1997/98 õa keemiaolümpiaadi piirkondliku vooru ülesannete lahendused
11. klass

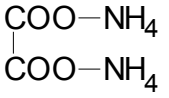
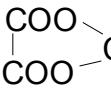
1. a) $M(A^+) = 35{,}5\ \text{g/mol} \cdot \frac{1}{63{,}9} \cdot 36{,}1 = 20{,}1\ \text{g/mol}$

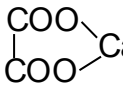
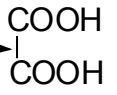
$M(A^{2+}) = 71{,}0\ \text{g/mol} \cdot \frac{1}{63{,}9} \cdot 36{,}1 = 40{,}1\ \text{g/mol}$

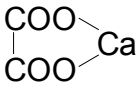
$M(A^{3+}) = 106{,}5\ \text{g/mol} \cdot \frac{1}{63{,}9} \cdot 36{,}1 = 60{,}2\ \text{g/mol}$

b) Ainsana sobib molaarmass 40,1, mis kuulub kaltsiumile. Kaltsium reageerib toatemperatuuril veega.

c) 1) $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

2) $CaCl_2 +$   $+ 2NH_4Cl$

3)  $+ HCl \rightarrow$  $+ CaCl_2$

4)  $\xrightarrow{\text{mõõd. }^{o}t}$ $CaCO_3 + CO$

III IV II

C C C

5) $CaCO_3 \xrightarrow{^{o}t,\ ^{o}t} CaO + CO_2$

d) Disproportsioneerumisreaktsioonil tekib süsinikmonooksiid CO ja kaltsiumkarbonaadi lagunemisel tekib süsinikdioksiid CO_2.

e) **A** – Ca, kaltsium; **B** –$CaCl_2$, kaltsiumkloriid; **C** – CaO_4C_2. kaltsiumoksalaat; **D** – $CaCO_3$, kaltsiumkarbonaat; **E** – CaO, kaltsiumoksiid.

2. a) $CH_4(g) + 2O_2(g) = CO_2(g) + 2H_2O(v)$

$C_2H_2(g) + 2{,}5O_2(g) = 2CO_2(g) + H_2O(v)$

b) $V_M = 1\,mol \cdot 0{,}0820 \frac{atm \cdot dm^3}{mol \cdot K} \cdot 298\ \text{K} \cdot \frac{1}{1\ \text{atm}} = 24{,}436\ \text{dm}^3/mol \approx$ **24,4 dm^3/mol**

c) $\frac{2}{1} \cdot V(CH_4)\ \text{dm}^3 \cdot \frac{1\ \text{mol}}{24{,}4\ \text{dm}^3} \cdot 18\ \text{g/mol} + \frac{1}{1}[12{,}0 - V(CH_4)]dm^3 \cdot \frac{1\ \text{mol}}{24{,}4\ \text{dm}^3} \cdot 18\ \text{g/mol} = 14{,}0\ \text{g}$

$V(CH_4)$ = **7,0 dm^3**

$V(C_2H_2)$ = **5,0 dm^3**

d) $CH_4 \Leftrightarrow 2O_2$ $\quad V(O_2) = \frac{2}{1} \cdot 7{,}0\ \text{dm}^3 = 14{,}0\ \text{dm}^3$

$C_2H_2 \Leftrightarrow 2{,}5O_2$ $\quad V(O_2) = \frac{2{,}5}{1} \cdot 5{,}0\ \text{dm}^3 = 12{,}5\ \text{dm}^3$

$26{,}5\ \text{dm}^3$

$$V(õhk) = 26{,}5\ \mathrm{dm^3} \cdot \frac{1}{0{,}209} = 126{,}8\ \mathrm{dm^3} \approx \mathbf{127\ dm^3}$$

e) $\Delta H_c^o(CH_4)$ = 2·(-285,8) + (-393,5) - (-74,85) - 2·(0) = **-890,25 kJ/mol**

$\Delta H_c^o(C_2H_2)$ = (-285,8) + 2·(-393,5) - 226,7 - 2,5·(0) = **-1299,5 kJ/mol**

f) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(v)$ $\quad \Delta H_c^o$ = -890,25 kJ/mol

$C_2H_2(g) + 2{,}5O_2(g) \rightarrow 2CO_2(g) + H_2O(v)$ $\quad \Delta H_c^o$ = -1299,5 kJ/mol

g) $\Delta H_c^o(CH_4) = 7{,}0\ dm^3 \cdot \frac{1\ \mathrm{mol}}{24{,}4\ \mathrm{dm^3}} \cdot -890{,}25\ \mathrm{kJ/mol} = -255{,}4\ \mathrm{kJ} = -260\ \mathrm{kJ}$

$\Delta H_c^o(C_2H_2) = 5{,}0\ \mathrm{dm^3} \cdot \frac{1\ \mathrm{mol}}{24{,}4\ \mathrm{dm^3}} \cdot (-1299{,}5)\ \mathrm{kJ/mol} = -266\ \mathrm{kJ} \approx -270\ \mathrm{kJ}$

