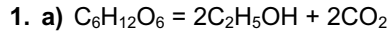


KEEMIAÜLESANNETE LAHENDAMISE LAHTINE VÕISTLUS

Vanem rühm (11. ja 12. klass)

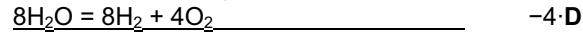
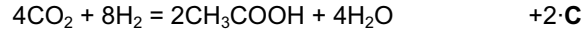
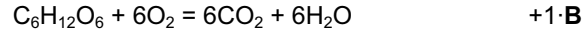
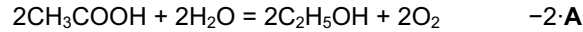
Tallinn, Tartu, Kuressaare, Narva, Pärnu, Kohtla-Järve 7. november 2009

Ülesannete lahendused

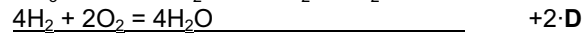
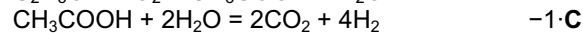
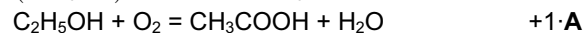
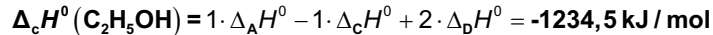
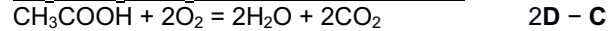
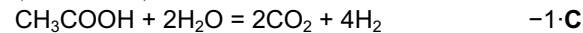
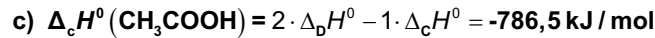


b) Kasutades Hessi seadust saadakse:

$$\Delta H^0 = 1 \cdot \Delta_B H^0 - 2 \cdot \Delta_A H^0 + 2 \cdot \Delta_C H^0 - 4 \cdot \Delta_D H^0$$



$$\Delta H^0 = [-2559,8 - 2 \cdot (-448) + 2 \cdot (-180,7) - 4 \cdot (-483,6)] \text{ kJ/mol} = -90,8 \text{ kJ/mol}$$



2. a) $m_{\text{kaalutis}} = m_{\text{NaOH}} + m_{\text{lisand, H}_2\text{O}} = 0,51 \text{ M} \cdot 200 \text{ cm}^3 \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} \cdot \frac{40,0 \text{ g}}{1 \text{ mol}} = 4,08 \text{ g}$

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

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

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

$$m_{\text{NaOH}} + 52,08 m_{\text{NaOH}} = 53,08 m_{\text{NaOH}} = 204,2 \text{ g} \quad m_{\text{NaOH}} = \frac{204,2 \text{ g}}{53,08} = 3,847 \text{ g}$$

$$m_{\text{lisand, H}_2\text{O}} = 4,08 \text{ g} - 3,847 \text{ g} = 0,233 \text{ g}$$

$$\%(\text{H}_2\text{O}) = \frac{0,233 \text{ g}}{4,08 \text{ g}} \cdot 100 = 5,7$$

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

$$n(\text{H}_2\text{SO}_4) = 0,0162 \text{ mol} - n(\text{SO}_3)$$

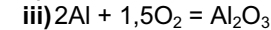
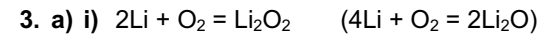
$$\frac{80,07 \text{ g}}{1 \text{ mol}} \cdot n(\text{SO}_3) + \frac{98,08 \text{ g}}{1 \text{ mol}} \cdot (0,0162 \text{ mol} - n(\text{SO}_3)) = 1,5 \text{ g}$$

$$n(\text{SO}_3) = \frac{(98,08 \cdot 0,0162 - 1,5) \text{ g}}{(98,08 - 80,07) \text{ g/mol}} = 0,00494 \text{ mol}$$

$$\%(\text{SO}_3) = \frac{0,00494 \text{ mol} \cdot 80,07 \text{ g/mol}}{1,5 \text{ g}} \cdot 100 = 26$$

c) $c(\text{NaOH}) = (4,08 - 0,235) \text{ g} \cdot \frac{1 \text{ mol}}{40 \text{ g}} \cdot \frac{1}{200 \text{ cm}^3} \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} = 0,481 \frac{\text{mol}}{\text{dm}^3}$

