2004/2005 õa keemiaolümpiaadi piirkonnavooru ülesannete lahendused

11. klass

1. a) Os järjenumber on 76, seega ühes aatomis on 76 e^-

$n(e^-) = 1\ cm^3 \cdot 22{,}6\ g/cm^3 \cdot \frac{1\,mol}{190{,}2\ g} \cdot 76 = 9{,}03\ mol$

b) i) nihkub saaduste suunas

ii) nihkub saaduste suunas, sest rõhk suureneb

iii) tasakaal ei muutu, kui mitte arvestada tühist ruumala muutust, mis on tingitud tahke aine lisamisest

c) i) $\overset{-III}{CH_3}-\overset{0}{C}\equiv\overset{-I}{CH}$ summaarne $-\frac{4}{3}$

ii) $\overset{-II}{CH_2}=\overset{-I}{CH}-\overset{-I}{CH}=\overset{-II}{CH_2}$ summaarne $-\frac{3}{2}$

iii) $\overset{-III}{CH_3}-\overset{III}{COOH}$ summaarne 0

d) i) 1F

ii) 2F

iii) 4F

e) i) I_2, jood

ii) CO_2, tahke süsinikdioksiid, kuiv jää

iii) $HgCl_2$, elavhõbe(II)kloriid, sublimaat

f) Leelismetallide korral $2n(\text{leelismetall}) \Leftrightarrow n(H_2)$

Järelikult $n(\text{leelismetall}) = \frac{2}{1} \cdot 0{,}1\,mol = 0{,}2\ mol$

Seega leelismetallide kaalutud keskmiseks molaarmassiks on $\frac{4{,}6\ g}{0{,}2\,mol} = 23{,}0\ g/mol$.

Et üheks elemendiks on suure molaarmassiga Rb (85,5 g/mol), siis teise leelismetalli molaarmass peab olema väiksem kui 23 g/mol.
Selleks leelismetalliks saab olla ainult **Li** (6,9 g/mol).

2. a) i) $CH_4 + 2O_2 = 2H_2O + CO_2$

ii) $2C_2H_6 + 7O_2 = 6H_2O + 4CO_2$
või $C_2H_6 + 3{,}5O_2 = 3H_2O + 2CO_2$

b) i) $\Delta H_c^0(CH_4) = [2\ mol \cdot (-241{,}8\ kJ/mol) + 1\ mol \cdot (-393{,}5\ kJ/mol - 1\ mol \cdot (-74{,}6\ kJ/mol)] \cdot \frac{1}{mol} = -802{,}5\ kJ/mol$

ii) $\Delta H_c^0(C_2H_6) = [3 \cdot (-241{,}8) + 2 \cdot (-393{,}5) - 1 \cdot (-84{,}0)]\ kJ/mol = -1428{,}4\ kJ/mol$

c) $\Delta H^0(CH_4) = 705\ g \cdot 0{,}95 \cdot \frac{1\,mol}{16{,}04\ g} \cdot (-802{,}5\ kJ/mol) = -\ 33508\ kJ$

$\Delta H^0(C_2H_6) = 705\ g \cdot 0{,}02\ \frac{1\,mol}{30{,}07\ g} \cdot (-1428{,}4 kJ/mol) = -669{,}5\ kJ$

$E = -[-33508 + (-669{,}5)]kJ/m^3 = 34177{,}5\ kJ/m^3 \approx 34200\ kJ/m^3$

d) $V = 22{,}1\ m^2 \cdot 2{,}5\ m = 55{,}25\ m^3$ (kaks tüvenumbrit on täpsus)

$\Delta T = 25\ ^0C - 5\ ^0C = 20\ ^0$

$V_M = 22{,}4 \cdot \frac{278}{273}\ dm^3/mol = 22{,}81\ dm^3/mol$

$n(õhk) = 55{,}25\ m^3 \cdot \frac{1\,mol}{0{,}02281\,m^3} = 2422\ mol$

$\Delta E = 2422\ mol \cdot 29{,}16\ J/(mol \cdot K) \cdot 20\ K = 1412\ 617\ J$

$V(maagaas) = \frac{1412\,kJ}{34{,}200\,kJ/m^3} = 0{,}041\ m^3 \approx 41$ liitrit

