

KEEMIAÜLESANNETE LAHENDAMISE LAHTINE VÕISTLUS

Noorem rühm (9. ja 10. klass)

Tallinn, Tartu, Kuressaare, Narva, Pärnu, Kohtla-Järve 10. november 2007

Ülesannete lahendused

1. a) i) $4\text{FeS}_2 + 11\text{O}_2 = 2\text{Fe}_2\text{O}_3 + 8\text{SO}_2$
 ii) $\text{Fe}_2\text{O}_3 + \text{CO} = 2\text{FeO} + \text{CO}_2$
 iii) $\text{FeO} + \text{H}_2\text{SO}_4 = \text{FeSO}_4 + \text{H}_2\text{O}$
 iv) $\text{FeSO}_4 + \text{Zn} = \text{ZnSO}_4 + \text{Fe}\downarrow$
 v) $2\text{Fe} + 3\text{Cl}_2 = 2\text{FeCl}_3$
 vi) $\text{FeCl}_3 + 3\text{NaOH} = \text{Fe}(\text{OH})_3\downarrow + 3\text{NaCl}$
 vii) $2\text{Fe}(\text{OH})_3 = \text{Fe}_2\text{O}_3 + 3\text{H}_2\text{O}$
 viii) $\text{Fe}_2(\text{SO}_4)_3 + 3\text{BaCl}_2 = 3\text{BaSO}_4\downarrow + 2\text{FeCl}_3$
- b) Binaarne ühend on XCl_n
 $35,5n / (A_r(\text{X}) + 35,5n) = 0,247 \quad A_r(\text{X}) = 35,5n / 0,247 - 35,5n = 108n$
 $\text{X} - \text{Ag}$, hõbe $\quad \text{XCl}_n - \text{AgCl}$, hõbekloriid
- c) nõrgalt happeline
- d) x) $10\text{FeSO}_4 + 2\text{KMnO}_4 + 8\text{H}_2\text{SO}_4 = 5\text{Fe}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 8\text{H}_2\text{O}$
 $2\text{Fe}^{\text{II}} - 2e^- = 2\text{Fe}^{\text{III}} \quad | \times 5$
 $\text{Mn}^{\text{VII}} + 5e^- = \text{Mn}^{\text{II}} \quad | \times 2$

2. a) $m(\text{HCl}) = 36,03 \text{ dm}^3 \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} \cdot \frac{1,629 \cdot 10^{-3} \text{ g}}{1 \text{ cm}^3} = 58,69 \text{ g}$

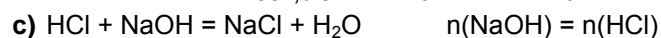
$m(\text{lahus}) = 58,69 \text{ g} + 500 \text{ cm}^3 \cdot \frac{0,999 \text{ g}}{1 \text{ cm}^3} = 558,2 \text{ g}$

$V(\text{lahus}) = 558,2 \text{ g} \cdot \frac{1 \text{ cm}^3}{1,050 \text{ g}} = 531,6 \text{ cm}^3 \approx \mathbf{532 \text{ cm}^3}$

$\%(\text{HCl}) = \frac{58,69 \text{ g}}{558,2 \text{ g}} \cdot 100 = \mathbf{10,5}$

b) $n(\text{HCl}) = 58,69 \text{ g} \cdot \frac{1 \text{ mol}}{36,46 \text{ g}} = 1,61 \text{ mol}$

$c(\text{HCl}) = 1,61 \text{ mol} \cdot \frac{1}{531,6 \text{ cm}^3} \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} = 3,03 \frac{\text{mol}}{\text{dm}^3} = \mathbf{3,03 \text{ M}}$



$m(\text{NaOH}) = 1,61 \text{ mol} \cdot \frac{40,00 \text{ g}}{1 \text{ mol}} = \mathbf{64,4 \text{ g}}$

3. a) **M** – Cu, vask **Q** – CO, süsinikmonooksiid
G – H₂, vesinik **M₂O** – Cu₂O, vask(I)oksiid
K – H₂O, vesi **MO** – CuO, vask(II)oksiid
L – C, süsinik