$$V(\text{NaOH}) = \frac{2}{1} \cdot 0,0162 \text{ mol} \cdot \frac{1 \text{ dm}^3}{0,481 \text{ mol}} \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} = 67,4 \text{ cm}^3$$



b) i) $P(\text{Li}) = \frac{1}{2} \cdot 561000 \frac{\text{J}}{\text{mol}} \cdot \frac{1 \text{ W} \cdot 1 \text{ s}}{1 \text{ J}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} \cdot \frac{1 \text{ mol}}{6,94 \text{ g}} \cdot \frac{1000 \text{ g}}{1 \text{ kg}} \cdot 0,5 = 5610 \text{ W} \cdot \text{h/kg}$

$$P(\text{Si}) = \frac{1}{1} \cdot 856000 \frac{\text{J}}{\text{mol}} \cdot \frac{1 \text{ W} \cdot 1 \text{ s}}{1 \text{ J}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} \cdot \frac{1 \text{ mol}}{28,09 \text{ g}} \cdot \frac{1000 \text{ g}}{1 \text{ kg}} \cdot 0,5 = 4230 \text{ W} \cdot \text{h/kg}$$

$$P(\text{Al}) = \frac{1}{2} \cdot 1582000 \frac{\text{J}}{\text{mol}} \cdot \frac{1 \text{ W} \cdot 1 \text{ s}}{1 \text{ J}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} \cdot \frac{1 \text{ mol}}{26,98 \text{ g}} \cdot \frac{1000 \text{ g}}{1 \text{ kg}} \cdot 0,5 = 4072 \text{ W} \cdot \text{h/kg}$$

Suurim võimsus massi ühiku kohta (W·h/kg) on liitium akul.

ii) $P(\text{Li}) = \frac{5610 \text{ W} \cdot \text{h}}{1 \text{ kg}} \cdot \frac{0,535 \text{ g}}{1 \text{ cm}^3} \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} \cdot \frac{1 \text{ kg}}{1000 \text{ g}} = 3000 \text{ W} \cdot \text{h/dm}^3$

$$P(\text{Si}) = \frac{4230 \text{ W} \cdot \text{h}}{1 \text{ kg}} \cdot \frac{2,33 \text{ kg}}{1 \text{ dm}^3} = 9860 \text{ W} \cdot \text{h/dm}^3$$

$$P(\text{Al}) = \frac{4072 \text{ W} \cdot \text{h}}{1 \text{ kg}} \cdot \frac{2,70 \text{ kg}}{1 \text{ dm}^3} = 10990 \text{ W} \cdot \text{h/dm}^3$$

Suurim võimsus ruumala ühiku kohta (W·h/dm³) on alumiinium akul.

c) Li-aku lahusti ja elektrolüüt: CH_3COOH
 Anood: $\text{Li} + \text{CH}_3\text{COOH} = \text{CH}_3\text{COOLi} + \text{H}^+ + \text{e}^- \quad | \cdot 4$
 Katood: $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- = 2\text{H}_2\text{O}$
 Kokku: $4\text{Li} + \text{O}_2 + 4\text{CH}_3\text{COOH} = 4\text{CH}_3\text{COOLi} + 2\text{H}_2\text{O}$
 Li-õhk akud pole veel kommertsiaalselt saadaval, kuid neid arendatakse paljudes laborites.

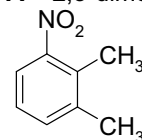
Al-aku: lahusti: H_2O elektrolüüt: NaOH
 Anood: $\text{Al} + 4\text{OH}^- = [\text{Al}(\text{OH})_4]^- + 3\text{e}^- \quad | \cdot 4$
 Katood: $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- = 4\text{OH}^- \quad | \cdot 3$
 Kokku: $4\text{Al} + 3\text{O}_2 + 6\text{H}_2\text{O} + 4\text{OH}^- = 4[\text{Al}(\text{OH})_4]^-$
 Selline patarei (mitte taaslaetav) võimsustihedusega 1300 Wh kg^{-1} on kasutatav USA sõjaväes.

