

**2003/2004 õa keemiaolümpiaadi piirkonnavooru
ülesannete lahendused
10. klass**

1. a) i) Need süsivesinikud keevad küll toatemperatuuril, kuid on lahustunud kõrgemal temperatuuril keevates süsivesinikes. Temperatuuri tõusuga gaaside lahustuvus väheneb. **ii)** CH₄, metaan; C₂H₆, etaan; C₃H₈, propaan; C₄H₁₀, butaan.

b) i) fraktsioneeriv destillatsioon; **ii)** krakkimine

c) i) metanool – CH₃OH; **ii)** etaandiool – CH₂OHCH₂OH,
iii) propaantriool – CH₂OHCHOHCH₂OH

d) i) 4 g NaOH 100 grammis lahuses; **ii)** 4 · 40 g NaOH ühes liitris lahuses.

e) i) kovalentne mittepolaarne; **ii)** kovalentne polaarne; **iii)** iooniline.

f) -III V -III III
NH₄NO₃, CH₃COOH

2. a) i) $m(\mathbf{B}) = 1,260 \text{ g} - 0,782 \text{ g} = 0,478 \text{ g}$

$n(\mathbf{B}) = n(\mathbf{C})$ (B - MgO, C - MgF₂)

$$\frac{0,478}{A_r(\text{Me}) + 16} = \frac{0,739}{A_r(\text{Me}) + 38}$$

$$A_r(\text{Me}) = 24,29 \approx 24,3 \quad \text{Me} = \mathbf{Mg} \quad (\mathbf{Y} - \text{MgCO}_3)$$

ii) 0,478 g m
MgO ⇌ MgCO₃
40,3 g/mol 84,3 g/mol

$$m(\mathbf{MgCO}_3) = \frac{1}{1} \cdot 0,478 \text{ g} \cdot \frac{1 \text{ mol}}{40,3 \text{ g}} \cdot 84,3 \text{ g/mol} = 0,9999 \text{ g} \approx \mathbf{1,00 \text{ g}}$$

iii) $t^0 t^0$
MgCO₃ = MgO + CO₂↑

b) i) A - Ag $t^0 t^0$

ii) 2Ag₂CO₃ = 4Ag + 2CO₂ + O₂ (Z - Ag₂CO₃)
m 0,782 g

Ag₂CO₃ ⇌ 2Ag
275,8 g/mol 107,9 g/mol

$$m(\mathbf{Ag}_2\mathbf{CO}_3) = \frac{1}{2} \cdot 0,782 \text{ g} \cdot \frac{1 \text{ mol}}{107,9 \text{ g}} \cdot 275,8 \text{ g/mol} = 0,999 \text{ g} \approx \mathbf{1,00 \text{ g}}$$

c) i) X - (NH₄)₂CO₃

ii) m[(NH₄)₂CO₃] = 3,30 g - 1,00 g - 1,00 g = 1,30 g

iii) $t^0 t^0$
(NH₄)₂CO₃ = 2NH₃↑ + CO₂↑ + H₂O↑

3. a) M_r(A) = 29,0 · 1,172 = 33,988 ≈ 34

Kuna A on binaarne kaheprootoniline hape, siis element Q on H ja aine A valem peaks olema H₂X.

A_r(X) = 34 - 1 - 1 = 32 X – S, väävel

b) i) H₂ + S = H₂S (aine A)

ii) 2H₂S + 3O₂ = 2SO₂ (oksiid B) + 2H₂O (oksiid C)

iii) SO₂ + H₂O = H₂SO₃ (hape E)

iv) SO₃ + H₂O = H₂SO₄ (hape F)

v) H₂SO₄ + NaCl (ühend G) = HCl + NaHSO₄ (vesiniksool)

c) i) $Z_2X_2Y_3 - Na_2S_2O_3$, naatriumtiosulfaat

ii) $m(Na_2S_2O_3) = 1000 \text{ g} \cdot 0,159 = 159 \text{ g}$

$$M(Na_2S_2O_3) = 158 \text{ g/mol}$$

$$n(Na_2S_2O_3) = n(\text{aine L})$$

$$n(Na_2S_2O_3) = \frac{159 \text{ g}}{158 \text{ g}} = 1,006 \text{ mol}$$

$$\Sigma m(H_2O \text{ aines L}) = 91 \text{ g} \cdot \frac{1}{1,006 \text{ mol}} \approx 90 \text{ g/mol}$$

$$n(H_2O) = 90 \text{ g} \cdot \frac{1 \text{ mol}}{18 \text{ g}} = 5 \text{ mol}$$

aine L – $Na_2S_2O_3 \cdot 5H_2O$, naatriumtiosulfaat-5-vesi

4. a) $m(^{235}\text{U}) = 22,4 \text{ tonn} \cdot \frac{1000 \text{ kg}}{\text{tonn}} \cdot 0,40 \cdot 0,0072 = 64,51 \text{ kg} \sim \mathbf{65 \text{ kg}}$

