

2011/2012 õ.a. keemiaolümpiaadi piirkonnavooru ülesannete lahendused

9. klass

$$1. a) n(\text{CO}_2) = \frac{112 \text{ ml}}{1000 \frac{\text{ml}}{\text{l}} \cdot 22,4 \frac{\text{l}}{\text{mol}}} = 0,005 \text{ mol} = 5 \text{ mmol}$$

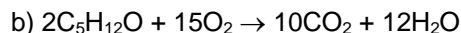
$$n(\text{H}_2\text{O}) = \frac{0,108 \text{ ml} \cdot 1 \frac{\text{g}}{\text{ml}}}{18 \frac{\text{g}}{\text{mol}}} = 0,006 \text{ mol} = 6 \text{ mmol}$$

$$\frac{n(\text{C})}{n(\text{H})} = \frac{6 \cdot 2 \text{ mmol}}{5 \text{ mmol}} = \frac{12}{5}$$

$$M(\text{C}_5\text{H}_{12}) = 72 \frac{\text{g}}{\text{mol}}$$

$$88 \frac{\text{g}}{\text{mol}} - 72 \frac{\text{g}}{\text{mol}} = 16 \frac{\text{g}}{\text{mol}}$$

Sellele vastab hapnik, molekulaarvalem on **C₅H₁₂O**.



c) Valem vastab üldvalemile $\text{C}_n\text{H}_{2n+2}\text{O}_x$, seega küllastatud ühend, võib olla alkohol või eeter.

2. a) A - CO₂, süsihappegaas ehk süsinikdioksiid

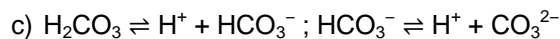
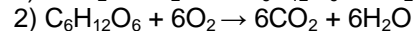
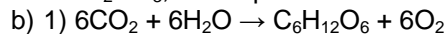
B - H₂O, vesi

C - C₆H₁₂O₆, glükoos

D - O₂, hapnik

E - CaCO₃, kaltsiumkarbonaat

F - H₂CO₃, süsihape



d) Fotosüntees ei saa toimuda ilma päikesevalguseta. Ei toimu kogu aeg: ainult valgus, pimedas mitte.

3. a) $\text{Ag}^+ + \text{Cl}^- = \text{AgCl} \downarrow$

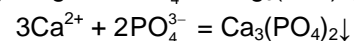
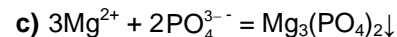
$$n(\text{Cl}^-) = n(\text{AgCl})$$

$$n(\text{Cl}^-) = \frac{1}{1} \cdot 143 \text{ mg} \cdot \frac{1 \text{ g}}{1000 \text{ mg}} \cdot \frac{1 \text{ mol}}{143 \text{ g}} = 0,001 \text{ mol}$$

$$m(\text{Cl}^-) = 0,001 \text{ mol} \cdot \frac{35,5 \text{ g}}{1 \text{ mol}} = 0,0355 \text{ g} \quad m_{\text{lahus}} = 10 \text{ cm}^3 \cdot \frac{1 \text{ g}}{1 \text{ cm}^3} = 10 \text{ g}$$

$$\%(\text{Cl}^-) = \frac{0,0355 \text{ g}}{10 \text{ g}} \cdot 100 = 0,355 \approx \mathbf{0,36}$$

b) $n(\text{AgNO}_3) = 3 \text{ cm}^3 \cdot \frac{1,2 \text{ g}}{1 \text{ cm}^3} \cdot 0,2 \cdot \frac{1 \text{ mol}}{170 \text{ g}} = \mathbf{0,004 \text{ mol} > 0,001 \text{ mol}}$



$$n(\text{Cl}^-, \text{poriloigus}) = 3,5 \text{ dm}^3 \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} \cdot \frac{0,001 \text{ mol}}{10 \text{ cm}^3} = 0,35 \text{ mol}$$

$$n(\text{PO}_4^{3-}) = \frac{2}{3} \cdot \frac{3}{10} \cdot 0,35 \text{ mol} = 0,07 \text{ mol}$$

$$m(\text{Na}_3\text{PO}_4) = 0,07 \text{ mol} \cdot \frac{164 \text{ g}}{1 \text{ mol}} = 11,48 \text{ g} \approx \mathbf{11 \text{ g}}$$

