2004/2005 õa keemiaolümpiaadi piirkonnavooru ülesannete lahendused

8. klass

1. a) i) $50 \cdot \frac{1\,\text{km}}{1000\,\text{m}} = 0{,}050\ \text{km}$

ii) $32\,\text{L} \cdot \frac{100\,\text{cL}}{1\,\text{L}} = 3200\ \text{cL}$

iii) $1000\,\text{kg/m}^3 \cdot \frac{1\,\text{m}^3}{1000\,\text{dm}^3} = 1\ \text{kg/dm}^3$

b) i) keemiliste nähtuste korral molekulide koostis muutub.

ii) Füüsikaliste nähtuste korral molekulide koostis ei muutu.

c) $L = 20{,}0\,\text{g} \cdot \frac{100\,\text{g}}{80\,\text{g}} = 25{,}0\ \text{g}$

d) Vee nivoo tõuseb **kõige vähem hõbedast** valmistatud kuuli sukeldamisel, sest hõbekuul on kõige väiksema ruumalaga. Suurem vee nivootõus on rauast kuuli sukeldamisel ja **kõige suurem tõus on Al** kuuli sukeldamisel, sest alumiiniumkuul on kõige suurema ruumalaga.

Ag < Fe < Al

2) a) $A_r(K) = 39{,}1$

$A_r(\mathbf{X}) = 74{,}6 - 39{,}1 = 35{,}5$

X – Cl **A** – KCl

b) i) $M_r(\mathbf{B}) = 23 \cdot \frac{100}{27} = 85$

ii) $m(O) = 85 - 23 - 14 = 48$ amü

$N(O) = 48\ \text{amü} \cdot \frac{1\,\text{aatom}}{16\ \text{amü}} = 3$ aatomit

B – $NaNO_3$

c) Eeldame, et molekulis **C** on üks Ca, üks H ja üks P aatom, siis

$N(O) = 3\,\text{aatomit} \cdot \frac{1}{43\%} \cdot 57\% = 4$ aatomit

C – $CaHPO_4$

3. a) **1** – keeduklaas, **2** – klaaspulk, **3** – lehter, **4** – kooniline (Erlenmeyeri) kolb, **5** – jaotuslehter, **6** – portselankauss, **7** – asbestvõrk, **8** – statiiv, **9** – gaasipõleti, **10** – ümarkolb, **11** - jahuti, **12** – termomeeter.

b) A . i) filtrimine, **ii)** tahkete ainete vedelikest eraldamine, **iii)** lahustuvus;

B. i) eraldamine jaotuslehtriga, **ii)** mittesegunevad vedelikud, **iii)** tihedus, lahustuvus;

C. i) aurustamine, **ii)** lahustunud tahke aine ja lahusti; **iii)** keemis- temperatuur;

D. i) destilleerimine, **ii)** segunevad vedelikud, **iii)** keemistemperatuur

c) i) kuumutamiseks, ii) keeduklaasi ei või ja portselankaussi pole soovitav lahtisel leegil kuumutada. Asbestvõrk ühtlustab väga suurt temperatuuride erinevust.

4. a)

A – H_2O, vesi – oksiid	vedelik
B – SiO_2, ränidioksiid, liiv – oksiid	tahke
C – I_2, jood – lihtaine	tahke
D – Hg, elavhõbe – lihtaine	vedelik

b) $\rho(\mathbf{A}) = \frac{\rho(\mathbf{D})}{13,5} = \frac{13,5\ g/cm^3}{13,5} = 1,00\ g/cm^3$

$\rho(\mathbf{B}) = \rho(\mathbf{A}) \cdot 2,65 = 1,00\ g/cm^3 \cdot 2,65 = 2,65\ g/cm^3$

$\rho(\mathbf{C}) = \rho(\mathbf{B}) \cdot 1,86 = 2,65\ g/cm^3 \cdot 1,86 = 4,93\ g/cm^3$

c) $t_{sul}(H_2O) = 0\ ^0C$

$t_{sul}(Hg) = -40\ ^0C$ (+40 ^0C ei saa olla, sest siis ei ole see toatemperatuuril vedelik)

$t_{keem}(H_2O) = 100\ ^0C$

$t_{keem}(Hg) = 100\ ^0C + 240\ ^0C = 340\ ^0C$

d) 1) Jaotuslehtri abil eraldame Hg. **2)** Filtreerimisega eraldame H_2O.
3) Sublimeerime I_2, jäägiks on SiO_2. I_2 võib eraldada liivast ka etanooli abil, sest I_2 lahustub ja lahuse eraldamise järel võib etanooli aurustada.