b) $n(^{235}\text{U}) = 64,51 \text{ kg} \cdot \frac{1000 \text{ g}}{\text{kg}} \cdot \frac{1 \text{ mol}}{235 \text{ g}} = 274,5 \text{ mol}$

$$N(^{235}\text{U}) = 274,5 \text{ mol} \cdot 6,02 \cdot 10^{23} \text{ aatomit/mol} = 1,652 \cdot 10^{26} \text{ aatomit}$$

$$\mathbf{\text{Energia } (^{235}\text{U}) = 3,2 \cdot 10^{-11} \text{ J/aatom} \cdot 1,652 \cdot 10^{26} \text{ aatomit} = 5,29 \cdot 10^{15} \text{ J} \approx 5,3 \cdot 10^{15} \text{ J} = \mathbf{5,3 \cdot 10^9 \text{ MJ}}}$$

c) $\mathbf{\text{Energia(DA)} = 5,2 \text{ MJ/kg} \cdot 2,71 \cdot 10^5 \text{ tonni} \cdot \frac{1000 \text{ kg}}{\text{tonn}} = 1,41 \cdot 10^9 \text{ MJ} \approx \mathbf{1,4 \cdot 10^9 \text{ MJ}}}$

5. a) $n(\text{Cl}^-) + n(\text{Br}^-) + 2n(\text{SO}_4^{2-}) + 2n(\text{CO}_3^{2-}) = n(\text{Na}^+) + n(\text{K}^+) + 2n(\text{Ca}^{2+}) + 2n(\text{Mg}^{2+})$

b) Olgu $x \text{ mol Mg}^{2+}$ ning $y \text{ mol Ca}^{2+}$, siis

$$2(x+y) = \frac{418}{35,5} + \frac{0,05}{80} + \frac{2 \cdot 23,8}{96} + \frac{2 \cdot 0,9}{60} - \frac{24,5}{23} - \frac{0,6}{39} = 0,6233 \text{ mol}$$

$$n(\text{Mg}^{2+}) + n(\text{Ca}^{2+}) = 0,6233 \text{ mol} / 2 = 0,3117 \text{ mol} \approx 0,31 \text{ mol}$$

c)
$$\left. \begin{array}{l} x+y = 0,3117 \\ 24x + 40y = 8,4 \end{array} \right\} x = 0,254 \text{ mol}$$

$n(\text{SO}_4^{2-}) = 23,8 \text{ g} / 96 \text{ (g/mol)} = 0,248 \text{ mol}$, seega tuleb $m(\text{MgSO}_4)$ arvutada SO_4^{2-} järgi.

$$m(\text{MgSO}_4) = 0,248 \text{ mol} \cdot 120 \text{ (g/mol)} = 29,7 \text{ g}$$

d) $m(\text{MgSO}_4) = 1 \text{ m}^3 \cdot 1000 \text{ kg/m}^3 \cdot 0,018 \cdot \frac{29,7 \text{ g}}{100 \text{ g}} = \mathbf{5,4 \text{ kg}}$

6. a) i) anoodil $2\text{H}_2\text{O} = \text{O}_2 + 4\text{H}^+ + 4\text{e}^-$

katoodil $4\text{H}^+ + 4\text{e}^- = 2\text{H}_2$

ii) anoodil $4\text{OH}^- = 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$

katoodil $4\text{H}_2\text{O} + 4\text{e}^- = 2\text{H}_2 + 4\text{OH}^-$

iii) anoodil $2\text{H}_2\text{O} = \text{O}_2 + 4\text{H}^+ + 4\text{e}^-$

katoodil $4\text{H}_2\text{O} + 4\text{e}^- = 2\text{H}_2 + 4\text{OH}^-$

b) $4\text{F} \Leftrightarrow 2\text{H}_2$ $n(\text{H}_2) = 2 \text{ mol}$; $4\text{F} \Leftrightarrow \text{O}_2$ $n(\text{O}_2) = 1 \text{ mol}$

$$4\text{F} \Leftrightarrow 1 \text{ mol} + 2 \text{ mol} = 3 \text{ mol H}_2 \text{ ja O}_2 \text{ segu}$$

$$V(\text{H}_2 \text{ ja O}_2) = 3 \text{ mol} \cdot 22,4 \text{ dm}^3/\text{mol} = 67,2 \text{ dm}^3 = 67,2 \text{ liitrit}$$

c) Väheneb vee hulk, happe hulk ei muutu

d) i) Väheneb, sest happe hulk jääb samaks, aga lahuse ruumala väheneb, seega suureneb $[\text{H}^+]$.

ii) Suureneb, sest suureneb $[\text{OH}^-]$ lahuse ruumala vähenemise tõttu.

iii) Jääb samaks, sest $[\text{H}^+] = [\text{OH}^-]$.