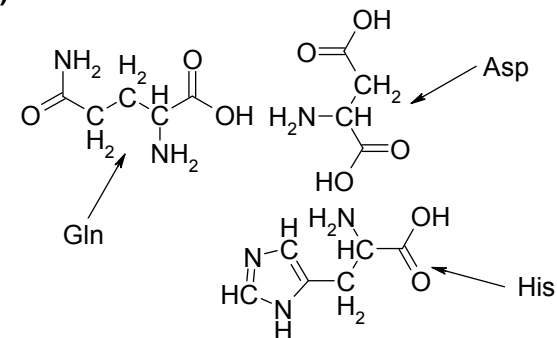
- b) i) $4\text{CuO} = 2\text{Cu}_2\text{O} + \text{O}_2$ iv) $\text{CO} + \text{H}_2 + \text{O}_2 = \text{CO}_2 + \text{H}_2\text{O}$
 ii) $\text{Cu}_2\text{O} + \text{H}_2 = 2\text{Cu} + \text{H}_2\text{O}$ v) $\text{CO}_2 + \text{Ca}(\text{OH})_2 = \text{CaCO}_3\downarrow + \text{H}_2\text{O}$
 iii) $\text{H}_2\text{O} (\text{gaas}) + \text{C} = \text{CO} + \text{H}_2$

4. a) Summaarne valem on C₁₅H₂₂N₆O₇

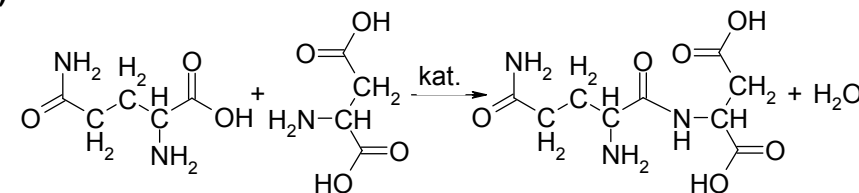
$\%_{\text{aatom}}(\text{N}) = \frac{6}{15 + 22 + 6 + 7} \cdot 100 = \mathbf{12}$

$\%_{\text{mass}}(\text{N}) = \frac{6 \cdot 14}{15 \cdot 12 + 22 \cdot 1 + 6 \cdot 14 + 7 \cdot 16} \cdot 100 = \mathbf{21}$

b)



c)



5. a) $n(\text{C}_2\text{H}_5\text{OH}) = n(\text{CO}_2) = 972 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{24 \text{ dm}^3} = 40,5 \text{ mol} = \mathbf{41 \text{ mol}}$

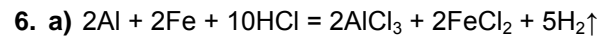
b) $V(\text{e tanool}) = 40,5 \text{ mol} \cdot \frac{46 \text{ g}}{1 \text{ mol}} \cdot \frac{1 \text{ cm}^3}{0,792 \text{ g}} \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} = 2,35 \text{ dm}^3$

$\% \text{vol}(\text{etanool}) = \frac{2,35 \text{ dm}^3}{30 \text{ dm}^3} \cdot 100 = \mathbf{7,8}$

c) $n(\text{glükoos}) = \frac{40,5 \text{ mol}}{2} \cdot \frac{1}{0,95} \cdot \frac{1,5}{1} = 32 \text{ mol}$

$m(\text{glükoos}) = 32 \text{ mol} \cdot \frac{180 \text{ g}}{1 \text{ mol}} \cdot \frac{1 \text{ kg}}{1000 \text{ g}} = 5,76 \text{ kg}$

$m(\text{oder}) = 5,76 \text{ kg} \cdot \frac{1}{0,3} = \mathbf{19 \text{ kg}}$



b) $c(\text{Fe, lahus B}) = \frac{0,247 \text{ mmol}}{1 \text{ dm}^3} \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} \cdot \frac{5,00 \text{ cm}^3}{50,0 \text{ cm}^3} \cdot \frac{55,85 \text{ mg}}{1 \text{ mmol}} = 0,00138 \frac{\text{mg}}{\text{cm}^3}$