3. a) $N(S) = 55{,}85 \cdot \frac{53{,}45}{46{,}55} \cdot \frac{1}{32} = 2$

B – FeS_2, rauddisulfiid

$4FeS_2 + 11O_2 = 2Fe_2O_3 + 8SO_2$

II (-) III
$Fe - 1e^- = Fe$
$2\cdot(-I)$ (-) $2\cdot IV$ } 11 | 4
$S_2 - 10e^- = 2S$
$2\cdot0$ (-) $2\cdot(-II)$
$O_2 + 4e^- = 2O$ 4 | 11

b) **X** – $(CaSO_4)_2 \cdot H_2O$, ehituskips
Y – $CaSO_4$, surnud kips

c) **A** – SO_2, vääveldioksiid
C – CaS, kaltsiumsulfiid
D – CaO, kaltsiumoksiid
E – SO_3, vääveltrioksiid
F – NO_2, lämmastikdioksiid

d) i) $CaSO_4 + 2C = CaS + 2CO_2$
ii) $CaS + 3CaSO_4 = 4CaO + 4SO_2$
iii) $2SO_2 + O_2 = 2SO_3$
iv) $SO_2 + NO_2 = SO_3 + NO$
v) $Cu + 4HNO_3 = Cu(NO_3)_2 + 2NO_2 + 2H_2O$
vi) $O_2 + 2NO = 2NO_2$

4. a) **X** – C_nH_{2n} $M(\mathbf{X}) = M(õhk) \cdot 2{,}42 = 29\ g/mol \cdot 2{,}42 = 70{,}18\ g/mol$

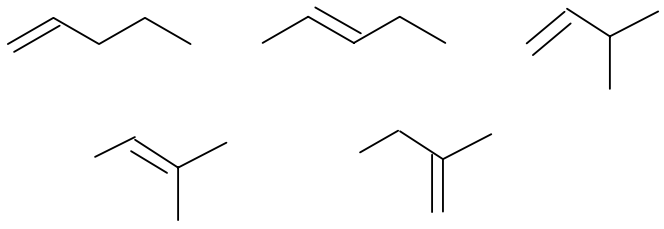
$12\ g/mol \cdot n + 2n \cdot 1{,}01\ g/mol = 70{,}18\ g/mol$

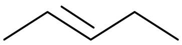
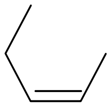
$n = 5$

X – C_5H_{10}

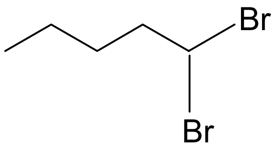
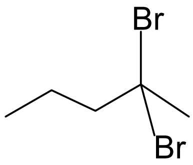
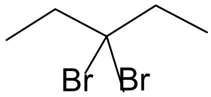
b) **Y** – $C_5H_{10}Br_2$
Z – $C_5H_{11}Br$

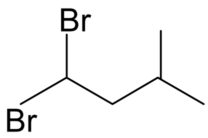
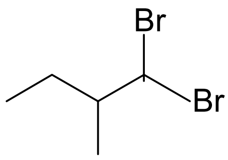
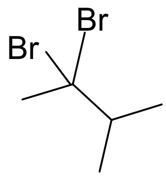
c)

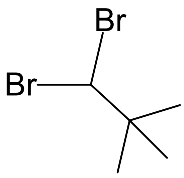


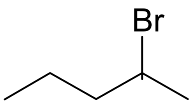
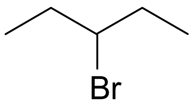
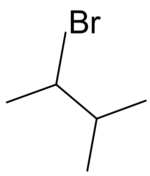
d)  

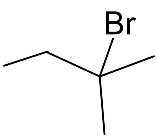
trans cis

e)   



f) i)   

ii) 

5. a) **A** + (2N + 2)Br_2 = C_NBr_{2N+2} + (2N + 2)HBr

$$n(HBr) = n(AgBr) = 19{,}84\ g \cdot \frac{1\,mol}{(107{,}87 + 79{,}90)\,g} = 0{,}1057\ mol$$

