask(II)kloriid (õige valem – 0,5; (1)
Y – $FeBr_2$, raud(II)bromiid õige nimetus – 0,5) (1)
Z – ZnI_2, tsink(II)jodiid (1) **3**

b) **1.** $Cu^{2+} + 2OH^- = Cu(OH)_2\downarrow$ (0,5)

2. $H^+ + Cl^- = HCl\uparrow$ (0,5)

3. $Ag^+ + Cl^- = AgCl\downarrow$ (0,5)

4. $Fe^{2+} + 2OH^- = Fe(OH)_2\downarrow$ (0,5)

$4Fe(OH)_2 + O_2 + 2H_2O = 4Fe(OH)_3\downarrow$ (1,5)

$\begin{cases} Fe^{II} - 1e^- = Fe^{III} \quad | \times 4 \\ O_2^0 + 4e^- = 2O^{-II} \end{cases}$ (tasakaalustamine 0,5)

5. $2Br^- + SO_4^{2-} + 4H^+ = SO_2\uparrow + Br_2 + 2H_2O$ (1,5)

$\begin{cases} 2Br^{-I} - 2e^- = Br_2^0 \\ S^{VI} + 2e^- = S^{IV} \end{cases}$ (tasakaalustamine 0,5)

6. $Ag^+ + Br^- = AgBr\downarrow$ (0,5)

7. $Zn^{2+} + 2OH^- = Zn(OH)_2\downarrow$ (0,5)

$Zn(OH)_2 + 2OH^- = [Zn(OH)_4]^{2-}$ (1)

8. $8I^- + SO_4^{2-} + 10H^+ = H_2S\uparrow + 4I_2 + 4H_2O$ (1,5)

$\begin{cases} 2I^{-I} - 2e^- = I_2^0 \quad | \times 4 \\ S^{VI} + 8e^- = S^{-II} \end{cases}$ (tasakaalustamine 0,5)

9. $Ag^+ + I^- = AgI\downarrow$ (0,5) **9**

12 p

5. a) (punktides **a)**-**c)** õige valem – 0,25; õige nimetus – 0,25)
F – H_2S, divesiniksulfiid $M_r(\mathbf{F}) = 29 \cdot 1{,}17 = 34$ (2·0,5)
B – S, väävel (0,5) **1,5**

b) $M_r(\mathbf{C}) = M_r(\mathbf{A}) + x \cdot 32 = 1{,}54 M_r(\mathbf{A})$ Kui $x = 2$, siis $M_r(\mathbf{A}) = 119$ (1)
A – Sn, tina (0,5) **C** – SnS_2, tina(IV)sulfiid (0,5) **2**

c) **X** – Pb, plii (0,5) **Y** – PbS, plii(II)sulfiid (0,5)
Z – $PbCl_2$, plii(II)kloriid (0,5)
D – $Na_2[Sn(OH)_6]$, naatriumheksahüdroksostannaat(IV) (0,5)
E – Na_2S, naatriumsulfiid (0,5) **2,5**

d) $Sn + 2S = SnS_2$ (1)
$SnS_2 + 6NaOH = Na_2[Sn(OH)_6] + 2Na_2S$ (1)
$Pb + S = PbS$ (1)
$PbS + 2HCl = PbCl_2 + H_2S\uparrow$ (1) **4**

10 p

6. a) **D_2O** (0,5)
Aine üldine struktuur on mõlemal molekulil sama, aga D_2O on **suurem**a **molekulmass**iga ja läheb gaasifaasi kõrgemal temperatuuril. (Peale selle on raskes vees vesinikside tugevam.) (0,5) **1**

b) **DH** (1)
D_2O elektrolüüsil tekib D_2. Selle reageerimisel Li-ga tekib LiD, mis kokkupuutel H_2O-ga annab DH.

$2D_2O \overset{\text{elektrolüüs}}{=} O_2\uparrow + 2D_2\uparrow$ (1)
$D_2 + 2Li = 2LiD$ (1)
$LiD + H\text{-}OH = LiOH + DH\uparrow$ (1) **4**

c) $\boldsymbol{V_m(H_2O)} = V_m(D_2O) = \dfrac{M}{\rho} = \dfrac{18\ \text{g}}{1\ \text{mol}} \cdot \dfrac{1\ \text{cm}^3}{1\ \text{g}} = \mathbf{18\ \dfrac{cm^3}{mol}}$ (0,5)

$\boldsymbol{\rho(D_2O)} = 1{,}0\ \dfrac{\text{g}}{\text{cm}^3} \cdot \dfrac{20}{18} = \mathbf{1{,}1\ \dfrac{g}{cm^3}}$ (0,5) **1**

d) $H_2O \rightleftarrows H^+ + OH^-$ $(2H_2O \rightleftarrows H_3O^+ + OH^-)$ (0,5)
$K_v = [H^+][OH^-] = 1{,}0 \cdot 10^{-14}$ $[H^+] = [OH^-]$
$[H^+]^2 = 1{,}0 \cdot 10^{-14}$ $\mathbf{[H^+] = \sqrt{1{,}0 \cdot 10^{-14}} = 1{,}0 \times 10^{-7}\ M}$ (1,5)

e) Kuna tasakaalukonstant kasvab temperatuuri kasvades (st reaktsiooni tasakaal nihkub H_2O dissotsieerumise suunas ehk pärisuunas), siis on tegemist endotermilise reaktsiooniga ($\boldsymbol{\Delta H > 0}$). (2·0,5) **3**

9 p