$c(\text{Fe, lahus A}) = \frac{0,148}{0,320} \cdot 0,00138 \frac{\text{mg}}{\text{cm}^3} = 0,000638 \frac{\text{mg}}{\text{cm}^3}$

c) $\%(\text{Fe, sulam}) = 0,000638 \frac{\text{mg}}{\text{cm}^3} \cdot \frac{50 \text{ cm}^3}{5 \text{ cm}^3} \cdot \frac{100 \text{ cm}^3}{0,250 \text{ g}} \cdot \frac{1 \text{ g}}{1000 \text{ mg}} \cdot 100 = 0,255$

KEEMIAÜLESANNETE LAHENDAMISE LAHTINE VÕISTLUS

Vanem rühm (11. ja 12. klass)

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Ülesannete lahendused

1. a) NaHCO_3 – naatriumvesinikkarbonaat, söögisooda

K_2CO_3 – kaaliumkarbonaat, potas

HCl – vesinikkloriidhape, soolhape

CO_2 – süsinikdioksiid, süsihappegaas

$\text{NaHCO}_3 + \text{HCl} = \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2\uparrow$

$\text{K}_2\text{CO}_3 + 2\text{HCl} = 2\text{KCl} + \text{H}_2\text{O} + \text{CO}_2\uparrow$

b) NaCl ja KCl on mõlemad värvitud kristallid, tahke jääk on valge pulber.

c) i) $n = \frac{pV}{RT} = 1 \text{ atm} \cdot 19,7 \text{ dm}^3 \cdot \frac{1 \text{ mol} \cdot \text{K}}{0,082 \text{ atm} \cdot \text{dm}^3} \cdot \frac{1}{(273 + 25) \text{ K}} = \mathbf{0,806 \text{ mol}}$

ii) Tähistame söögisooda massi x ja potase massi y -ga

$$\begin{cases} \frac{x}{84} + \frac{y}{138} = 0,806 \\ \frac{58,5x}{84} + \frac{2 \cdot 74,5y}{138} = 56,72 \end{cases} \quad \begin{cases} m(\text{NaHCO}_3) = x = 58,8 \text{ g} \\ m(\text{K}_2\text{CO}_3) = y = 14,6 \text{ g} \end{cases}$$

NaHCO_3 ja K_2CO_3 massivahekord on **4,03 : 1**.

iii) $\%(\text{H}_2\text{O}) = \frac{75 \text{ g} - 58,8 \text{ g} - 14,6 \text{ g}}{75 \text{ g}} \cdot 100 = \frac{1,6 \text{ g}}{75 \text{ g}} \cdot 100 = \mathbf{2,1}$

d) $\frac{58,5x}{84} + \frac{2 \cdot 74,5y}{138} = x + y$

Otsitav suurus $\frac{x}{y} = \frac{1 - 1,08}{0,696 - 1} = 0,26 = \frac{1}{3,8}$

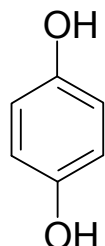
NaHCO_3 ja K_2CO_3 massivahekord peab olema **1:3,8**.

2. a) $\text{DHB}(\text{OH})_2 \rightarrow \text{DHB}(\text{=O})_2 + 2\text{e}^- + 2\text{H}^+$ ($z = 2$)

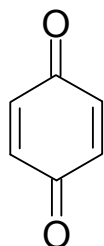
b) $n = \frac{q}{zF} = \frac{It}{zF} = 206 \text{ mA} \cdot \frac{1 \text{ A}}{1000 \text{ mA}} \cdot 1 \text{ h} \cdot \frac{3600 \text{ s}}{1 \text{ h}} \cdot \frac{1}{2} \cdot \frac{1 \text{ mol}}{96485 \text{ C}} =$
 $= 0,00384 \text{ mol}$

$M = 415 \text{ mg} \cdot \frac{1 \text{ g}}{1000 \text{ mg}} \cdot \frac{1}{0,00384 \text{ mol}} = \mathbf{108 \text{ g/mol}}$

