

2002/2003 õa keemiaolümpiaadi lõppvooru ülesannete lahendused

10. klass

1. a) i) **A** – CO₂, süsinikdioksiid

B – H₂, vesinik

C – Na, naatrium

ii) **D** – H₂SO₄, väävelhape

E – NH₃, ammoniaak

b) CO₂ täidetud õhupall on ohutu, H₂ on plahvatusohtlik ja NH₃ on hingamist ärritav.

c) $M_r(\text{õhk}) = 29 < M_r(\text{CO}_2) = 44$, langeb põrandale
 $M_r(\text{õhk}) = 29 > M_r(\text{H}_2) = 2$, tõuseb lakke
 $M_r(\text{õhk}) = 29 > M_r(\text{NH}_3) = 17$, tõuseb lakke

d) **F** – NaOH, naatriumhüdroksiid

G – NaHCO₃, naatriumvesinikkarbonaat

H – NH₄HCO₃, ammooniumvesinikkarbonaat

I – (NH₄)₂SO₄, ammooniumsulfaat

J – Na₂SO₄, naatriumsulfaat

e) i) $2\text{Na} + 2\text{H}_2\text{O} = 2\text{NaOH} + \text{H}_2\uparrow$

ii) $2\text{NaOH} + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$

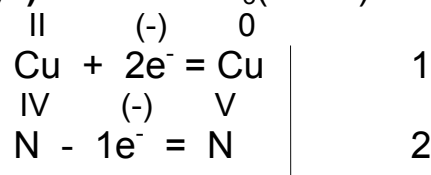
iii) $\text{NaOH} + \text{CO}_2 = \text{NaHCO}_3$

iv) $2\text{NaHCO}_3 + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + 2\text{CO}_2 + 2\text{H}_2\text{O}$

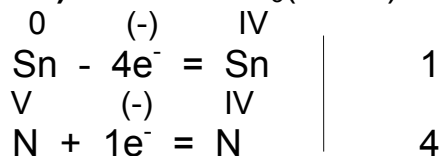
v) $\text{CO}_2 + \text{NH}_3 + \text{H}_2\text{O} = \text{NH}_4\text{HCO}_3$

vi) $2\text{NH}_4\text{HCO}_3 + \text{H}_2\text{SO}_4 = (\text{NH}_4)_2\text{SO}_4 + 2\text{CO}_2 + 2\text{H}_2\text{O}$

2. a) i) $\text{Cu} + 4\text{HNO}_3(\text{konts}) = \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$



ii) $\text{Sn} + 4\text{HNO}_3(\text{konts}) = \text{H}_2\text{SnO}_3 \cdot \text{H}_2\text{O} + 4\text{NO}_2$

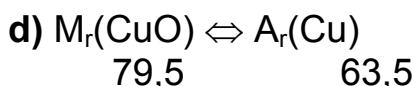


b) Sn(OH)₄, tina(IV)hüdroksiid

c) $m(\text{H}_2\text{SnO}_3 \cdot \text{H}_2\text{O}) = 32,61 \text{ g} - 5,08 \text{ g} = 27,53 \text{ g}$

$M_r(\text{H}_2\text{SnO}_3 \cdot \text{H}_2\text{O}) \Leftrightarrow A_r(\text{Sn})$
186,6 118,6

$$\%(\text{Sn}) = 27,53 \text{ g} \cdot 118,6 \cdot \frac{1}{186,6} \cdot \frac{1}{139,88 \text{ g}} \cdot 100 = \mathbf{12,51}$$



$$m[\text{Cu, vask(II)oksiidis}] = 0,636 \text{ g} \cdot 63,5 \cdot \frac{1}{79,5} = 0,508 \text{ g}$$

$$m(\text{Cu, saadud sulamis}) = (5,08 \text{ g} - 0,508 \text{ g}) \cdot 0,0556 = 0,254 \text{ g}$$

$$\%(\text{Au}) = (5,08 \text{ g} - 0,508 \text{ g} - 0,254 \text{ g}) \cdot \frac{1}{5,08 \text{ g}} \cdot 100 = \mathbf{85,0}$$

3. a) Mineraalsest osast lendub põletamisel sama kogus CO_2 , nagu eraldub seda soolhappega reageerimisel.

$$m(\text{CO}_2) = 6,74 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{22,4 \text{ dm}^3} \cdot 44 \text{ g/mol} = 13,2 \text{ g}$$

$$\text{i) } \%(\text{kerogeen}) = (100 \text{ g} - 13,2 \text{ g} - 53,0 \text{ g}) \cdot \frac{1}{100 \text{ g}} \cdot 100 = \mathbf{33,8}$$

$$\text{ii) } \%(\text{mineraalne osa}) = (100 \text{ g} - 33,8 \text{ g}) \cdot \frac{1}{100 \text{ g}} \cdot 100 = \mathbf{66,2}$$