5. a) Järjenumber = prootonite arv = elektronide arv

b) i) 26 – $A_r(\mathbf{X})$ = 10 (punkt 1)

$A_r(\mathbf{X})$ = 26 – 10 = 16

X – O, hapnik 8, VI, 16

ii) 16 – N prooton(**Z**) = 10 (punkt 3)

N prooton (**Z**) = 16 – 10 = 6

Z – C, süsinik 6, IV, 12

iii) N prooton (**Y**) – N prooton (**Q**) = 10 (punkt 2)

8 + 6 + [N prooton (**Y**) + N prooton (**Q**)] = 26 (tekstist)

N prooton (**Y**) = 10 + N prooton (**Q**)

10 + N prooton (**Q**) + n prooton (**Q**) = 12

N prooton (**Q**) =1

Q – H, vesinik 1, I, 1

iv) VI + rühm (**Y**) + IV + rühm (**Q**) = 12 (süsiniku aatommass)

rühm (**Y**) + rühm (**Q**) = 2

Järelikult **Y** ja **Q** on esimese rühma elemendid.

Punktist 2) järeldub, et **Y** on Na ja **Q** on H.

Y – Na, naatrium 11, I, 23

c) 8 + 11 + 6 + 1 = 26

VI + I + IV + I = XII

1) 26 – 16 = 10 **2)** 11 – 1 = 10 **3)** 16 – 6 = 10

6. a) $N_a = 1\ g \cdot \frac{1\ "kaaluviht"}{1,66 \cdot 10^{-24}\ g} = 6,02 \cdot 10^{23}$ "kaaluvihti"

b) $M_r(O_2) = 32$, see tähendab $32\ \frac{amü}{molekul}$

$m[N_A(amü)] = 1\ g$

Avogadro arvu amü mass

$m[N_A(O_2)] = 32 \cdot 1\ g = 32\ g$

Avogadro arvu O_2 molekulide mass

c) $M_r(NaCl) = 58,5$ NaCl molekul on ühe amü massist 58,5 korda suurem

$m[N_A(NaCl)] = 58,5\ g$

Avogadro arvu NaCl molekulide mass

$m(NaCl) = 58,5\ g \cdot \frac{1}{6,02 \cdot 10^{23}\ molekuli} = 9,72 \cdot 10^{-23}\ g/molekul$

2004/2005 õa keemiaolümpiaadi piirkonnavooru ülesannete lahendused

9. klass

1. a) i) 100 cm^2 < 1 m^2, pindala; **ii)** 1 kg/dm^3 = 1 g/cm^3, tihedus;

iii) 86400 s = 1 ööpäev; aeg; **iv)** 10000 cm^3 > 1 L; ruumala

b) i) $2H_2 + O_2 = 2H_2O$, ei ; **ii)** $2NaOH + CO_2 = Na_2CO_3 + H_2O$, jah;

