KEEMIAÜLESANNETE LAHENDAMISE LAHTINE VÕISTLUS
Vanem rühm (11. ja 12. klass)

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Ülesannete lahendused

1. a) $m_{\text{kaalutis}} = m_{\text{NaOH}} + m_{\text{H}_2\text{O}} = 0{,}510\ \text{M} \cdot 200\ \text{cm}^3 \cdot \frac{1\ \text{dm}^3}{1000\ \text{cm}^3} \cdot \frac{40{,}0\ \text{g}}{1\ \text{mol}} = 4{,}08\ \text{g}$

$m_{\text{lahus}} = m_{\text{NaOH}} + m_{\text{lahusti}} = 200\ \text{cm}^3 \cdot \frac{1{,}021\ \text{g}}{1\ \text{cm}^3} = 204{,}2\ \text{g}$

$m_{\text{NaOH}} = \frac{0{,}480\ \text{mol}}{1\ \text{kg}} \cdot \frac{1\ \text{kg}}{1000\ \text{g}} \cdot m_{\text{lahusti}} \cdot \frac{40{,}0\ \text{g}}{1\ \text{mol}} = 0{,}0192 \cdot m_{\text{lahusti}}$

$m_{\text{lahusti}} = 52{,}08 \cdot m_{\text{NaOH}}$

$m_{\text{NaOH}} + 52{,}08 \cdot m_{\text{NaOH}} = 53{,}08 \cdot m_{\text{NaOH}} = 204{,}2\ \text{g}$

$m_{\text{NaOH}} = \frac{204{,}2\ \text{g}}{53{,}08} = 3{,}847\ \text{g}$

$m_{\text{lisand, H}_2\text{O}} = 4{,}08\ \text{g} - 3{,}847\ \text{g} = 0{,}23\ \text{g}$

$\mathbf{\%(H_2O) =} \frac{0{,}233\ \text{g}}{4{,}08\ \text{g}} \cdot 100 = \mathbf{5{,}7\%}$

b) $n(\text{H}_2\text{SO}_4) = \frac{1}{2} \cdot \frac{0{,}324\ \text{mol}}{1\ \text{dm}^3} \cdot 100\ \text{cm}^3 \cdot \frac{1\ \text{dm}^3}{1000\ \text{cm}^3} = 0{,}0162\ \text{mol}$

$n(\text{SO}_3) = x$

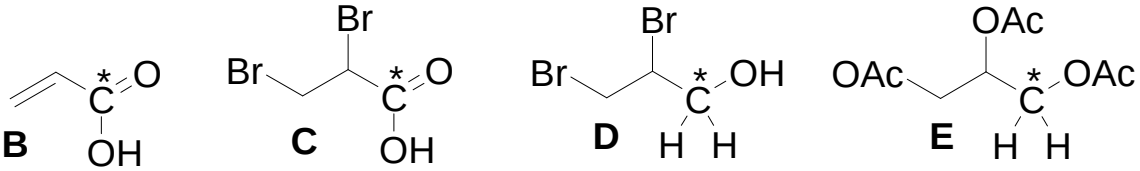
$n(\text{H}_2\text{SO}_4) = 0{,}0162\ \text{mol} - x$

$\frac{80{,}07\ \text{g}}{1\ \text{mol}} \cdot x + \frac{98{,}08\ \text{g}}{1\ \text{mol}} \cdot (0{,}0162\ \text{mol} - x) = 1{,}50\ \text{g}$

$n(\text{SO}_3) = \frac{(98{,}08 \cdot 0{,}0162 - 1{,}50)\ \text{g}}{(98{,}08 - 80{,}07)\ \text{g/mol}} = 0{,}00494\ \text{mol}$

$\mathbf{\%(SO_3)} = \frac{0{,}00494\ \text{mol} \cdot 80{,}07\ \text{g/mol}}{1{,}50\ \text{g}} \cdot 100 = \mathbf{26}\%$

2. b) **A** – $^*CO_2$

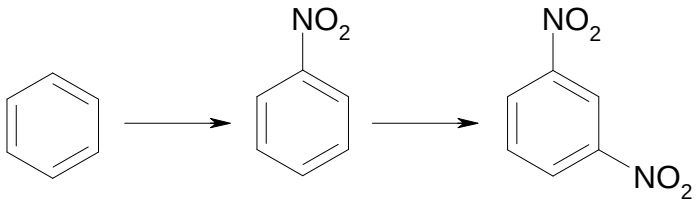


i) – H^+ (HCl)
ii) – Br_2
iii) – happeline või aluseline hüdrolüüs (HCl või NaOH)

