

1999/2000 õa keemiaolümpiaadi III vooru ülesannete lahendused

10. klass

1. a) H_4SiO_4 , H_3PO_4 , H_2SO_4 , HClO_4
 b) $\text{S} + \text{Hg} = \text{HgS}$
 c) i) Kui **L** on **Hg**, siis **X** saab olla ainult **Tl**, sest see on peaarühma element, mille oksüdatsiooniaste peaks olema III. Au ei sobi, sest see pole peaarühma element ega reageeri veega.
 ii) Ühend **A** saab olla **Tl₂SO₄**, sest **Tl** oksüdatsiooniaste on tavaliselt I. Kahe talliumiooni sisaldusele soolas (sulfaadis) viitab ka talliumi erakordselt kõrge protsendiline sisaldus ühendis **A**.
 d) i) $4\text{Tl} + 2\text{H}_2\text{O} + \text{O}_2 = 4\text{TlOH}$
 ii) $2\text{TlOH} + \text{H}_2\text{SO}_4 = \text{Tl}_2\text{SO}_4 + 2\text{H}_2\text{O}$
 e) amalgaam
 f) $\%(\text{Tl}) = \frac{2 \cdot 204,4}{504,9} \cdot 100 = 80,97$
2. a) **X** – HNO_3 , lämmastikhape; **Y** – HCl , vesinikkloriidhape; **Z** – H_2SO_4 , väävelhape
 b) **A** – $\text{Cu}(\text{NO}_3)_2$, vask(II)nitraat; **B** – CuCl_2 , vask(II)kloriid; **C** – CuSO_4 , vask(II)sulfaat
 c) $\text{Cu} + 4\text{HNO}_3 = \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$
 ühend **A**
 d) i) segamisel osaleb reaktsioonis hapnik
 ii) $2\text{Cu} + 4\text{HCl} + \text{O}_2 = 2\text{CuCl}_2 + 2\text{H}_2\text{O}$
 ühend **B**
 iii) $2\text{Cu} + 2\text{H}_2\text{SO}_4 + \text{O}_2 = 2\text{CuSO}_4 + 2\text{H}_2\text{O}$
 ühend **C**
 e) i) $\text{CuCl}_2 + 2\text{AgNO}_3 = \text{Cu}(\text{NO}_3)_2 + 2\text{AgCl} \downarrow$
 ühend **G**, hõbekloriid
 ii) $\text{CuSO}_4 + \text{BaCl}_2 = \text{CuCl}_2 + \text{BaSO}_4 \downarrow$
 ühend **H**, baariumsulfaat
 f)

Cu	Y	Cu(NO₃)₂	Y	CuCl₂	Y	CuSO₄
63,5 g/mol	188 g/mol	188 g/mol	188 g/mol	134 g/mol	134 g/mol	160 g/mol

 i) kristallhüdraat **D** – $\text{Cu}(\text{NO}_3)_2 \cdot n'\text{H}_2\text{O}$

$$n'(\text{H}_2\text{O}) = 1 \text{ mol} \cdot \frac{63,5 \text{ g/mol}}{0,496 \text{ g}} \cdot 1,89 \text{ g} - \frac{0,496 \text{ g}}{63,5 \text{ g/mol}} \cdot 188 \text{ g/mol} \cdot \frac{1 \text{ mol}}{18 \text{ g}} = 3 \text{ mol}$$
D – $\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$
 ii) kristallhüdraat **E** – $\text{CuCl}_2 \cdot n''\text{H}_2\text{O}$

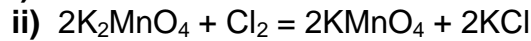
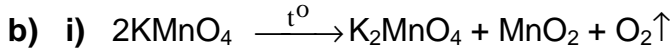
$$n''(\text{H}_2\text{O}) = 1 \text{ mol} \cdot \frac{63,5 \text{ g/mol}}{0,496 \text{ g}} \cdot 1,33 \text{ g} - \frac{0,496 \text{ g}}{63,5 \text{ g/mol}} \cdot 134 \text{ g/mol} \cdot \frac{1 \text{ mol}}{18 \text{ g}} = 2 \text{ mol}$$
E – $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$
 iii) kristallhüdraat **F** – $\text{CuSO}_4 \cdot n'''\text{H}_2\text{O}$