c) lähteaine



saadus

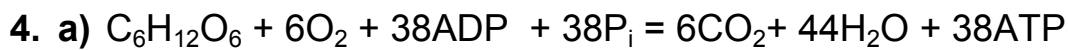
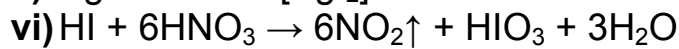
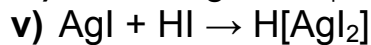
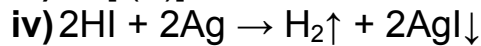
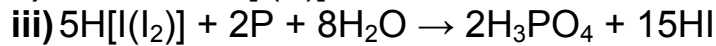
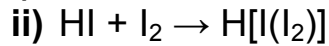
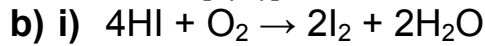
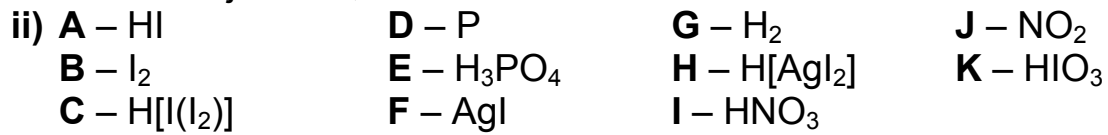


d) i) Ekstraheerimine süsteemis vesi - orgaaniline lahusti (nt etüüleeter):
hüdokinoon jääb veefaasi, kinoon – orgaanilisse faasi.

ii) Veest ümberkristalliseerimine ja filtreerimine: kinoon ei lahustu vees, seega sadeneb nõu põhja ning filtreeritakse välja.

$$3. \text{ a) i) } \mathbf{J} - \mathbf{X}_n\mathbf{O}_m \quad \frac{m \cdot A_r(\text{O})}{n \cdot A_r(\mathbf{X}) + m \cdot A_r(\text{O})} = 0.6955 \quad A_r(\mathbf{X}) = \frac{7.0048 \cdot m}{n}$$

Kui $m = 2$ ja $n = 1$, siis $\mathbf{J} - \text{NO}_2$



b) $\Delta G(\text{ATP teke}) = 38 \text{ mol} \cdot \frac{50 \text{ kJ}}{1 \text{ mol}} = \mathbf{1900 \text{ kJ}}$

c) $\Delta G(\text{oks. fosfor.}) = (-2823,2 + 1900) \text{ kJ/mol} = -923,2 \text{ kJ/mol} =$
 $= \mathbf{-900 \text{ kJ/mol}}$

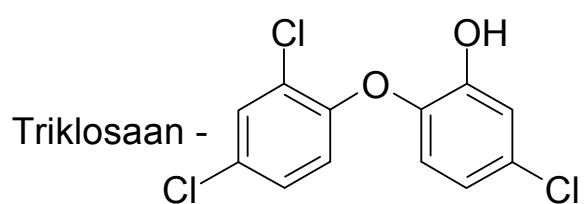
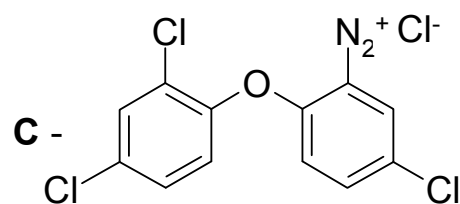
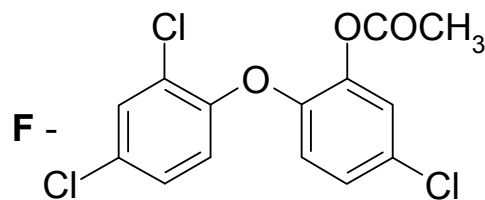
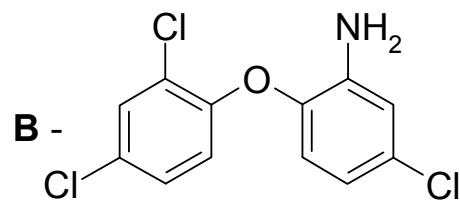
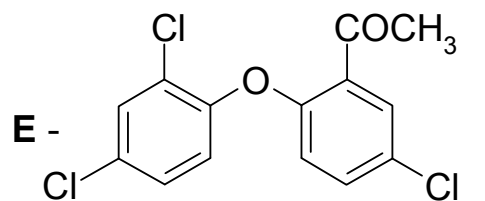
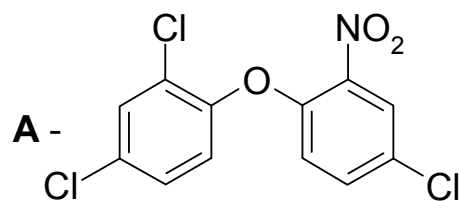
d) $\text{Efektiivsus} = \frac{1900}{2823,2} \cdot 100 = \mathbf{67}$

