2003/2004 õa keemiaolümpiaadi lõppvooru ülesannete lahendused
12. klass

1. Ratsionaalne on lähtuda täpselt 1 liitrist õllest.

m_{ass}(õlu) = 1 liiter $\cdot \frac{988\,g}{1\,liiter}$ = 988 g

V(alc) = 1 liiter · 0,074 = 74 cm^3

m_{ass}(alc) = 74 cm^3 · 0,791 g/cm^3 = 58,53 g ≈ 59 g

$m_{ass}(H_2O)$ = 988 g – 59 g = 929 g

$m(alc) = 59\ g \cdot \frac{1\,mol}{46\,g} \times \frac{1}{0{,}929\,kg}$

$\Delta T = 59\ g \cdot \frac{1\,mol}{46\,g} \times \frac{1}{0{,}929\,kg} \times 1{,}86 \frac{K \times kg}{mol} = 2{,}57\ K \approx 2{,}6\ K$

Märkus: Õlles on ka muid lisandeid, mistõttu võib ΔT väärtust ümardada ülespoole.

T = 0 ^{0}C - ΔT = **-2,6 ^{0}C**

2. **a)** $C_8H_{18}(v) + 12{,}5O_2(g) = 8CO_2(g) + 9H_2O(v)$

b) $\Delta H_c^0(C_8H_{18}) = [8\cdot(-393{,}5\ kJ) + 9\cdot(-285{,}8\ kJ) - (-249{,}9\ kJ)]\cdot \frac{1}{mol}$ =

= **-5470,3 kJ/mol**

c) 1000 K –298 K = 702 K

$\Delta H_c^{1000\ K}(C_8H_{18})$ = -5470,3 kJ/mol + (9·40,7) kJ/mol – 41,5 kJ/mol +

+702 · (0,0753·9 + 0,0371·8-0,0294·12,5-0,1878) kJ/mol =

= **-4851,2 kJ/mol**

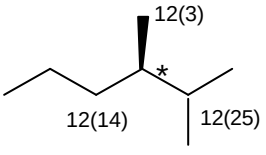
d) i) ΔU_c^0(oktaan) = -5470,3 kJ/mol – (8-12,5) mol·8,314 $\frac{J}{K \times mol}$ ·298 K ·

$\cdot \frac{1\,kJ}{1000J}$ = **-5459,2 kJ/mol**

ii) $\Delta U_c^{1000\ K}$(oktaan) = -4851,2 kJ/mol – (17-13,5)·8,314 $\frac{J}{K \times mol}$ ·1000 K·

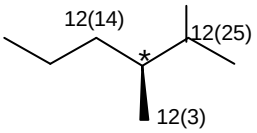
$\times \frac{1\,kJ}{1000J}$ = **-4880,3 kJ/mol**

e) i)



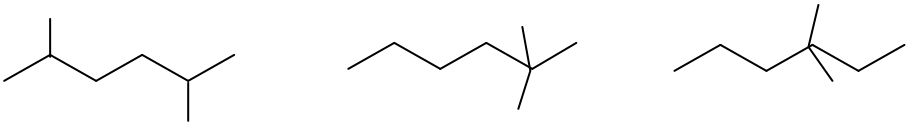
R

ii)



S

iii)



3. **a)** 6·2·(-I) 12·(-II)

E – 12e- = **E**

6·II 6·**z**

B + 12e^- = **B**

$\mathbf{z} = \frac{12+12}{6} = \mathbf{4}$

b)

A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
H	C	N	O	S	Cl	K	Fe	Sn	I

c) **1)** $FeCl_3 + 6(NH_4)_2S_2 + 6KCN = K_3[Fe(SCN)_6] + 6(NH_4)_2S + 3KCl$

2) $2K_3[Fe(SCN)_6] + SnCl_2 + 2KCl = SnCl_4 + 2K_4[Fe(SCN)_6]$

3) $10\ K_3[Fe(SCN)_6] + 72KIO_3 + 24H_2O + 6H_2SO_4 = 51K_2SO_4 + 60HCN + 36I_2 + 5Fe_2(SO_4)_3$

d) **2** $K_3[Fe(SCN)_6] + \mathbf{32}HNO_3 + 8H_2O = 3K_2SO_4 + \mathbf{1}Fe_2(SO_4)_3 + 6(NH_4)_2SO_4 + 12CO_2 + \mathbf{32}NO$

$6\cdot(-II)$ $6\cdot VI$

$6S - 48e^- = 6S$ | 1

V II

$N + 3e^- = N$ | 16

x 2, sest **1** Fe ei saa $Fe_2(SO_4)_2$ moodustada

e) **i)** kaaliumheksatiotsüanaatoferraat(III)

$K_3[Fe(SCN)_6] \rightleftharpoons 3K^+ + [Fe(SCN)_6]^{3-}$

ii) ammooniumdisulfiid

$(NH_4)_2S_2 \rightleftharpoons 2NH_4^+ + S_2^{2-}$

iii) kaaliumheksatiotsüanaatoferraat(II)

$K_4[Fe(SCN)_6] \rightleftharpoons 4K^+ + [Fe(SCN)_6]^{4-}$

4. a) **i)** $ZnS + 2HCl = ZnCl_2 + H_2S\uparrow$

$ZnCO_3 + 2HCl = ZnCl_2 + H_2O + CO_2\uparrow$

ii) $2KMnO_4 + 5H_2S + 3H_2SO_4 = K_2SO_4 + 2MnSO_4 + 5S + 8H_2O$

iii) $2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 = K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$

iv) $ZnCO_3 \overset{0\ t}{=} ZnO + CO_2\uparrow$

$ZnO + SiO_2 = ZnSiO_3$

b) **i)** $n(ZnS) \Leftrightarrow n(H_2S) \Leftrightarrow \frac{5}{2}n(KMnO_4,algul) - n(H_2C_2O_4)$