iii) $3H_2 + N_2 = 2NH_3$, ei; **iv)** $C + O_2 = CO_2$, ei

$2\cdot(-II)$ (-) $2\cdot 0$

c) i) $2O - 4e^- = O_2$ oksüdeerumine

$2\cdot 0$ (-) $2\cdot(-II)$

ii) $O_2 + 4e^- = 2O$ redutseerumine

-II (-) VI

iii) $S - 8e^- = S$ oksüdeerumine

v (-) -III

iv) $N + 8e^- = N$ redutseerumine

d) SiO_2 – neutraalne, sest SiO_2 ei lahustu vees

SO_2 – happeline, sest moodustub väävlishape

Na_2O – aluseline, sest moodustub NaOH

NaCl – neutraalne, sest NaCl on tugeva happe ja tugeva aluse sool

$AlCl_3$ – happeline, nõrga aluse ja tugeva happe sool

Na_2CO_3 – aluseline, tugeva aluse ja nõrga happe sool

2. a) i) A_r(mittemetall) = 16 $\cdot \frac{27,3}{72,7}$ = 6 ei sobi

A_r(mittemetall = 2 · 16 · $\frac{27,3}{72,7}$ = **12** Mittemetall on **C**

ii) A_r(metall) = 16· $\frac{71,5}{28,5}$ = **40,1** Metall on **Ca**

iii) B – CO_2, süsinikdioksiid

D – CaO, kaltsiumoksiid

$^0t^0t$

b) i) $CaCO_3$ (aine **A**)= $CaO + CO_2$

ii) $CaO + H_2O = Ca(OH)_2$

$CO_2 + H_2O = H_2CO_3$

$Ca(OH)_2 + H_2CO_3 = CaCO_3$ (aine **A**) $+ 2H_2O$

c) $CaCO_3 + 2CH_3COOH = (CH_3COO)_2Ca + CO_2 + H_2O$

d) $M_r[(CH_3COO)_2Ca] = 4 \cdot 12 + 6 \cdot 1 + 4 \cdot 16 + 40 = 158$

%(Ca) = $\frac{40}{158} \cdot 100 = 25{,}3 \approx$ **25**

e) $\mathbf{m(CaCO_3)} = 0{,}90 \cdot 4/3\pi(0{,}25)^3\ cm^3 \cdot 2{,}68\ g/cm^3 =$ **~0,16 g**

3. a) $C_3H_8 + 5O_2 = 3CO_2 + 4H_2O$

b) i) $\overset{500\ g}{1C_3H_8} \Leftrightarrow \overset{m}{5O_2}$

$\underset{44\ g/mol}{} \quad \underset{32\ g/mol}{}$

$n(C_3H_8) = 500\ g \cdot \frac{1\,mol}{44\ g} = 11{,}36\ mol$

$\mathbf{m(O_2)} = \frac{5}{1} \cdot 500g \cdot \frac{1\,mol}{44\ g} \cdot 32\ g/mol = 1818\ g \approx$ **1800 g**

ii) $1C_3H_8 \Leftrightarrow 3CO_2$

$\mathbf{m(CO_2)} = \frac{3}{1} \cdot 11{,}36\ mol \cdot 44\ g/mol =$ **1500 g**

iii) $1C_3H_8 \Leftrightarrow 4H_2O$

$\mathbf{m(H_2O)} = \frac{4}{1} \cdot 11{,}36\ mol \cdot 18\ g/mol = 818\ g \approx$ **820 g**

c) Lämmastiku mass ei muutu

$m(N_2) = 30000\ dm^3 \cdot 1{,}29\ g/dm^3 \cdot 0{,}76 = 29412\ g$

Enne gaasi põlemist oli hapnikku

$m(O_2) = 30000\ dm^3 \cdot 1{,}29\ g/dm^3 \cdot 0{,}24 = 9288\ g$

Peale gaasi põlemist oli hapnikku

$m'(O_2) = 9288\ g - 1818\ g = 7470\ g$

$\%(CO_2) = \frac{1500}{29412 + 7470 + 1500} \cdot 100 =$ **≈ 3,9**

d) Gaaside korral on mahu- ja mooliprotsent sama.

$n(N_2) = 29412\ g \cdot \frac{1\,mol}{28\ g} = 1050\ mol$

$n'(O_2) = 7470\ g \cdot \frac{1\,mol}{32\ g} = 233\ mol$

$n(CO_2) = 1500\ g \cdot \frac{1\,mol}{44\ g} = 34\ mol$

$\%vol(CO_2) = \frac{34}{34 + 233 + 1050} \cdot 100 =$ **2,6**

Tähelepanu: Gaaside ruumalaid pole vaja leida, sest V(gaas) = n(gaas)·V_M. Mahuprotsendi leidmisel molaarruumalad taanduvad.

