

2008/2009 õ.a. keemiaolümpiaadi lõppvõru ülesannete lahendused

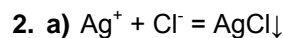
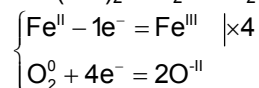
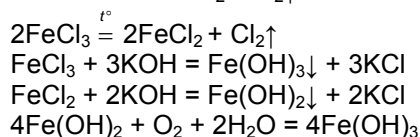
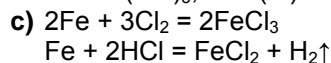
9. klass

1. a) $\rho(\mathbf{A}_2) = 35,5 \cdot \rho(\mathbf{H}_2)$ $M(\mathbf{A}_2) / V_m = 35,5 \cdot M(\mathbf{H}_2) / V_m$

$M(\mathbf{A}_2) = 35,5 \cdot M(\mathbf{H}_2) = 35,5 \cdot 2 \text{ g/mol} = 71 \text{ g/mol}$

$M_r(\mathbf{A}) = 71 / 2 = 35,5$ $\mathbf{A} - \text{Cl, kloor}$

- b) $\mathbf{X} - \text{Fe, raud}$ $\mathbf{A}_2 - \text{Cl}_2, \text{ kloor}$
 $\mathbf{B} - \text{FeCl}_3, \text{ raud(III)kloriid}$ $\mathbf{C} - \text{FeCl}_2, \text{ raud(II)kloriid}$
 $\mathbf{D} - \text{Fe(OH)}_3, \text{ raud(III)hüdroksoiid}$ $\mathbf{E} - \text{Fe(OH)}_2, \text{ raud(II)hüdroksoiid}$



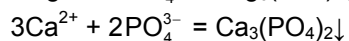
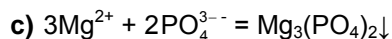
$n(\text{Cl}^-) = n(\text{AgCl})$

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

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

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

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

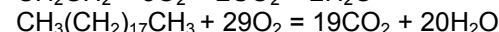
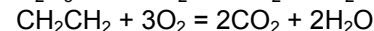
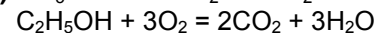


$n(\text{Cl}^-, \text{poriloigus}) = 3,5 \text{ dm}^3 \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} \cdot \frac{0,001 \text{ mol}}{10 \text{ cm}^3} = 0,35 \text{ mol}$

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

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

3. a) $\text{CH}_3\text{COOH} - \text{äädikas, etaanhape}$ $\text{C}_2\text{H}_5\text{OH} - \text{piiritus, etanool}$
 $\text{CH}_2\text{CH}_2 - \text{etüleen, eteen}$ $\text{CH}_3(\text{CH}_2)_{17}\text{CH}_3 - \text{parafiin, nonadekaan}$



- c) Iga aine korral tuleb leida süsinikdioksiidi ruumala, kuna veeaur kondenseerub toatemperatuuril.

$V(\text{CH}_3\text{COOH}) = \frac{2}{1} \cdot 1 \text{ g} \cdot \frac{1 \text{ mol}}{60 \text{ g}} \cdot \frac{22,4 \text{ dm}^3}{1 \text{ mol}} = 0,75 \text{ dm}^3$

$V(\text{C}_2\text{H}_5\text{OH}) = \frac{2}{1} \cdot 1 \text{ g} \cdot \frac{1 \text{ mol}}{46 \text{ g}} \cdot \frac{22,4 \text{ dm}^3}{1 \text{ mol}} = 0,97 \text{ dm}^3$

$V(\text{CH}_2\text{CH}_2) = \frac{2}{1} \cdot 1 \text{ g} \cdot \frac{1 \text{ mol}}{28 \text{ g}} \cdot \frac{22,4 \text{ dm}^3}{1 \text{ mol}} = 1,6 \text{ dm}^3$

$V(\text{CH}_3(\text{CH}_2)_{17}\text{CH}_3) = \frac{19}{1} \cdot 1 \text{ g} \cdot \frac{1 \text{ mol}}{268 \text{ g}} \cdot \frac{22,4 \text{ dm}^3}{1 \text{ mol}} = 1,6 \text{ dm}^3$

Kõige suurema õhupalli saaksime 1,0 g etüleen ja parafiini põletamisest.

4. a) emulsioon

- b) Pentaan aurustub, oktaan jääb vee pinnale.

$m(\text{C}_5\text{H}_{12}) = 500 \text{ t} \cdot 0,5 = 250 \text{ t}$

$n(\text{C}_5\text{H}_{12}) = \frac{m}{M} = 250 \text{ t} \cdot \frac{10^6 \text{ g}}{1 \text{ t}} \cdot \frac{1 \text{ mol}}{72 \text{ g}} = 3,5 \cdot 10^6 \text{ mol}$

$V(\text{C}_5\text{H}_{12}) = n \cdot V_m = 3,5 \cdot 10^6 \text{ mol} \cdot \frac{22,4 \text{ dm}^3}{1 \text{ mol}} \cdot \frac{1 \text{ m}^3}{1000 \text{ dm}^3} = 7,7 \cdot 10^4 \text{ m}^3 \approx$

$\approx \mathbf{8 \cdot 10^4 \text{ m}^3}$

- c) Merepinnale jääb oktaan, seega:

$m(\text{C}_8\text{H}_{18}) = 500 \text{ t} \cdot 0,5 = 250 \text{ t}$

$V(\text{C}_8\text{H}_{18}) = \frac{m}{\rho} = 250 \text{ t} \cdot \frac{10^3 \text{ kg}}{1 \text{ t}} \cdot \frac{1 \text{ dm}^3}{0,703 \text{ kg}} = 3,6 \cdot 10^5 \text{ dm}^3 \approx \mathbf{4 \cdot 10^5 \text{ dm}^3}$

$S(\text{C}_8\text{H}_{18}) = 3,6 \cdot 10^5 \text{ dm}^3 \cdot \frac{1 \text{ ha}}{3 \text{ dm}^3} = 1,2 \cdot 10^5 \text{ ha} \approx \mathbf{1 \cdot 10^5 \text{ ha}}$

- d) Pentaani jaoks:

$N(\text{C}_5\text{H}_{12}, \text{g}) = n \cdot N_A = \frac{V}{V_m} \cdot N_A = 1 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{22,4 \text{ dm}^3} \cdot 6,02 \cdot 10^{23} \frac{\text{molekuli}}{\text{mol}} =$
 $= 2,7 \cdot 10^{22} \text{ molekuli} \approx \mathbf{3 \cdot 10^{22} \text{ molekuli}}$

$N(\text{C}_5\text{H}_{12}, \text{v}) = n \cdot N_A = \frac{m}{M} \cdot N_A = \frac{\rho \cdot V}{M} \cdot N_A = 1 \text{ dm}^3 \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} \cdot \frac{0,629 \text{ g}}{1 \text{ cm}^3} \cdot \frac{1 \text{ mol}}{72 \text{ g}} \cdot$
 $6,02 \cdot 10^{23} \frac{\text{molekuli}}{\text{mol}} = 5,3 \cdot 10^{24} \text{ molekuli} \approx \mathbf{5 \cdot 10^{24} \text{ molekuli}}$

Oktaani jaoks:

$$N(\text{C}_8\text{H}_{18}, v) = n \cdot N_A = \frac{m}{M} \cdot N_A = \frac{\rho \cdot V}{M} \cdot N_A = 1 \text{ dm}^3 \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} \cdot \frac{0,703 \text{ g}}{1 \text{ cm}^3} \cdot \frac{1 \text{ mol}}{114 \text{ g}} \cdot 6,02 \cdot 10^{23} \frac{\text{molekuli}}{\text{mol}} = 3,7 \cdot 10^{24} \text{ molekuli} \approx \mathbf{4 \cdot 10^{24} \text{ molekuli}}$$

5. a) Tselluloos on (polü)sahhariid.

Ühes lülis peab paiknema **kolm** hüdroksüülrühma, sest üks hapniku aatom on tsükli sees ja iga tsükli kohta tuleb ka üks tsükleid ühendav hapniku aatom.

$$M_r(\text{C}_6\text{H}_7\text{O}_2(\text{OH})_3) = 6 \cdot 12 + 10 \cdot 1 + 5 \cdot 16 = 162$$

$$\text{b) } n(\text{C}) = 4000 \cdot 6 \cdot \frac{1 \text{ mol}}{6,02 \cdot 10^{23}} = \mathbf{4,0 \cdot 10^{-20} \text{ mol}}$$

c) $(\text{C}_6\text{H}_7\text{O}_{11}\text{N}_3)_n$

$$M_r(\text{C}_6\text{H}_7\text{O}_2(\text{ONO}_2)_3) = 6 \cdot 12 + 7 \cdot 1 + 11 \cdot 16 + 3 \cdot 14 = 297$$

d) Lülide arv tselluloosi molekulis ei ole selle arvutuse jaoks oluline ja kogu arvutuse võib sooritada ühe molekuli korduva osa kohta.

$$m = \frac{1}{1} \cdot 350 \text{ g} \cdot 0,9 \cdot \frac{297}{162} = 578 \text{ g} \approx \mathbf{580 \text{ g}}$$

6. a) **Z** – H_2O , vesi (vesi eraldus mineraalist **A**, $M_r(\text{Z}) = \frac{1}{2} \cdot 258 \cdot 0,14 = 18$)

X – SiO_2 , ränidioksiid (liiv, $M_r(\text{X}) = \frac{1}{2} \cdot 258 \cdot 0,465 = 60$)

Q võib keemiliste omaduste alusel olla kas Al_2O_3 (102 g/mol) või Fe_2O_3 (160 g/mol), sest alumiinium ja raud passiveeruvad kontsentreeritud väävelhappe toimel. Täpsemalt saame tuvastada mineraali **A** kaudu:

$$M_r(\text{Q}) = \frac{1}{1} \cdot 258 \cdot 0,395 = 102$$

Q – Al_2O_3 , alumiiniumoksiid

mineraal **A** – $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ ehk $\text{Al}_2\text{Si}_2\text{O}_9\text{H}_4$

mineraal **B** – $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ ehk $\text{Al}_2\text{Si}_2\text{O}_7$

mineraal **D** – $2\text{Al}_2\text{O}_3 \cdot 3\text{SiO}_2$ ehk $\text{Al}_4\text{Si}_3\text{O}_{12}$

mineraal **E** – $3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ ehk $\text{Al}_6\text{Si}_2\text{O}_{13}$

b) $\text{Al}_2\text{Si}_2\text{O}_9\text{H}_4 \xrightarrow{t^\circ} \text{Al}_2\text{Si}_2\text{O}_7 + 2\text{H}_2\text{O}$