$\Sigma \Delta H_c^o$ = -255 + (-266) = -521 kJ ≈ **-520 kJ**

3. a) $1{,}00 \cdot 10^6$ g

Na_2SiO_3	⇔	ΔH
122 g/mol		123 kJ/mol

$$\Delta H = \frac{1}{1} \cdot 1{,}00 \cdot 10^6 \cdot \frac{1\ \mathrm{mol}}{122\ \mathrm{g}} \cdot 123\ \mathrm{kJ/mol} = 1{,}008 \cdot 10^6\ \mathrm{kJ} \approx \mathbf{1{,}01 \cdot 10^6\ kJ}$$

b)

m(1-0,05)		$-1{,}008 \cdot 10^6$ kJ
C	⇔	ΔH
12 g/mol		-394 kJ/mol·(1-0,7)

Märkus: Saagise % võib kirjutada ka süsiniku kohale: 30 % süsinikust kulub kasuliku energia saamiseks. (-) märk näitab, et süsinik eraldab vajaliku energia. Silikaadi tekkimine tarbib energiat (+).

$$\mathrm{m(süsinik)} = \frac{1}{1} \cdot (-1{,}008 \cdot 10^6)\ \mathrm{kJ} \cdot \frac{1\ \mathrm{mol}}{-394\ \mathrm{kJ} \cdot 0{,}3} \cdot 12\ \mathrm{g/mol} \cdot \frac{1}{0{,}95} = 1{,}077 \cdot 10^5\ \mathrm{g} \approx \mathbf{108\ kg}$$

4.

a) $9CH{\equiv}CH \rightarrow 3CH_2{=}CH{-}C{\equiv}CH$

$1CH_2{=}CH{-}C{\equiv}C{-}CH{=}CH_2$

$$\mathrm{n(dimeer)} = \frac{3}{9} \cdot 0{,}200\ \mathrm{mol} \cdot 0{,}900 = 0{,}0600\ \mathrm{mol}$$

$$n(trimeer) = \frac{1}{9} \cdot 0{,}200\ \mathrm{mol} \cdot 0{,}900 = 0{,}0200\ \mathrm{mol}$$

b) $CH_2{=}CH{-}C{\equiv}CH + 3Br_2 = CH_2Br{-}CHBr{-}CBr_2{-}CHBr_2$

c) Dimeer ⇔ $3Br_2$ $\quad n(Br_2) = \frac{3}{1} \cdot 0{,}0600$ mol = 0,180 mol

d) $1C_6H_6 + 6KMnO_4 + 9H_2SO_4 = 6MnSO_4 + 6CO_2 + 12H_2O + 3K_2SO_4$

6·(-I) (-) 6·IV

$C_6 - 30e^- \rightarrow 6C$ 1

VII (-) II

$Mn \quad 5e^- \rightarrow Mn$ 6

5. a) $n(H_2SO_4) = 20{,}0\ \text{g} \cdot 0{,}200 \cdot \frac{1\ \text{mol}}{98{,}1\ \text{g}} = \mathbf{0{,}0408\ mol}$

b) $n[Ca(OH)_2] = 10{,}90\ \text{g} \cdot \frac{1\ \text{mol}}{74{,}10\ \text{g}} = \mathbf{0{,}1471\ mol}$

c) n[$Ca(OH)_2$]= 0,1471 mol - 0,0408 mol = **0,1063 mol**

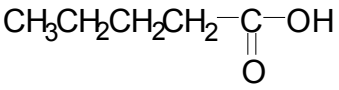
d) $H_2SO_4 \Leftrightarrow Ca(OH)_2$ $n(H_2SO_4)$ = 0,1063 mol

$$\frac{x\ \text{g}\ (SO_3)}{80{,}1\ \text{g/mol}} + \frac{(10{,}0 - x)\ \text{g}\ (H_2SO_4)}{98{,}1\ \text{g/mol}} = 0{,}1063\ \text{mol}$$

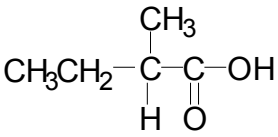
0,01248x + 0,1019 -0,01019x = 0,1063
0,00229x = 0,0044 $m(SO_3)$ = 1,9 g

$$\%(SO_3) = \frac{1{,}9\ g}{10{,}0\ \text{g}} \cdot 100 = \mathbf{19}$$

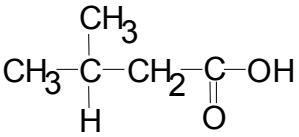
6. a)



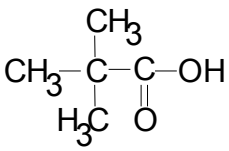
pentaanhape



2-metüülbutaanhape



3-metüülbutaanhape



2,2-dimetüülpropaanhape

b) $CH_3COOH + HOC_2H_5 \xrightarrow{H+} CH_3C(=O)–O–C_2H_5 + H_2O$

etaanhape etanool etüületanaat vesi