4. a) A – H_2O, vesi

B – H_2S, divesiniksulfiid

C – Na_2S, naatriumsulfiid

D – MgS, magneesiumsulfiid

Q – H_2, vesinik

X – O, hapnik

Y – S, väävel

b) A: neutraalne, lõhnatu, mittemürgine, mittelenduv

B: happeline, mädamuna lõhnaga, mürgine, lenduv (gaas)

c) i) $2H_2O + 2Na = 2NaOH + H_2\uparrow$

ii) $H_2S + 2NaOH = Na_2S + 2H_2O$

iii) $O_2 + 2Mg = 2MgO$

iv) $S + Mg = MgS$

5. a) $m(\text{smaragd}) = 3{,}00\ \text{ct} \cdot \frac{0{,}200\ \text{g}}{1\,\text{ct}} = 0{,}600\ \text{g}$

i) $m(\mathbf{A}) = 0{,}600\ \text{g} \cdot \frac{0{,}45}{100} = 0{,}0027\ \text{g}$

$\mathbf{V(A)} = 0{,}0027\ \text{g} \cdot \frac{1\,\text{mol}}{44\ \text{g}} \cdot \frac{22400\ \text{cm}^3}{\text{mol}} = 1{,}37\ \text{cm}^3 \approx \mathbf{1{,}4\ cm^3}$

ii) $m(\mathbf{B}) = 0{,}600\ \text{g} \cdot \frac{0.95}{100} = 0{,}0057\ \text{g}$

$\mathbf{n(B)} = 0{,}0057\ \text{g} \cdot \frac{1\,\text{mol}}{120\ \text{g}} = 0{,}0000475\ \text{mol} \approx \mathbf{0{,}000048\ mol = 4{,}8 \cdot 10^{-5}\ mol}$

b) A – CO_2, süsinikdioksiid

C – Fe_2O_3, raud(III)oksiid

D – SO_2, vääveldioksiid

E – SO_3, vääveltrioksiid

Z – $Fe(NO_3)_3$, raud(III)nitraat

B – FeS_2

c) i) $2SO_2 + O_2 = 2SO_3$

ii) $SO_3 + H_2O = H_2SO_4$

iii) $Fe_2O_3 + 6HNO_3 = 2Fe(NO_3)_3 + 3H_2O$

d) %(Fe) = $\frac{55,9}{242} \cdot 100$ = **23,1**

e) i) $FeS_2 \Leftrightarrow Fe$

m(Fe) = $\frac{1}{1} \cdot 0,0000475\ \text{mol} \cdot 55,85\ \text{g/mol}$ = 0,002652 g

%(Fe) = $\frac{0,002652}{0,600} \cdot 100$ ≈**0,44**

ii) V(smaragd) = $0,600\ \text{g} \cdot \frac{1\ \text{cm}^3}{2,75\ \text{g}}$ = **0,218 cm^3**

6. a) i) Soola **B** molekul peab sisaldama metalli, mille oksüdatsiooniaste on II, sest metalli ja H_2 suhe on 1 : 1. Järelikult soola **B** valem on **A**Cl_2.

A_r (**A**) = $2 \cdot 35,45 \cdot \frac{47,98}{52,02}$ = 65,39

ii) A – Zn, tsink

b) B – $ZnCl_2$, tsinkkloriid

C – $Zn(NO_3)_2$, tsinknitraat

D – $Zn(OH)_2$, tsinkhüdroksiid

E – CO_2, süsinikdioksiid

F – $ZnCO_3$, tsinkkarbonaat

G – ZnO, tsinkoksiid

H – CO, süsinikmonooksiid

X – $AgNO_3$, hõbenitraat

Y – AgCl, hõbekloriid

c) i) $Zn + 2HCl = ZnCl_2$ (**B**) + $H_2\uparrow$

ii) $2AgNO_3 + ZnCl_2 = Zn(NO_3)_2$ (**C**) + 2AgCl (**Y**)

iii) $Zn(NO_3)_2 + 2KOH = Zn(OH)_2\downarrow$ (**D**) + $2KNO_3$

iv) $Zn(OH)_2 + 2HNO_3 = Zn(NO_3)_2 + 2H_2O$

v) $Zn(OH)_2 + CO_2 = ZnCO_3\downarrow$ (**F**) + H_2O

vi) $Zn(OH)_2 \xrightarrow{t^0} ZnO$ (**G**) + H_2O

vii) $ZnCO_3 \xrightarrow{t^0} ZnO$ (**G**) + CO_2

viii) ZnO + C = Zn + CO (**H**)

ix) $2CO + O_2 = 2\ CO_2$ (**E**)