Si-aku: lahusti: H_2O elektrolüüt: NaOH
 Anood: $\text{Si} + 6\text{OH}^- = [\text{SiO}_2(\text{OH})_2]^{2-} + 2\text{H}_2\text{O} + 4\text{e}^-$
 Katoodil: $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- = 4\text{OH}^-$
 Kokku: $\text{Si} + \text{O}_2 + 2\text{OH}^- = [\text{SiO}_2(\text{OH})_2]^{2-}$

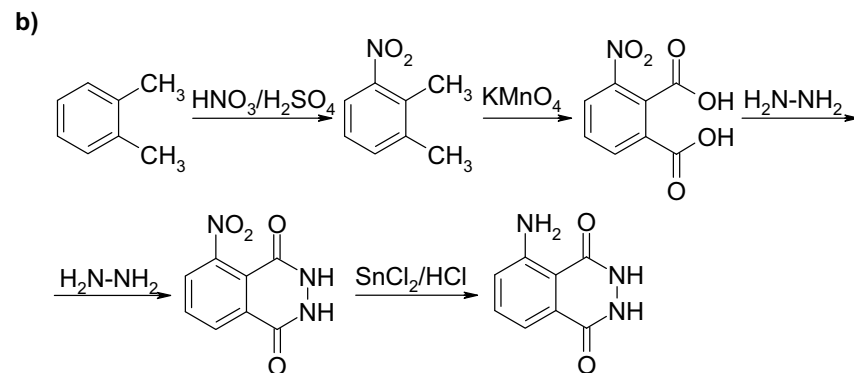
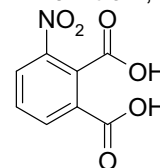
d) $\text{Si} (25,7\%) < \text{Al} (8,1\%) < \text{Li} (0,002\%)$
 Liitium on kaks suurusjärku kallim kui räni ja alumiinium.

5. a) X – H
 A – H_2O_2 D – CH_4 G – SiH_4 J – Cl_2 M – HSiCl_3
 B – H_2O E – H_2S H – HF K – H_2 N – SiCl_4
 C – NH_3 F – HCl I – O_2 L – Si O – SiO_2
 b) $2\text{H}_2\text{O}_2 = 2\text{H}_2\text{O} + \text{O}_2$ $4\text{HCl} + \text{MnO}_2 = \text{Cl}_2 + 2\text{H}_2\text{O} + \text{MnCl}_2$
 $\text{N}_2 + 3\text{H}_2 = 2\text{NH}_3$ $\text{Si} + 3\text{HCl} = \text{HSiCl}_3 + \text{H}_2$
 $4\text{S} + \text{CH}_4 = \text{CS}_2 + 2\text{H}_2\text{S}$ $4\text{HSiCl}_3 = \text{SiH}_4 + 3\text{SiCl}_4$
 $\text{CS}_2 + 3\text{O}_2 = \text{CO}_2 + 2\text{SO}_2$ $\text{SiCl}_4 + 2\text{H}_2\text{O} = \text{SiO}_2 + 4\text{HCl}$
 $\text{H}_2 + \text{Cl}_2 = 2\text{HCl}$ $4\text{HF} + \text{SiO}_2 = 2\text{H}_2\text{O} + \text{SiF}_4$

6. a) A – 2,3-dimetüülnitrobenseen

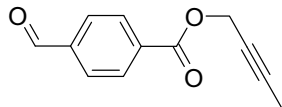


B – 3-nitro-1,2-benseendikarboksüülhape

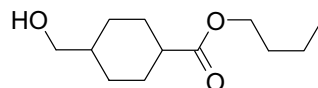


c) Luminooli helenduse kutsuvad esile Fe^{2+} ioonid. Seega Hundi rinnaesisel olev plekk võis olla ükskõik milline raud(II)ioone sisaldav lahus – sealhulgas veri. Karu tehtud test ei öelnud täiesti kindlalt, et tegemist oli verega. Isegi kui see oleks Jänese veri, ei tõestaks see, et Hunt Jänese ära sõi. See oleks ainult tõenäoline.

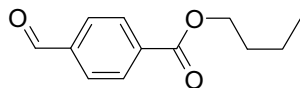
4.



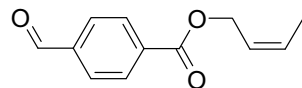
A



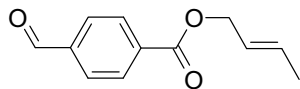
B



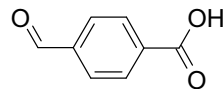
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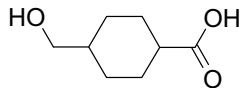
D1



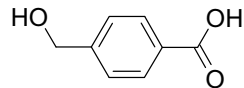
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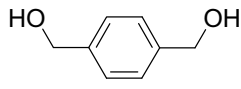
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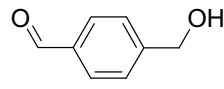
F



G



H



I