$n(ZnS) = \frac{5}{2}\cdot 0{,}9300\ mol/dm^3 \cdot 0{,}05009\ dm^3 - 0{,}5070\ mol/dm^3 \cdot 0{,}03246\ dm^3 = 0{,}1000\ mol$

$\mathbf{\%(ZnS)} = 0{,}1000\ mol \cdot 97{,}46\ g/mol \cdot \frac{1}{12{,}00\ g} \cdot 100 = \mathbf{81{,}21}$

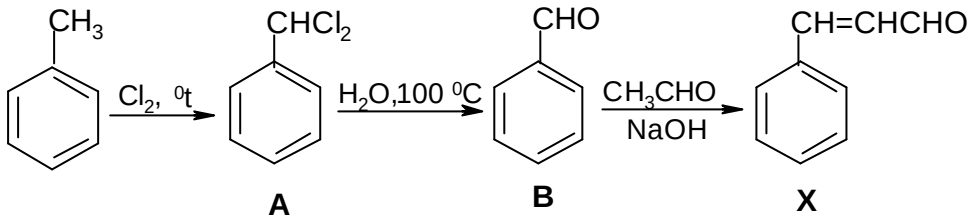
ii) $n(ZnCO_3) \Leftrightarrow n(CO_2)$

$n(ZnCO_3) = 1{,}32\ g \cdot \frac{1\ mol}{44{,}01\ g} = 0{,}0300\ mol$

$\mathbf{\%(ZnCO_3)} = 0{,}0300\ mol \cdot 125{,}4\ g/mol \cdot \frac{1}{48{,}00\ g} \cdot 100 = \mathbf{7{,}84}$

iii) $\mathbf{\%(SiO_2)} = 100 - 7{,}84 - 81{,}21 = \mathbf{10{,}95}$

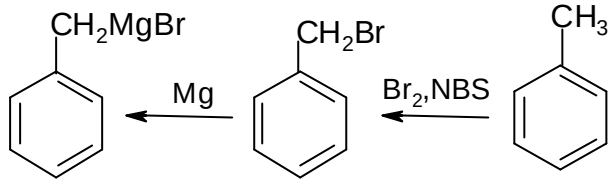
5. a) i)



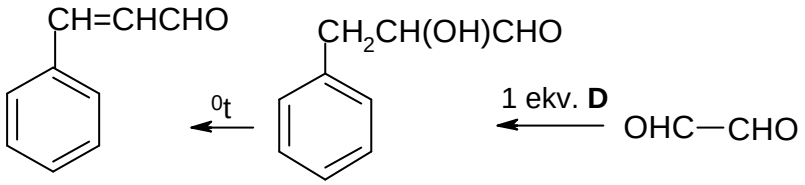
A **B** **X**

Jasperi skeem

ii)



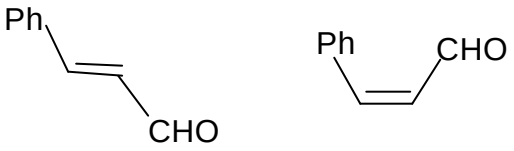
D **C**



X **E**

Kauri skeem

b)



trans-isomeer

cis-isomeer

6. a) 0,413 K = 1,86 K·kg/mol · 2 g/M(ühend **C**) · 1/0,1 kg

M(ühend **C**) = 1,86 K·kg/mol · 2 g · 1/0,1 kg · 1/0,413 K = 90,1 g/mol

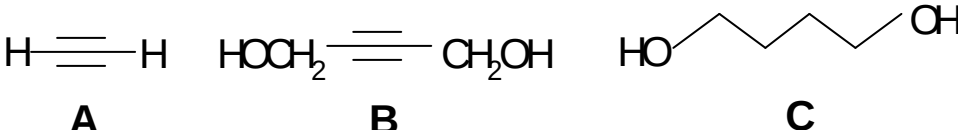
$n(C) = 90{,}1\ g \cdot 0{,}533 \cdot \frac{1\,mol}{12\,g} = 4\ mol$

$n(H) = 90{,}1\ g \cdot 0{,}112 \cdot \frac{1\,mol}{1g} = 10\ mol$

$n(O) = 90{,}1\ g \cdot (1 - 0{,}533 - 0{,}112) \cdot \frac{1\,mol}{16\,g} = 2\ mol$

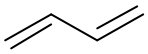
Ühend **C** on $C_4H_{10}O_2$

b)

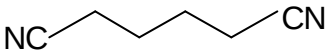


A **B** **C**

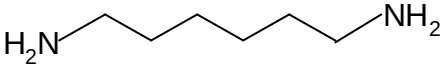
D



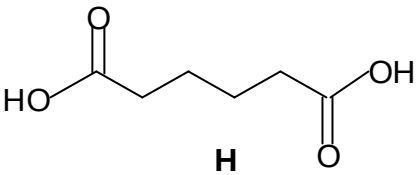
E



F

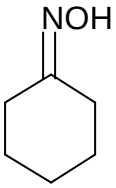


G

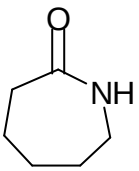


H

c)



I



J

d)