2004/2005 õa keemiaolümpiaadi piirkonnavooru ülesannete lahendused

10. klass

1. a) i) H_3BO_3 – boorhape, hape

ii) $Al(OH)_3$ – alumiiniumhüdroksiid, alus

iii) Na_2O_2 – naatriumperoksiid, peroksiid

iv) LiH – liitiumhüdriid, sool

b) i) 10^6 mm = 1 km

ii) 10^3 mL = 1L

iii) 1 kg/dm^3 = 1 g/cm^3

iv) 1 g = $6{,}02 \cdot 10^{23}$ amü

c) i) tugevad happed on: HI, H_2SO_4, HNO_3

ii) nõrgad happed on: H_2S, H_2SO_3, H_2SiO_3, HNO_2, H_2CO_3

d) m(Cu) = $14\ \text{g} \cdot \frac{417}{583} \approx 10{,}0$ g

m(juveelikuld) = $14\ \text{g} \cdot \frac{1000}{583} \approx 24{,}0$ g

e) $\overset{-III}{N}H_4\overset{V}{N}O_3 \rightleftharpoons NH_4^+ + NO_3^-$

x + 4 = 1 x – 6 = -1

x = -3 x = 5

2. a) $\frac{x}{100\%} \cdot 34{,}97 + \frac{100\% - x}{100\%} \cdot 36{,}97 = 35{,}45$

x · 34,97 + (100% - x) · 36,97 = 35,45 · 100%

34,97x + 36,97 · 100% - 36,97x = 35,45 · 100%

2,00x = 1,52 · 100%

x = 76,0%

%mol($^{35}_{17}$Cl) = 76,0

%mol($^{37}_{17}$Cl) = 100 – 76,0 = 24,0

b) m($^{35}_{17}$Cl) = 0,760 mol · 34,97 g/mol = 26,58 g

%($^{35}_{17}$Cl) = $\frac{26{,}58}{35{,}45} \cdot 100 = 74{,}97 \approx$ **75,0**

%($^{37}_{17}$Cl) = 25,0

c) $\rho(Cl_2) = \frac{35{,}45\ g \cdot 2}{22{,}4\ dm^3} \cdot \frac{1000\ dm^3}{1 m^3} \cdot \frac{1 kg}{1000\ g} = 3{,}165\ kg/m^3 \approx$ **3,17 kg/m³**

3. a) $MnO_4^- + 5Fe^{2+} + 8H^+ = Mn^{2+} + 5Fe^{3+} + 4H_2O$

VII (-) II

$Mn + 5e^- = Mn$ | 1

II (-) III

$Fe - 1e^- = Fe$ | 5

b) $5Fe^{2+} \Leftrightarrow 1MnO_4^-$

$m(Fe^{2+}) = \frac{5}{1} \cdot 0{,}04722\ L \cdot 0{,}02242\ mol/L \cdot 55{,}85\ g/mol = 0{,}2956\ g$

$\%(Fe^{2+}) = \frac{0{,}2956}{0{,}8040} \cdot 100 = 36{,}77$

c) $FeO \cdot Fe_2O_3 \Leftrightarrow Fe_3O_4$

$5Fe_3O_4 \Leftrightarrow 15Fe^{2+} \Leftrightarrow 3MnO_4^-$

$\%(Fe_3O_4)$ $= \frac{5}{3} \cdot 0{,}04722\ L \cdot 0{,}02242\ mol/L \cdot 231{,}54\ g/mol \cdot \frac{1}{0{,}8040\ g} \cdot 100 =$ **50,81**

4. a) $C_4H_{10}O + 6O_2 = 4CO_2 + 5H_2O$

b) Enne $N(O_2) + N(N_2) + N(eeter) = 2{,}5 \cdot 10^{10}$

pärast $N(N_2) + N(CO_2) + N(H_2O) = 2{,}7 \cdot 10^{10}$

$N(O_2) = \frac{6}{1} N(eeter)$

$N(CO_2) = \frac{4}{1} N(eeter)$

$N(H_2O) = \frac{5}{1} N(eeter)$

(I) enne $(6+1)N(eeter) + N(N_2) = 2{,}5 \cdot 10^{10}$

(II) pärast $(4+5)N(eeter) + N(N_2) = 2{,}7 \cdot 10^{10}$ (II võrrandist lahutame I)