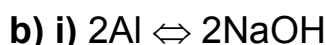
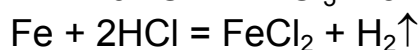
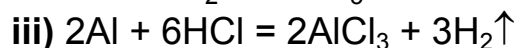
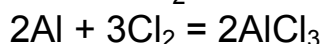
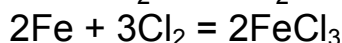
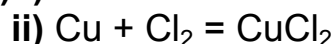
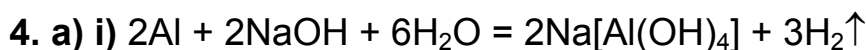
$$\text{ehk } \text{mineraalne osa} = 100\% - 33,8\% = 66,2\%$$

$$\text{b) } \%(\text{saagis}) = 0,338 \cdot 0,66 \cdot 100 = \mathbf{22,3}$$

$$\text{c) } m(\text{tahke jääk põlevkivi utmisel}) = 100 \text{ g} - 1,9 \text{ g} - 5,6 \text{ g} - 22,3 \text{ g} = 70,2 \text{ g}$$

$$\text{i) } \%(\text{poolkoks}) = (70,2 \text{ g} - 66,2 \text{ g}) \cdot \frac{1}{100 \text{ g}} \cdot 100 = \mathbf{4,0}$$

$$\text{ii) } \%(\text{poolkoks, kerogeenist}) = 4 \text{ g} \cdot \frac{1}{33,8 \text{ g}} \cdot 100 = 11,8 \approx \mathbf{12}$$



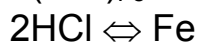
$$m(\text{Al}) = \frac{2}{2} \cdot 40,0 \text{ g} \cdot \frac{1 \text{ mol}}{40,0 \text{ g}} \cdot 26,98 \text{ g/mol} = 26,98 \text{ g} \approx \mathbf{27,0 \text{ g}}$$

$$\text{ii) } n(\text{HCl, lähte}) = 1035 \text{ cm}^3 \cdot 1,10 \text{ g/cm}^3 \cdot 0,100 \cdot \frac{1 \text{ mol}}{36,5 \text{ g}} = 3,12 \text{ mol}$$



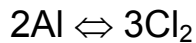
$$n(\text{HCl})_{\text{Al}} = \frac{6}{2} \cdot 1,00 \text{ mol} = 3,00 \text{ mol}$$

$$n(\text{HCl})_{\text{Fe}} = 3,12 \text{ mol} - 3,00 \text{ mol} = 0,12 \text{ mol}$$



$$m(\text{Fe}) = \frac{1}{2} \cdot 0,12 \text{ mol} \cdot 55,85 \text{ g/mol} = 3,35 \text{ g} \approx \mathbf{3,4 \text{ g}}$$

$$\text{iii) } n(\text{Cl}_2, \text{ lähte}) = 37,4 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{22,4 \text{ dm}^3} = 1,6696 \text{ mol} \approx \mathbf{1,67 \text{ mol}}$$

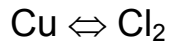


$$n(\text{Cl}_2)_{\text{Al}} = \frac{3}{2} \cdot 1,00 \text{ mol} = 1,50 \text{ mol}$$



$$n(\text{Cl}_2)_{\text{Fe}} = \frac{3}{2} \cdot 0,060 \text{ mol} = 0,090 \text{ mol}$$

$$n(\text{Cl}_2)_{\text{Cu}} = 1,67 \text{ mol} - 1,50 \text{ mol} - 0,090 \text{ mol} = 0,08 \text{ mol}$$



$$m(\text{Cu}) = 0,08 \text{ mol} \cdot 63,55 \text{ g/mol} = 5,08 \text{ g} \approx \mathbf{5,1 \text{ g}}$$

5. a) i) **A** – H_2O_2 , vesinikperoksiid

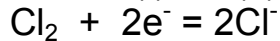
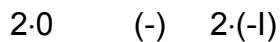
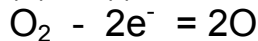
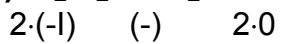
B – Cl_2 , kloor