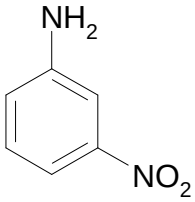
3. **a)** i) $C_6H_5NO_2 + 3(NH_4)_2S = C6H_5NH_2 + 3S + 6NH_3 + 2H_2O$

ii) $C_6H_5NO_2 + 2Zn + 4NH_4Cl = C_6H_5NHOH + 2Zn(NH_3)_2Cl_2 + H_2O$

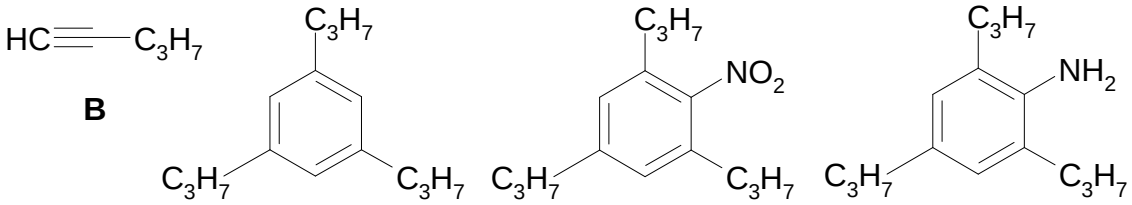
b) Benseeni nitreerimine:



c) Ammooniumvesiniksulfiidiga redutseerimisel tekib *m*-nitroaniliin mis sisaldab 20,3% lämmastikku.



d) Konts. väävelhappe juuresolekul alküünid trimeriseeruvad, andes 1,3,5-trialküülbenseeni.



e) 1,3,5-tripropüülbenseen sisaldab kolm +R rühma ja seetõttu omab olulist nukleofiilset iseloomu elektrofiilse asenduse reaktsioonidel. Tavaliste nitreerimise tingimuste kasutamisel areeni tuuma sisse läheb kaks kuni kolm nitrorühma ja mononitroderivaati ei õnnestu saada.

4. **a**) $n(\text{EDTA}) = 52{,}6\ \text{cm}^3 \cdot 0{,}00312\ \frac{\text{mmol}}{\text{cm}^3} = 0{,}164\ \text{mmol}$

$$c(\text{CaCO}_3) = \frac{0{,}164\ \text{mmol}}{50\ \text{cm}^3} \cdot \frac{1000\ \text{cm}^3}{1\,\text{dm}^3} \cdot 100\ \frac{\text{mg}}{\text{mmol}} = \mathbf{328}\ \frac{\mathbf{mg}}{\mathbf{dm^3}}$$

b) $n(\text{ioonid 100 ml}) = 0{,}328\ \text{mmol}$

$CaCO_3$ sisaldus x mmol, siis $MgCO_3$ on $0{,}328 - x$ mmol ja nende massid on $100x$ ja $84 \cdot (0{,}328 - x)$ mg.

$$x = \frac{32{,}45\ \text{mg} - 84{,}3\ \text{mg/mmol} \cdot 0{,}328\ \text{mmol}}{(100{,}1 - 84{,}3)\ \text{mg/mmol}} = 0{,}304\ \text{mmol}$$

$$c\left(\mathrm{Ca^{2+}}\right) = \mathbf{3,04}\ \frac{\mathbf{mmol}}{\mathbf{dm^3}}$$

$$c\left(\mathrm{Mg^{2+}}\right) = 10 \cdot (0{,}328 - 0{,}306)\ \frac{\mathrm{mmol}}{\mathrm{dm^3}} = \mathbf{0,24}\ \frac{\mathbf{mmol}}{\mathbf{dm^3}}$$

c) $c\left(\mathrm{Ca^{2+}}\right) = \dfrac{94{,}4\ \mathrm{mg/dm^3}}{40{,}1\ \mathrm{mg/mmol}} = \mathbf{2,36}\ \dfrac{\mathbf{mmol}}{\mathbf{dm^3}}$

Erinevus on tingitud sellest, et esimeses analüüsis saadud katioonide kontsentratsioon on suurendatud, kuna EDTA-ga saavad reageerida ka teised vees sisalduvad katioonid ja teises analüüsis kuiva aine massi suurendavad ka teised vees sisalduvad soolad.