4. a) hapnikul on oks. aste alati -2, lämmastikul aga:

N₂O - +1 - 44 g/mol

NO - +2 - 30 g/mol

N₂O₃ - +3 - 76 g/mol

NO₂ - +4 - 46 g/mol

N₂O₅ - +5 - 108 g/mol

b) $N_A = 6,02 \cdot 10^{23}$

$$m(1 \text{ mol } (\text{N}_x\text{O}_y)) = 4,99 \cdot 10^{-23} \text{ g} \cdot 6,02 \cdot 10^{23} = 30 \text{ g}$$

Seega $M = 30 \text{ g/mol}$

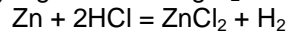
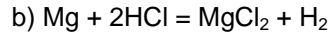
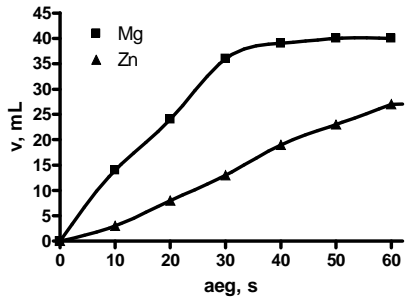
Oksiid **X** on **NO**

c) $n(\text{NO}) = 188 \text{ km} \cdot \frac{1 \text{ mol}}{10 \text{ km}} = 18,8 \text{ mol}$

$$m(\text{NO}) = n \cdot M = 18,8 \text{ mol} \cdot 30 \frac{\text{g}}{\text{mol}} = 564 \text{ g}$$

$$\frac{546 \text{ g}}{188 \text{ km}} = 3 \frac{\text{g}}{\text{km}}, \text{ mis on normist kõrgem.}$$

5.



c) Mg on aktiivsem metall kui Zn.

d) Mg, kuna vesiniku hulk pärast 50 sekundit enam ei suurene.

e) Saab arvutada vaid Mg andmete järgi. $0,04 \text{ L} / 22,4 \text{ L/mol} \cdot 24,3 = 0,04 \text{ g}$

6. a) Soolas C on Cl sisaldus 74,47 %

$$\% \text{Cl} = \frac{x \cdot M(\text{Cl})}{x \cdot M(\text{Cl}) + 1 \text{ mol} \cdot M(\text{X})} \cdot 100\% = 74,47\%$$

$$0,2553 \cdot x \cdot M(\text{Cl}) = 0,7447 \cdot 1 \text{ mol} \cdot M(\text{X})$$

$$M(\text{X}) = \frac{0,2553 \cdot x \cdot M(\text{Cl})}{0,7447 \cdot 1 \text{ mol}} = \frac{0,2553 \cdot x \cdot 35,45 \text{ g/mol}}{0,7447 \cdot 1 \text{ mol}}$$

Kui $x=1$ mol, siis $M(\text{X})=12,15 \text{ g/mol}$ – ei vasta metallile

$x=2$ mol, siis $M(\text{X})=24,31 \text{ g/mol}$ – **Magneesium**

$x=3$ mol, siis $M(\text{X})=36,45 \text{ g/mol}$ – ei vasta metallile

$x=4$ mol, siis $M(\text{X})=48,61 \text{ g/mol}$ – ei vasta metallile

C valem on MgCl_2 .

Elemendi Y oksiid D, mis tekib B põlemisel õhus on Y_qO_w :

$$\% \text{Y} = \frac{q \cdot M(\text{Y})}{q \cdot M(\text{Y}) + w \cdot M(\text{O})} \cdot 100\% = 46,76\%$$

$$0,5324 \cdot q \cdot M(\text{Y}) = 0,4676 \cdot w \cdot M(\text{O})$$

$$M(\text{Y}) = \frac{0,4676 \cdot w \cdot M(\text{O})}{0,5324 \cdot q} = \frac{0,4676 \cdot w \cdot 16,00 \text{ g/mol}}{0,5324 \cdot q}$$

Kui $q=1$ mol, $w=1$ mol, $M(\text{Y})=14,05 \text{ g/mol}$. Ei sobi.

