KEEMIAÜLESANNETE LAHENDAMISE LAHTINE VÕISTLUS

Noorem rühm (9. ja 10. klass)

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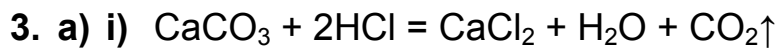
Ülesannete lahendused

1. a) i) $\%(CuSO_4) = \dfrac{56,1\,g \cdot 159,5\,\frac{g}{mol} \cdot 100}{249,5\,g/mol \cdot (56,1\,g + 457\,g)} = \mathbf{6,99}$ 1

ii) $n(CuSO_4) = \dfrac{342\,g \cdot 0,0699}{159,5\,g/mol} = \mathbf{0,150\ mol}$ 1

iii) $n(Ba(OH)_2) = \dfrac{2,29\,kg \cdot 1000\,g/kg \cdot 0,05}{171\,g/mol} = \mathbf{0,67\,mol}$ 1

iv) $n(CO_2) = \dfrac{7,2\,dm^3}{22,4\,dm^3/mol} = \mathbf{0,32\,mol}$ 1

v) $n((NH_4)_2SO_4) = \dfrac{118\,cm^3 \cdot 1,115\,g/cm^3 \cdot 0,2}{132\,g/mol} = \mathbf{0,2\,mol}$ 1

b) $FeCl_2 + Ba(OH)_2 = BaCl_2 + Fe(OH)_2\downarrow$ 1
$CuSO_4 + Ba(OH)_2 = Cu(OH)_2\downarrow + BaSO_4\downarrow$ 1
$Ba(OH)_2 + CO_2 = BaCO_3\downarrow + H_2O$ 1
$BaCl_2 + (NH_4)_2SO_4 = BaSO_4\downarrow + 2NH_4Cl$ 1

c) i) sade nr 1: $Fe(OH)_2$, $Cu(OH)_2$ ja $BaSO_4$.   1
ii) sade nr 2: $BaCO_3$ ja $BaSO_4$.   1

d) Baariumhüdroksiidi jääb peale esimest sadestamist alles 0,67 mol − 0,2 mol − 0,15 mol = 0,32 mol. Tekib 0,2 mol $BaCl_2$. Süsihappegaasiga sadestatakse 0,32 mol Ba^{2+} ja neutraliseeritakse ära hüdroksiid. Lahusesse jääb alles 0,2 mol baariumkloriidi, mis ammooniumsulfaadiga reageerides annab 0,2 mol baariumsulfaadi sadet. Kloriidist ja ammooniumioonidest jääb lahusesse alles 0,4 mol NH_4Cl. Kuna pärast lahuse aurutamist veel kuumutati jääki ja ammooniumkloriid kuumutades laguneb, siis ei jää portselankaussi suurt midagi. $\dfrac{1}{\mathbf{12p}}$

2. a) $CH_4 + 2O_2 = CO_2 + 2H_2O$ 1
b) $\Delta H = 1 \cdot (-393,5\ kJ/mol) + 2 \cdot (-241,8\ kJ/mol) - 1 \cdot (-74,8\ kJ/mol)$
$\mathbf{\Delta H = -802,3\ kJ/mol}$ 2

c) $n(CH_4) = \dfrac{1}{2} \cdot 502\,\dfrac{mg}{dm^3} \cdot 250000\ dm^3 \cdot \dfrac{1\,g}{1000\,mg} \cdot \dfrac{1}{30\,g/mol} = 2090\ mol$ 2

$E = 802,3\ kJ/mol \cdot 2090\ mol \cdot \dfrac{1\ GJ}{10^6\ kJ} = \mathbf{1,68\ GJ}$ 1

d) $E = \dfrac{1}{2} \cdot 12 \cdot 300 \text{ m}^3 \cdot 1000 \dfrac{\text{dm}^3}{\text{m}^3} \cdot \dfrac{1 \text{ mol}}{22{,}4 \text{ dm}^3} \cdot 802{,}3 \dfrac{\text{kJ}}{\text{mol}} \cdot \dfrac{1 \text{ GJ}}{10^6 \text{ kJ}}$