5. a) glütseriin: $C_3H_8O_3$; M = 92,1 g/mol = 0,0921 kg/mol

$$m = \frac{\dfrac{0{,}15x}{0{,}0921\ \mathrm{kg/mol}}}{(1-0{,}15)\,x\ \mathrm{kg}} = \frac{1{,}629x\ \mathrm{mol}}{0{,}85x\ \mathrm{kg}} = 1{,}916\ \frac{\mathrm{mol}}{\mathrm{kg}}$$

$$\Delta T = K_f m = 1{,}86\ \frac{\mathrm{K \cdot kg}}{\mathrm{mol}} \cdot 1{,}916\ \frac{\mathrm{mol}}{\mathrm{kg}} = 3{,}6\ \mathrm{K}$$

Jäätumistemperatuuri on **−3,6 °C**.

b) $c(15\%) = \dfrac{0{,}15x}{0{,}0921\ \mathrm{kg/mol}} \cdot 1{,}05\ \dfrac{\mathrm{kg}}{\mathrm{dm^3}} = 1{,}71\ \dfrac{\mathrm{mol}}{\mathrm{dm^3}}$

$$\pi = 1{,}711\ \mathrm{M} \cdot 0{,}0821\ \frac{\mathrm{dm^3 \cdot atm}}{\mathrm{K \cdot mol}} \cdot 298\ \mathrm{K} = \mathbf{42\ atm}$$

$$c(\mathrm{max}) = \frac{60\ \mathrm{MPa}}{0{,}0821\ \dfrac{\mathrm{dm^3 \cdot atm}}{\mathrm{K \cdot mol}} \cdot 298\ \mathrm{K}} \cdot \frac{1\ \mathrm{atm}}{1{,}01325\ \mathrm{MPa}} = \mathbf{2,4\ M}$$

6. a) $m(\mathrm{HgS}) = \dfrac{7{,}652\ \mathrm{g}}{200{,}59\ \mathrm{g/mol}} \cdot 232{,}66\ \mathrm{g/mol} = 8{,}875\ \mathrm{g}$

m(FeS) = m(kinaver) − m(HgS) = 1,125 g = m(A)

A – FeS, raud(II)sulfiid

Olgu **B** on CaSO4, siis vastavalt reaktsioonivõrrandile n(**B**)= ¼ n(Hg)

$$M(\mathbf{B}) = \frac{4m(\mathrm{B})}{n(\mathrm{HgS})} = 4 \cdot 1{,}2985\ \mathrm{g} \cdot \frac{200{,}59\ \mathrm{g/mol}}{7{,}652\ \mathrm{g}} = 136{,}2\ \mathrm{g}$$

B – $CaSO_4$, kaltsium sulfaat

b) $4HgS + 4CaO \rightarrow 4Hg + CaSO_4 + 3CaS$

$CaSO_4 + 2H_2O \rightarrow CaSO_4 \cdot 2H_2O$

$2CaS + 2H_2O \rightarrow Ca(HS)_2 + Ca(OH)_2$

$CaO + H_2O \rightarrow Ca(OH)_2$

$Ca(HS)_2 + CO_2 + H_2O \rightarrow CaCO_3 + 2H_2S$

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

$CaSO_4 \cdot 2H_2O \xrightarrow{t} CaSO_4 + 2H_2O$

c) $m(\mathrm{CaO}) = 56{,}02\ \mathrm{g} \cdot \dfrac{7{,}652\ \mathrm{g}}{200{,}59\ \mathrm{g/mol}} = \mathbf{2{,}137\ g}$

d) $4\mathrm{FeS} + 7\mathrm{O_2} \rightarrow 2\mathrm{Fe_2O_3} + 4\mathrm{SO2}$
$\mathrm{CaS} + 2\mathrm{O_2} \rightarrow \mathrm{CaSO_4}$

e) $\%(\mathrm{FeS}) = \dfrac{1{,}1235\ \mathrm{g}}{10{,}000\ \mathrm{g}} \cdot 100 = \mathbf{11{,}23\%}$

$\%(\mathrm{HgS}) = \left(1 - \dfrac{1{,}1235\ \mathrm{g}}{10{,}000\ \mathrm{g}}\right) \cdot 100 = \mathbf{88{,}77\%}$