

2006/2007 õa keemiaolümpiaadi lõppvoorü ülesannete lahendused
10. klass

1. a) X – Cr, kroom

A – CrO, kroom(II)oksiid

B – Cr₂O₃, kroom(III)oksiid

C – CrO₃, kroom(VI)oksiid

D – Cr(OH)₃, kroom(III)hüdroksiid

E – CrCl₃, kroom(III)kloriid

F – K₃[Cr(OH)₆], kaaliumheksahüdroksükromaat(III)

G – K₂CrO₄, kaaliumkromaat

H – K₂Cr₂O₇, kaaliumdikromaat

b) i) Cr(OH)₃ + 3HCl = CrCl₃ + 3H₂O

ii) Cr(OH)₃ + 3KOH = K₃[Cr(OH)₆]

iii) 2K₃[Cr(OH)₆] + 3Br₂ + 4KOH = 2K₂CrO₄ + 6KBr + 8H₂O

iv) Cr₂O₃ + 4KOH + KClO₃ = 2K₂CrO₄ + KCl + 2H₂O

v) 2K₂CrO₄ + H₂SO₄ = K₂Cr₂O₇ + K₂SO₄ + H₂O

vi) K₂Cr₂O₇ + konts. H₂SO₄ = 2CrO₃↓ + K₂SO₄ + H₂O

c) I – [Cr(H₂O)₆]Cl₃

K – [Cr(H₂O)₅Cl]Cl₂·H₂O

L – [Cr(H₂O)₄Cl₂]Cl·2H₂O

$$2. a) V(96,2 \% \text{ vol etanooli lahus}) = \frac{4000 \text{ dm}^3}{0,962} = 4158 \text{ dm}^3 \approx 4160 \text{ dm}^3$$

$$b) i) m(\text{etanool}) = 15000 \text{ dm}^3 \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} \cdot 0,4 \cdot \frac{0,78924 \text{ g}}{1 \text{ cm}^3} = 4,735 \cdot 10^6 \text{ g}$$

$$m(40 \% \text{ vol etanooli lahus}) = 15000 \text{ dm}^3 \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} \cdot \frac{0,94805 \text{ g}}{1 \text{ cm}^3} = 1,422 \cdot 10^7 \text{ g}$$

$$V(\text{H}_2\text{O}) = (14,22 - 4,735) \cdot 10^6 \text{ g} \cdot \frac{1 \text{ cm}^3}{0,99820 \text{ g}} \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} = 9502 \text{ dm}^3 \approx 9500 \text{ dm}^3$$

$$ii) m(96,2 \% \text{ vol etanooli lahus}) = \frac{15000 \text{ dm}^3 \cdot 0,4 \cdot \frac{1000 \text{ cm}^3}{1 \text{ dm}^3} \cdot \frac{0,80608 \text{ g}}{1 \text{ cm}^3}}{0,962} = 5,028 \cdot 10^6 \text{ g}$$

$$V(\text{H}_2\text{O}) = (14,22 - 5,028) \cdot 10^6 \text{ g} \cdot \frac{1 \text{ cm}^3}{0,99820 \text{ g}} \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} = 9210 \text{ dm}^3 \approx 9200 \text{ dm}^3$$

$$c) \Delta V(\text{H}_2\text{O}) = (9502 - 9210) \text{ dm}^3 = 293 \text{ dm}^3 \approx 300 \text{ dm}^3$$

$$\% = \frac{293 \text{ dm}^3}{9210 \text{ dm}^3} \cdot 100 = 3,17 \approx 3$$

3. a) Br⁻ + Ag⁺ → AgBr↓

Ag⁺ + SCN⁻ → AgSCN↓

$$b) i) n(\text{AgNO}_3 \text{ liig}) = n(\text{NH}_4\text{SCN}) = 19,30 \text{ cm}^3 \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} \cdot \frac{0,04480 \text{ mol}}{1 \text{ dm}^3} = 8,646 \cdot 10^{-4} \text{ mol}$$

$$ii) n(\text{AgNO}_3 \text{ üld}) = 31,20 \text{ cm}^3 \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} \cdot \frac{0,2180 \text{ mol}}{1 \text{ dm}^3} = 6,8016 \cdot 10^{-3} \text{ mol}$$

$$n(\text{KBr}) = n(\text{AgBr}) = (6,8016 - 0,8646) \cdot 10^{-3} \text{ mol} = 5,937 \cdot 10^{-3} \text{ mol}$$

$$m(\text{KBr}) = 5,937 \cdot 10^{-3} \text{ mol} \cdot \frac{119,01 \text{ g}}{1 \text{ mol}} = 0,7066 \text{ g}$$

$$iii) \%(\text{KBr}) = \frac{0,7066 \text{ g}}{0,8230 \text{ g}} \cdot 100 = 85,85$$

c) Ei sobi.