$2N(eeter) = 2 \cdot 10^9$

$N(eeter) = 1 \cdot 10^9$

$N(O_2) = 6 \cdot 10^9$

$N(CO_2) = 4 \cdot 10^9$

$N(H_2O) = 5 \cdot 10^9$

$N(N_2) = 25 \cdot 10^9 - 6 \cdot 10^9 - 1 \cdot 10^9 = 18 \cdot 10^9$

i) enne **%mol(eeter)** = $\frac{1}{25} \cdot 100 =$ **4**

%mol(O_2) = $\frac{6}{25} \cdot 100 =$ **24**

%mol(N_2) = $\frac{18}{25} \cdot 100 =$ **72**

ii) pärast **%mol(N_2)** = $\frac{18}{27} \cdot 100 =$ **67**

%mol(H_2O) = $\frac{5}{27} \cdot 100 \approx$ **18**

%mol(CO_2) = $\frac{4}{27} \cdot 100 = 14{,}8 \approx$ **15**

5. ^0t

a) $Ca(HCO_3)_2 = CaCO_3\downarrow + CO_2\uparrow + H_2O$

b) $Ca(HCO_3)_2 + Ca(OH)_2 = 2CaCO_3\downarrow + 2H_2O$

$Ca(OH)_2 + Na_2CO_3 = CaCO_3\downarrow + 2NaOH$

$CaSO_4 + Na_2CO_3 = CaCO_3\downarrow + Na_2SO_4$

c) atomaarne hapnik

d) $Al_2(SO_4)_3 + 3Ca(HCO_3)_2 = 2Al(OH)_3\downarrow + 3CaSO_4 + 6CO_2\uparrow$

e) Koheval $Al(OH)_3$ sademel on suur eripind ja seetõttu suur adsorptsioonivõime.

f) $m[Al_2(SO_4)_3] = 100\ m^3 \cdot 1020\ kg/m^3 \cdot 1{,}00 \cdot 10^{-5} = 1{,}02$ kg

$M[Al_2(SO_4)_3 \cdot 18H_2O] = 666$ g/mol

$M[Al_2(SO_4)_3] = 342$ g/mol

$m[Al_2(SO_4)_3 \cdot 18H_2O]$ = $1{,}02\ kg \cdot \frac{666}{342} = 1{,}986\ kg \approx$ **1,99 kg**

6. a) $m(100\%) = 1000\ cm^3 \cdot 0{,}4 \cdot 0{,}78927\ g/cm^3 = 315{,}708$ g

$m(40\%vol) = 1000\ cm^3 \cdot 0{,}9480\ g/cm^3 = 948{,}0$ g

Tähelepanu: Kümnendiku grammi täpsus

$V(H_2O) = 948{,}0\ g - 315{,}708\ g) \cdot \frac{1\ cm^3}{0{,}99823\ g} = 633{,}4\ cm^3$

Kontraktsioon = $1000\ cm^3 - 400\ cm^3 - 633{,}4\ cm^3 = -33{,}4\ cm^3$

b) $V(96{,}2\%vol) = 1000\ cm^3 \cdot 0{,}4 \cdot \frac{1}{0{,}962} = 415{,}8\ cm^3$

$m(96{,}2\%vol) = 1000\ cm^3 \cdot 0{,}4 \frac{1}{0{,}962} \cdot 0{,}80608\ g/cm^3 = 335{,}17$ g

$V(H_2O) = (948{,}0\ g - 335{,}17g) \cdot \frac{1\,cm^3}{0{,}99823\ g} = 613,\ 9\ cm^3$

Kontraktsioon = $1000\ cm^3 - 415{,}8\ cm^3 - 613{,}9\ cm^3 = -29{,}7\ cm^3$

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} $M(\mathbf{X}) = M(õhk) \cdot 2{,}42 = 29\ g/mol \cdot 2{,}42 = 70{,}18\ g/mol$