$$n'''\text{H}_2\text{O} = 1 \text{ mol} \cdot \frac{63,5 \text{ g/mol}}{0,248 \text{ g}} \cdot 0,98 \text{ g} - \frac{0,248 \text{ g}}{63,5 \text{ g/mol}} \cdot 160 \text{ g/mol} \cdot \frac{1 \text{ mol}}{18 \text{ g}} = 5 \text{ mol}$$
F – $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
 g) i) $[\text{Cu}(\text{H}_2\text{O})_2\text{Cl}_2]$
 ii) $[\text{Cu}(\text{H}_2\text{O})_3\text{NO}_3]\text{NO}_3$
 iii) $[\text{Cu}(\text{H}_2\text{O})_4]\text{SO}_4(\text{H}_2\text{O})$
3. a) i) $\text{C}_3\text{H}_8 + 5\text{O}_2 = 3\text{CO}_2 + 4\text{H}_2\text{O}$
 ii) $\text{DH}_c(\text{C}_3\text{H}_8) = 3 \cdot (-394 \text{ kJ/mol}) + 4 \cdot (-242 \text{ kJ/mol}) - 1 \cdot (-104 \text{ kJ/mol}) - 5 \cdot 0 = -2046 \text{ kJ/mol}$
 Märkus: Kõikide kordajate dimensiooniks on mol/mol, mis taandub.
 b) i) $4\text{C} + 5\text{H}_2 = \text{C}_4\text{H}_{10}$
 ii) $\text{DH}_f(\text{C}_4\text{H}_{10}) = 4 \cdot (-394 \text{ kJ/mol}) + 5 \cdot (-242 \text{ kJ/mol}) - 1 \cdot (-2655 \text{ kJ/mol}) = -131 \text{ kJ/mol}$
 c) $\Delta H(\text{C}_4\text{H}_{10}) = 21,0 \text{ kg} \cdot \frac{1000 \text{ g}}{1 \text{ kg}} \cdot \frac{1 \text{ mol}}{58,1 \text{ g}} \cdot (-2655 \text{ kJ/mol}) = -9,60 \cdot 10^5 \text{ kJ}$

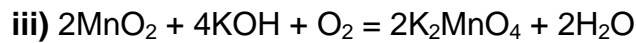
$$m(\text{C}_3\text{H}_8) = -9,60 \cdot 10^5 \text{ kJ} \cdot \frac{1 \text{ mol}}{-2046 \text{ kJ}} \cdot \frac{0,0440 \text{ kg}}{\text{mol}} = \mathbf{20,6 \text{ kg}}$$

d) Rohkem, sest auru kondenseerumine on eksotermiline protsess.

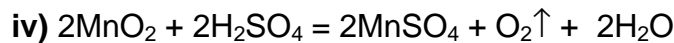
4. a) **A** – KMnO_4 , kaaliumpermanganaat
B – K_2MnO_4 , kaaliummanganaat
C – MnO_2 , mangaandioksiid e mangaan(IV)oksiid
D – O_2 , hapnik
E – MnSO_4 , mangaansulfaat



ühend **A**



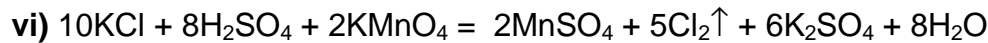
ühend **B**



ühend **E** gaas **D**

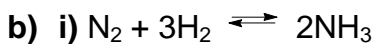


ühend **A** ühend **C**



ühend **E**

5. a) $c(\text{gaas}) = \frac{n(\text{gaas})}{1 \text{ dm}^3} \cdot \frac{1}{\text{dm}^3} \cdot 1 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{0,05 \text{ dm}^3} = \mathbf{20 \text{ mol/dm}^3}$



ii) $K_{\text{tasak}} = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = \frac{(2\text{M})^2}{3\text{M} \cdot (5\text{M})^3} = \frac{4\text{M}^2}{3\text{M} \cdot 125\text{M}^3} = 0,0107 \cdot \frac{1}{\text{M}^2} \approx \mathbf{1 \times 10^{-2} \times \frac{1}{\text{M}^2}}$

c) i) $c(\text{H}_2) = 5\text{M} + \frac{3}{2} \cdot 2\text{M} = \mathbf{8\text{M}}$

ii) $c(\text{N}_2) = 3\text{M} + \frac{1}{2} \cdot 2\text{M} = \mathbf{4\text{M}}$

6. a) **M** – Mg, magneesium
X – CO_2 , süsinikdioksiid
Y – O_2 , hapnik
Z – N_2 , lämmastik
A – MgO , magneesiumoksiid
B – C, süsinik
C – Mg_3N_2 , magneesiumnitriid
D – $\text{Mg}(\text{OH})_2$, magneesiumhüdroksoid
E – NH_3 , ammoniaak
F – MgCO_3 , magneesiumkarbonaat