$E = 64{,}5 \text{ GJ} \approx \textbf{65 GJ}$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad$ $\underline{2}$

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ **8p**

3. a) i) $CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2\uparrow$ $\qquad\qquad\qquad\qquad\qquad$ 1
$\quad\;\;$ **ii)** $NaOH + HCl = NaCl + H_2O$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ 1
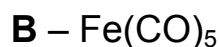
b) $n(\text{HCl}) = \left(25{,}00 \text{ cm}^3 \cdot 1{,}101 \dfrac{\text{mol}}{\text{dm}^3} - 24{,}31 \text{ cm}^3 \cdot 0{,}3603 \dfrac{\text{mol}}{\text{dm}^3} \right) \dfrac{1 \text{dm}^3}{1000 \text{ cm}^3}$

$\quad\;\;$ $n(\textbf{HCl}) = \textbf{0,01877 mol}$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad$ 1

c) $\%(\textbf{CaCO}_3) = \dfrac{0{,}01877\,\text{mol} \cdot \dfrac{1}{2} \cdot \dfrac{100{,}09\,\text{g}}{1\,\text{mol}}}{1{,}02\,\text{g}} \cdot 100\% = \textbf{92,1\%}$ $\qquad\qquad\qquad$ 1

d) Tiitrimisel tekkivate vigade vähendamiseks tuleks kogu eksperimenti veel vähemalt kaks korda korrata ja lugeda tõeliseks kaltsiumkarbonaadi sisalduseks kolme eksperimendi põhjal saadud kokkulangeva protsendilise sisalduse keskmist. $\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ 1

e) Kuna viga sõltub ainult arvutatud HCl moolide arvu erinevusest, siis:

$n(\text{HCl}) = \big(25{,}00 \text{ cm}^3 \cdot 1{,}101 \dfrac{\text{mol}}{\text{dm}^3} -$

$\qquad - 24{,}37 \text{ cm}^3 \cdot 0{,}3603 \dfrac{\text{mol}}{\text{dm}^3} \big) \cdot \dfrac{1 \text{dm}^3}{1000 \text{ cm}^3} = 0{,}01874\,\text{mol}$

$\quad\;\;$ $\%(\textbf{viga}) = \dfrac{0{,}01874 - 0{,}01877}{0{,}01877} \cdot 100 = \textbf{-0,2\%}$

$\quad\;\;$ ("−"tähistab, et $CaCO_3$ sisaldus tuleb õigest väärtusest 0,2% väiksem)$\underline{2}$