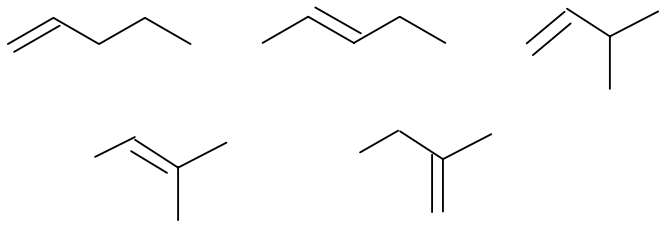
$12\ g/mol \cdot n + 2n \cdot 1{,}01\ g/mol = 70{,}18\ g/mol$

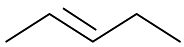
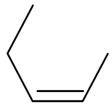
$n = 5$

X – C_5H_{10}

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

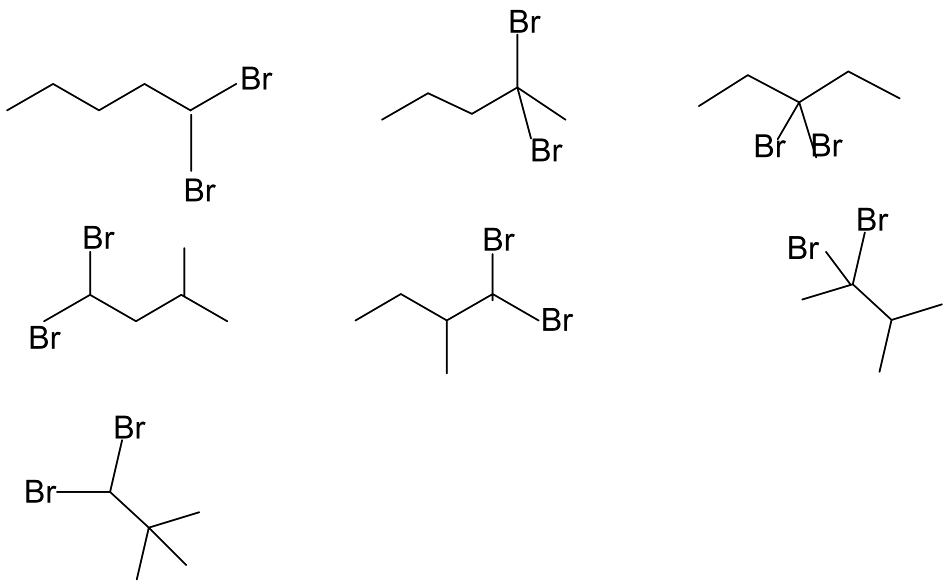
c)



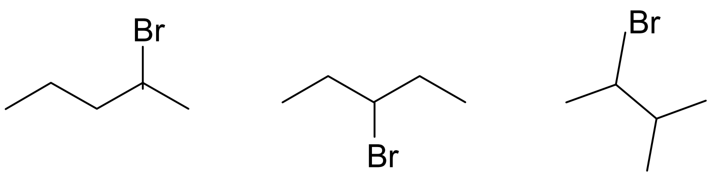
d)  

trans cis

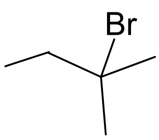
e)



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 $\Leftrightarrow$ (2N + 2)HBr

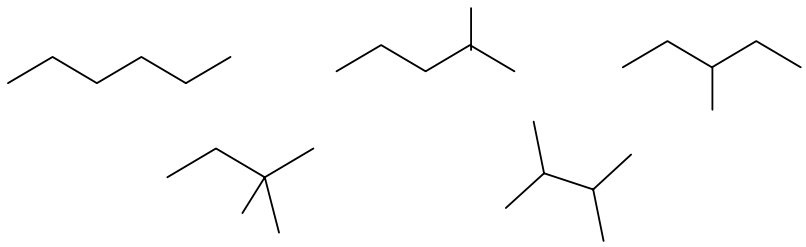
$$0{,}1057 = \frac{2N+2}{1} \cdot 0{,}00755 \qquad 2N + 2 = \frac{0{,}1057}{0{,}00755}$$

2N + 2 = 14

N = 6

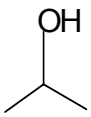
Süsivesiniku **A** brutovalem on C_6H_{14}

b)

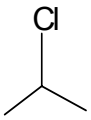


c) i) B – AgBr , hõbebromiid
C – CH_3Br, bromometaan, metüülbromiid
D – $CH_3CH=CH_2$, propeen

ii)