$q=2$ mol, $w=1$ mol, siis $M(\text{Y})=7,03 \text{ g/mol}$. Ei sobi.

$q=1$ mol, $w=2$ mol, siis $M(\text{Y})=28,11 \text{ g/mol}$. **Räni**

$q=2$ mol, $w=3$ mol, siis $M(\text{Y})=21,08 \text{ g/mol}$. Ei sobi.

D valem on SiO_2 .

Ühendi B (valem YZ_4) kindlakstegemine:

$$\% \text{Y} = \frac{1 \text{ mol} \cdot M(\text{Si})}{1 \text{ mol} \cdot M(\text{Si}) + 4 \cdot M(\text{Z})} \cdot 100\% = 100\% - 12,47\% = 87,53\%$$

$$0,1247 \cdot 1 \text{ mol} \cdot M(\text{Si}) = 0,8753 \cdot 4 \text{ mol} \cdot M(\text{Z})$$

$$M(\text{Z}) = \frac{0,1247 \cdot 1 \text{ mol} \cdot M(\text{Si})}{0,8753 \cdot 4 \text{ mol}} = \frac{0,1247 \cdot 1 \text{ mol} \cdot 28,09 \text{ g/mol}}{0,8753 \cdot 4 \text{ mol}} = 1,00 \text{ g/mol}$$

Z- vesinik. Ühend B on SiH_4 .

Ühendi A valem leidmine:

$$\% \text{Mg} = \frac{x \cdot M(\text{Mg})}{x \cdot M(\text{Mg}) + y \cdot M(\text{Si})} \cdot 100\% = 63,36\%$$

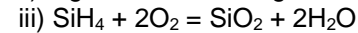
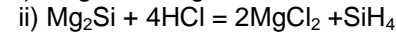
$$0,3664 \cdot x \cdot M(\text{Mg}) = 0,6336 \cdot y \cdot M(\text{Si})$$

$$\frac{x}{y} = \frac{0,6336 \cdot M(\text{Si})}{0,3664 \cdot M(\text{Mg})} = \frac{0,6336 \cdot 28,09 \text{ g/mol}}{0,3664 \cdot 24,30 \text{ g/mol}} = 2$$

Ühendi A valem on Mg_2Si .

X- Mg, Y- Si, A- Mg_2Si , B- SiH_4 , C- MgCl_2 , D- SiO_2 , E – H_2O

b) i) $2\text{Mg} + \text{Si} = \text{Mg}_2\text{Si}$



c)

$$n(\text{SiH}_4) = \frac{V(\text{SiH}_4)}{V_m} = \frac{0,500 \text{ dm}^3}{22,4 \text{ dm}^3/\text{mol}} = 0,0223 \text{ mol}$$

$$n(\text{Mg}) = 2 \cdot n(\text{SiH}_4)$$

$$n(\text{Si}) = n(\text{SiH}_4)$$

$$m(\text{Mg}) = n(\text{Mg}) \cdot M(\text{Mg}) = 0,0446 \text{ mol} \cdot 24,31 \text{ g/mol} = 1,08 \text{ g}$$

$$m(\text{Si}) = n(\text{Si}) \cdot M(\text{Si}) = 0,0223 \text{ mol} \cdot 28,10 \text{ g/mol} = 0,627 \text{ g}$$

d) Reaktsioonil vabanenud SiH_4 reaktsioonil hapnikuga vabaneb soojushulk:

$$\Delta H = n(\text{SiH}_4) \cdot 1288 \text{ kJ/mol} = 0,0223 \text{ mol} \cdot 1288 \text{ kJ/mol} = 28,7 \text{ kJ}$$

Sama soojushulk vabaneks grafiidi põlemisel, mille mass on:

$$m(\text{C}) = M(\text{C}) \cdot \frac{\Delta H}{393,5 \text{ kJ/mol}} = 12,0 \text{ g/mol} \cdot \frac{28,7 \text{ kJ}}{393,5 \text{ kJ/mol}} = 0,88 \text{ g} \approx 0,9 \text{ g}$$