0,00755 0,1057 mol

A ⇔ (2N + 2)HBr

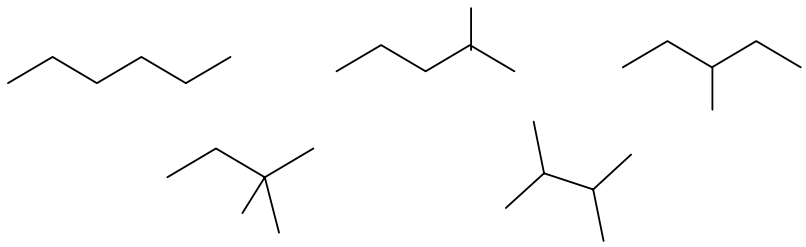
$$0{,}1057 = \frac{2N+2}{1}\cdot 0{,}00755 \qquad 2N + 2 = \frac{0{,}1057}{0{,}00755}$$

2N + 2 = 14

N = 6

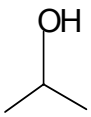
Süsivesiniku **A** brutovalem on C_6H_{14}

b)

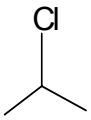


c) i) B – AgBr , hõbebromiid
C – CH_3Br, bromometaan, metüülbromiid
D – $CH_3CH=CH_2$, propeen

ii)



E – propaan-2-ool

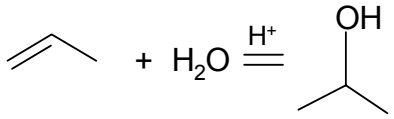


F — 2-kloropropaan

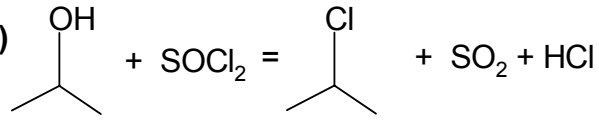
d) i) $CH_4 + Br_2 \xrightarrow{h\nu} CH_3Br + HBr$

ii) $CH_3Br + CH_2= CHBr + 2Na \rightarrow CH_3CH=CH_2 + 2NaBr$

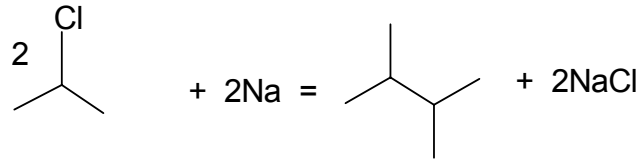
iii)



iv)



v)



6. a) i)

$$\mathbf{A}CO_3 \overset{^0t\,^0t}{=} \mathbf{A}O + CO_2\uparrow$$

ii) $2\mathbf{B}(NO_3)_2 = 2\mathbf{B}O + 4NO_2 + O_2$

b) $n[\mathbf{B}(NO_3)_2] = 2n(O_2) = 2 \cdot 1{,}24\ dm^3 \cdot \frac{1\ mol}{24{,}8\ dm^3} = 0{,}100\ mol$

c) $Ba(OH)_2 + CO_2 = BaCO_3\downarrow + H_2O$

$2Ba(OH)_2 + 4NO_2 = Ba(NO_2)_2 + Ba(NO_3)_2 + 2H_2O$

d) $\mathbf{A}CO_3 \Leftrightarrow CO_2 \Leftrightarrow BaCO_3 \Leftrightarrow Ba(OH)_2$

$n(\mathbf{A}CO_3) = 4{,}00\ dm^3 \cdot 0{,}100\ mol/dm^3 - \frac{46{,}0\ g}{153{,}3\ g/mol} = 0{,}100\ mol$

b) $m(\mathbf{A}) = 0{,}100\ mol \cdot M(\mathbf{A})$

m(**B**) = 0,100 mol · M(**B**)

$\frac{0{,}1394}{0{,}2210} = \frac{M(A)}{M(B)} \Rightarrow 0{,}631$

M(**A**) = 0,631 M(**B**)

$$0{,}1394 = \frac{0{,}1 \cdot M(B) \cdot 0{,}631}{0{,}1 \cdot 0{,}631 \cdot M(B) + 0{,}1 \cdot 60\ \text{g/mol} + 0{,}1 \cdot M(B) + 0{,}2 \cdot 62\ \text{g/mol}}$$

M(**B**) = 63,56 g/mol — **B** – Cu, vask

M(**A**) = 63,56 g/mol · 0,631 = 40,1 — **A** – Ca, kaltsium