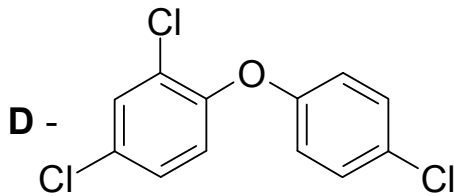
5. a) $\text{C} : \text{H} : \text{O} : \text{Cl} \quad \frac{49,78}{12,0} : \frac{2,44}{1,01} : \frac{11,05}{16,0} : \frac{36,73}{35,5} \Rightarrow 12 : 7 : 2 : 3 \quad \mathbf{C_{12}H_7O_2Cl_3}$

X – 2,4-diklorofenool

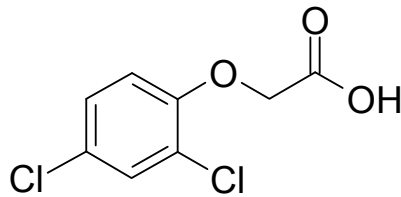
Y – difenüüleeter, fenoksübenseen

b)



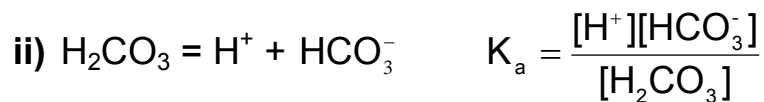


c)



6. a) i) $p(\text{CO}_2) = 0,000355 \cdot 1 \text{ atm} = 3,55 \cdot 10^{-4} \text{ atm} = \mathbf{3,6 \cdot 10^{-4} \text{ atm}}$

ii) $c(\text{CO}_2)_v = \frac{3,38 \cdot 10^{-2} \text{ M}}{1 \text{ atm}} \cdot 3,55 \cdot 10^{-4} \text{ atm} = \mathbf{1,2 \cdot 10^{-5} \text{ M}}$



iii) Kogu CO_2 on jaotunud H_2CO_3 ja HCO_3^- vahel, seega

$$c(\text{CO}_2)_v = [\text{H}_2\text{CO}_3] + [\text{HCO}_3^-] \quad (\text{massibilanss})$$

$$\text{Avaldame } [\text{H}_2\text{CO}_3]: [\text{H}_2\text{CO}_3] = c(\text{CO}_2)_v - [\text{HCO}_3^-] \quad (\text{I})$$

$$\text{Puhta happe lahuses: } [\text{H}^+] = [\text{HCO}_3^-] \quad (\text{laengubilanss}) \quad (\text{II})$$

Asendame seosed (I) ja (II) K_a avaldisse ja arvutame $[\text{H}^+]$:

$$K_a = \frac{[\text{H}^+]^2}{c(\text{CO}_2)_v - [\text{HCO}_3^-]} = \frac{[\text{H}^+]^2}{c(\text{CO}_2)_v - [\text{H}^+]}$$

$$[\text{H}^+]^2 + [\text{H}^+]K_a - c(\text{CO}_2)_v K_a = 0 \Rightarrow [\text{H}^+] = \frac{-K_a/2 \pm \sqrt{(K_a/2)^2 + c(\text{CO}_2)_v K_a}}{1}$$

$$[\text{H}^+] = \frac{-4,45 \cdot 10^{-7}}{2} + \sqrt{\left(\frac{4,45 \cdot 10^{-7}}{2}\right)^2 + 1,2 \cdot 10^{-5} \cdot 4,45 \cdot 10^{-7}} = 2,10 \cdot 10^{-6} \text{ M}$$

$$\text{pH} = -\log [\text{H}^+] = -\log(2,10 \cdot 10^{-6}) = \mathbf{5,68}$$

c) $\alpha = \frac{[\text{HCO}_3^-]}{c(\text{H}_2\text{CO}_3)_{\text{uld}}} = \frac{[\text{H}^+]}{c(\text{CO}_2)_v} = \frac{2,10 \cdot 10^{-6} \text{ M}}{1,2 \cdot 10^{-5} \text{ M}} \cdot 100 = 17,5 = \mathbf{18}$