C – KMnO_4 , kaaliumpermanganaat

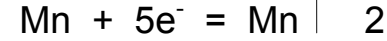
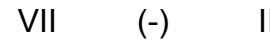
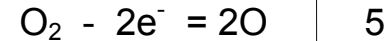
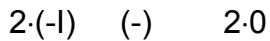
$$\text{ii) } \%(\text{O}_2, \text{H}_2\text{O}_2) = \frac{32}{34} \cdot 100 = \mathbf{94,1}$$

$$\%(\text{O}_2, \text{KMnO}_4) = \frac{64}{158} \cdot 100 = \mathbf{40,5}$$

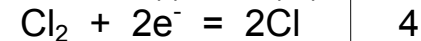
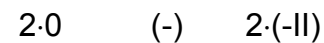
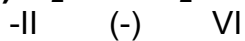
b) i) $\text{H}_2\text{O}_2 + \text{Cl}_2 = 2\text{HCl} + \text{O}_2$



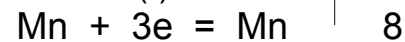
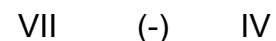
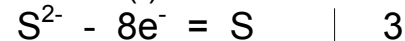
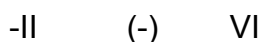
ii) $5\text{H}_2\text{O}_2 + 2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 = 1\text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 5\text{O}_2 + 8\text{H}_2\text{O}$



c) i) $\text{H}_2\text{S} + 4\text{H}_2\text{O} + 4\text{Cl}_2 = 8\text{HCl} + 1\text{H}_2\text{SO}_4$

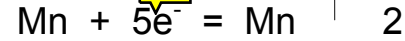
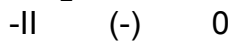


ii) $3\text{S}^{2-} + 8\text{KMnO}_4 + 4\text{H}_2\text{O} = 3\text{SO}_4^{2-} + 8\text{MnO}_2 + 8\text{KOH}$

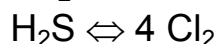


iii) $\text{H}_2\text{S} + \text{H}_2\text{O}_2 = \text{S} + 2\text{H}_2\text{O}$

iv) $5\text{H}_2\text{S} + 2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 = 5\text{S} + \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 8\text{H}_2\text{O}$

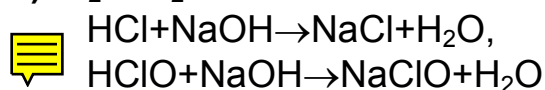


d) $1\text{H}_2\text{S} \Leftrightarrow 10\text{H}^+ \Leftrightarrow 10\text{NaOH}$; ja võrrandi c) i) järgi



$$n(\text{NaOH}) = \frac{10}{1} \cdot \frac{1}{4} \cdot 1\text{mol} = \mathbf{2,5\text{mol}}$$

e) $\text{Cl}_2 + \text{H}_2\text{O} = \text{HCl} + \text{HClO}$



6. a) $\text{C}_{12}\text{H}_{22}\text{O}_{11}(\text{t}) + 12\text{O}_2(\text{g}) = 12\text{CO}_2(\text{g}) + 11\text{H}_2\text{O}(\text{v})$ $\Delta\text{H}(\text{sahh, põlem})$

b) $\Delta\text{H}(\text{sahh, põlem}) = \Sigma\Delta\text{H}(\text{tekke, saad}) - \Sigma\Delta\text{H}(\text{tekke, lähte}) =$

$$= 12 \text{ mol} \cdot (-393,5 \text{ kJ/mol}) + 11 \text{ mol} \cdot (-285,8 \text{ kJ/mol}) - \text{mol} \cdot (-2222,0 \text{ kJ/mol}) - 12 \text{ mol} \cdot 0 \text{ kJ/mol} = -\mathbf{5643,8 \text{ kJ/mol}}$$

c) $\Delta\text{H} [\text{H}_2\text{O}(\text{v}) \rightarrow \text{H}_2\text{O}(\text{g})] = -241,8 \text{ kJ/mol} - (-285,8 \text{ kJ/mol}) = 44,0 \text{ kJ/mol}$

Plussmärk on seetõttu, et süsteem saab energiat

$M(\text{sahharoos}) = 342 \text{ g/mol}$

Ühe grammi suhkru oksüdeerumisel saame $+5643,8 \text{ kJ/mol} \cdot \frac{1 \text{ mol}}{342 \text{ g}} =$

$$= 16,502 \text{ kJ/g} \approx 16,5 \text{ kJ/g}$$

Ühe liitri vee aurustamiseks kulub

$$+44,0 \text{ kJ/mol} \cdot 1000 \text{ cm}^3 \cdot 1,00 \text{ g/cm}^3 \cdot \frac{1 \text{ mol}}{18,0 \text{ g}} = 2444 \text{ kJ} \approx 2440 \text{ kJ}$$

$$\mathbf{m(\text{sahharoos}) = 2444 \text{ kJ} \cdot \frac{1 \text{ g}}{16,5 \text{ kJ}} = 148 \text{ g}}$$