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ **7p**
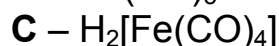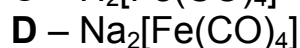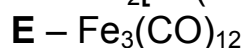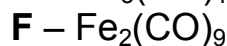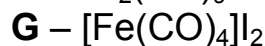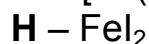
4. a) A – FeO $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ (+arvutus) 0.5
$\qquad$ **B** – $Fe(CO)_5$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ (+arvutus) 0.5
$\qquad$ **C** – $H_2[Fe(CO)_4]$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ 0.5
$\qquad$ **D** – $Na_2[Fe(CO)_4]$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad$ 0.5
$\qquad$ **E** – $Fe_3(CO)_{12}$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ (+arvutus) 0.5
$\qquad$ **F** – $Fe_2(CO)_9$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad$ (+arvutus) 0.5
$\qquad$ **G** – $[Fe(CO)_4]I_2$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ 0.5
$\qquad$ **H** – FeI_2 $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ (+arvutus) 0.5
$\qquad$ Ühendite üldvalem Fe_xZ_y
$\qquad$ **A**: $56x/0{,}78 = 56x + 16y \Rightarrow x = 1, y = 1$ $\qquad$ FeO
$\qquad$ **B**: $56x/0{,}29 = 56x + 28y \Rightarrow x = 1, y = 5$ $\qquad$ $Fe(CO)_5$
$\qquad$ **E**: $56x/0{,}33 = 56x + 28y \Rightarrow x = 1, y = 4$ $\qquad$ $Fe_3(CO)_{12}$
$\qquad$ **F**: $56x/0{,}31 = 56x + 28y \Rightarrow x = 2, y = 9$ $\qquad$ $Fe_2(CO)_9$
$\qquad$ **H**: $56x/0{,}18 = 56x + 127y \Rightarrow x = 1, y = 2$ $\qquad$ FeI_2
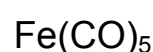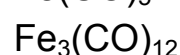
b) $FeO + H_2 = Fe + H_2O$ 1
   $Fe + 5CO = Fe(CO)_5$ 1
   $Fe(CO)_5 + Ba(OH)_2 = H_2[Fe(CO)_4] + BaCO_3$ 1
   $H_2[Fe(CO)_4] + 2Na = Na_2[Fe(CO)_4] + H_2$ 1
   $H_2[Fe(CO)_4] + 2I_2 = [Fe(CO)_4]I_2 + 2HI$ 1
   $Fe(CO)_5 + I_2 = [Fe(CO)_4]I_2 + CO$ 1
   $[Fe(CO)_4]I_2 = FeI_2 + 4CO$ 1
   $2Fe(CO)_5 = Fe_2(CO)_9 + CO$ 1
   $3Fe_2(CO)_9 = 2Fe_3(CO)_{12} + 3CO$ 1

                                                                      13p

5. a) Klaasi summaarne valem $Na_2O \cdot CaO \cdot 6SiO_2$ 1
   b) $C_xH_yO_z + (2x+y/2-z)/2\,O_2 = xCO_2 + y/2\,H_2O$ 1

   c) i) $n(O_2)_{alg} = \dfrac{1000 \text{ dm}^3}{22,4 \text{ dm}^3/\text{mol}} = 44,64 \text{ mol}$

   $\boldsymbol{n(O_2)_{reag} = 44,64 \text{ mol} \cdot 0,1344 = 6,00 \text{ mol}}$ 1

   ii) $n(\text{gaasid}) = \dfrac{1000 \text{ dm}^3}{21,0 \text{ dm}^3/\text{mol}} = 47,6 \text{ mol}$

   $n(\text{gaasid})_{nt} = \dfrac{1000 \text{ dm}^3}{22,91 \text{ dm}^3/\text{mol}} = 43,64 \text{ mol}$ 1

   Seega $n(H_2O)$ = 47,6 mol – 43,6 mol = **4,0 mol**   1
   y = 2 · 4 = 8
   iii) $\boldsymbol{n(CO_2)} = n(\text{gaasid})_{nt} - [n(O_2)_{alg} - n(O_2)_{reag}] = \boldsymbol{5,00 \text{ mol}}$ 1

   seega x = 5
   d) (10 + 4 − z)/2 = 6, siit z = 2 **MMA** summaarne valem on $C_5H_8O_2$ 1

                                                                       7p

6. a) A on väävel (S_8)   1   **E** on vääveltrioksiid (SO_3)   1
   B on divesiniksulfiid (H_2S)   1   **F** on väävelhape (H_2SO_4)   1
   C on vääveldioksiid (SO_2)   1   **G** on kaltsiumsulfaat ($CaSO_4$)   1
   D on väävlishappe (H_2SO_3)   1

   b)   1
   c) $S + H_2 = H_2S$ 0,5
   $2H_2S + 3O_2 = 2H_2O + 2SO_2$ 1
   $2H_2S + O_2 = 2H_2O + 2S$ 1
   $O_2 + 2SO_2 = 2SO_3$ 1
   $SO_2 + H_2O = H_2SO_3$ 0,5
   $SO_3 + H_2O = H_2SO_4$ 0,5
   $Ca(OH)_2 + H_2SO_4 = CaSO_4\!\downarrow + 2H_2O$ 0,5

                                                                      13p