4. a) 2LnPO₄ + 3H₂SO₄ = Ln₂(SO₄)₃ + 2H₃PO₄ (reaktsioon 1)

Th₃(PO₄)₄ + 6H₂SO₄ = 3Th(SO₄)₂ + 4H₃PO₄ (reaktsioon 1)

Ln₂(SO₄)₃ + 6NaOH = 3Na₂SO₄ + 2Ln(OH)₃↓ (reaktsioon 2)

Th(SO₄)₂ + 4NaOH = 2Na₂SO₄ + Th(OH)₄↓ (reaktsioon 2)

Ln(OH)₃ + 3HCl = LnCl₃ + 3H₂O (reaktsioon 3)

Th(OH)₄ = ThO₂ + 2H₂O (reaktsioon 4)

2LnCl₃ + 3Na₂CO₃ = Ln₂(CO₃)₃ + 6NaCl (reaktsioon 5)

b) Promeeetium, sest see on radioaktiivne ja laguneb looduses ära.

$$c) M(\text{Ln, Th}) = \frac{0,6 \cdot (31 + 4 \cdot 16)}{0,4} \text{ g/mol} = 142,46 \text{ g/mol}$$

$$M(\text{Ln}) = \left(\frac{142,46 \text{ g}}{1 \text{ mol}} - \frac{3}{4} \cdot 0,09 \cdot \frac{232,04 \text{ g}}{1 \text{ mol}} \right) \cdot \frac{1}{0,91} \text{ g/mol} = 139,33 \text{ g/mol}$$

$$n(\text{NaOH}) = \frac{6}{2} \cdot 1000 \text{ g} \cdot 0,6 \cdot 0,91 \cdot \frac{1 \text{ mol}}{139,33 \text{ g}} + \frac{4}{1} \cdot 1000 \text{ g} \cdot 0,6 \cdot 0,09 \cdot \frac{1 \text{ mol}}{232,04 \text{ g}} = 11,76 \text{ mol} + 0,9309 \text{ mol} = 12,68 \text{ mol}$$

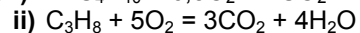
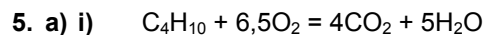
$$m(\text{NaOH}) = 12,68 \text{ mol} \cdot 40,0 \text{ g/mol} = 507,5 \text{ g} \approx 508 \text{ g}$$

d) n(HCl) = n(Ln) = 11,76 mol

$$V(\text{HCl}) = 11,76 \text{ mol} \cdot \frac{36,5 \text{ g}}{1 \text{ mol}} \cdot \frac{1}{0,37} \cdot \frac{1 \text{ cm}^3}{1,18 \text{ g}} \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} = 0,983 \text{ dm}^3$$

$$e) m(\text{Nd}_2(\text{CO}_3)_3 \cdot 3\text{H}_2\text{O}) = 1000 \text{ g} \cdot 0,600 \cdot 0,160 \cdot \frac{1 \text{ mol}}{144,2 \text{ g}} \cdot \frac{1}{2} \cdot \frac{522,6 \text{ g}}{1 \text{ mol}} = 174 \text{ g}$$

$$f) V(\text{Nd}) = 1000 \text{ g} \cdot 0,600 \cdot 0,160 \cdot \frac{1 \text{ cm}^3}{7,01 \text{ g}} = 13,7 \text{ cm}^3$$



b) i) $\Delta H_c^\circ(\text{isobutaan}) = [5 \cdot (-285,8) + 4 \cdot (-393,5) - (-134,2)] \text{ kJ/mol} =$
 $= -2868,8 \text{ kJ/mol}$

ii) $\Delta H_c^\circ(\text{propaan}) = [4 \cdot (-285,8) + 3 \cdot (-393,5) - (-103,8)] \text{ kJ/mol} =$
 $= -2219,9 \text{ kJ/mol}$

c) $n(\text{butaan}) = 450 \text{ g} \cdot 0,6 \cdot \frac{1 \text{ mol}}{58 \text{ g}} = 4,655 \text{ mol}$

$n(\text{isobutaan}) = 450 \text{ g} \cdot 0,1 \cdot \frac{1 \text{ mol}}{58 \text{ g}} = 0,776 \text{ mol}$

$n(\text{propaan}) = 450 \text{ g} \cdot 0,3 \cdot \frac{1 \text{ mol}}{44 \text{ g}} = 3,07 \text{ mol}$

$n(\text{gaas}) = (4,655 + 0,776 + 3,07) \text{ mol} = 8,50 \text{ mol}$

$V = \frac{nRT}{p} = 8,501 \text{ mol} \cdot 0,082 \frac{\text{atm} \cdot \text{dm}^3}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K} \cdot \frac{1}{1 \text{ atm}} = 207,7 \text{ dm}^3 \approx$
 $\approx 210 \text{ dm}^3$

d) Eralduv soojushulk

$q = - \left(4,655 \text{ mol} \cdot \frac{-2877,6 \text{ kJ}}{1 \text{ mol}} + 0,776 \text{ mol} \cdot \frac{-2868,8 \text{ kJ}}{1 \text{ mol}} + 3,07 \cdot \frac{-2219,9 \text{ kJ}}{1 \text{ mol}} \right) \cdot$
 $\cdot \frac{1 \text{ MJ}}{1000 \text{ kJ}} = 22,437 \text{ KJ} = 22 \text{ MJ}$

6. a) A – CO₂, süsinikdioksiid

B – O₂, hapnik

C – O₃, osoon

D – H₂O₂, vesnikperoksiid