E – propaan-2-ool

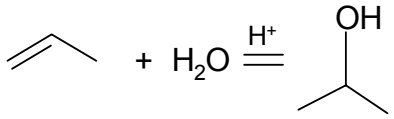


F — 2-kloropropaan

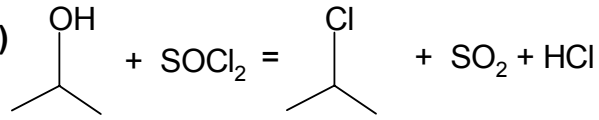
d) i) $CH_4 + Br_2 \xrightarrow{h\nu} CH_3Br + HBr$

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

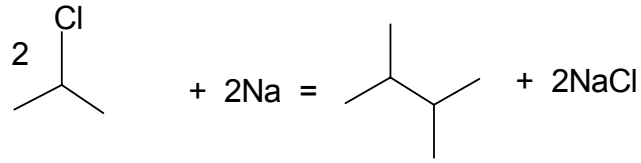
iii)



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

2004/2005 õa keemiaolümpiaadi piirkonnavooru ülesannete lahendused

12. klass

1. a) 2,2,3,3-tetrametüülpentaan

b) i) katoodprotsess, redutseerumine

ii) anoodprotsess, oksüdeerumine

c) $O_2 \Leftrightarrow 4e^-$

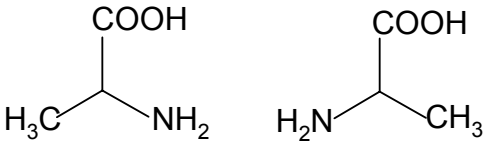
$n(O_2) = 48\,g \cdot \frac{1\,mol}{32\,g} = 1{,}5$ mol

$F = \frac{4}{1} \cdot 1{,}5 = 6$

d) pH on 7, sest me lahjendame hapet veega, mille pH on 7.

$[H^+] = 10^{-7}$(vees) + 10^{-9}(happest). Happelahuse lahjendamisel moodustunud vesinikioonide tühine kontsentratsioon ei suuda vees olevat vesinikioonide kontsentratsiooni mõjutada.

e)



S **R**

2. a)

I $\%(\mathbf{Y}) = \frac{M(\mathbf{Y})}{M(\mathbf{Y}) + (n-1) \cdot M(\mathbf{Q})} \cdot 100$

$0{,}1793 \cdot M(\mathbf{Y}) + 0{,}1793(n+1) \cdot M(\mathbf{Q}) = M(\mathbf{Y})$

$M(\mathbf{Y}) = \frac{0{,}1793}{0{,}8207} \cdot (n-1) \cdot M(\mathbf{Q})$

II $100 - \%(\mathbf{Y}) = \frac{M(\mathbf{Y})}{M(\mathbf{Y}) + (n+1) \cdot M(\mathbf{Q})} \cdot 100$

$0{,}1271 \cdot M(\mathbf{Y}) + 0{,}1271(n+1) \cdot M(\mathbf{Q}) = M(\mathbf{Y})$

$M(\mathbf{Y}) = \frac{0{,}1271}{0{,}8729} \cdot (n+1) \cdot M(\mathbf{Q})$

$\frac{0{,}1793}{0{,}8207} \cdot (n-1) = \frac{0{,}1271}{0{,}8729} \cdot (n+1)$

$1{,}500(n-1) = n+1$

$0{,}500n = 2{,}5$

$n=5$

Järelikult **X, Y** ja **Z** on V peaalarühma elemendid.

b) Kui halogeen **Q** on fluor F, siis

$M(\mathbf{Y}) = 4 \cdot 19$ g/mol $\cdot \frac{0{,}1793}{0{,}8207} = 16{,}6$ g/mol ei sobi

Kui halogeen **Q** on kloor Cl, siis

M(**Y**) = 4 · 35,5 g/mol $\cdot \frac{0{,}1793}{0{,}8207}$ = 31,0 g/mol, see on fosfor

Ei sobi ka Br [M(**Y**) = 69,8 g/mol] ja I [M(**Y**) = 110 g/mol]

Y – P, fosfor

Q – Cl, kloor

c) 0,4072 = $\frac{2M(\mathbf{Z})}{2M(\mathbf{Z}) + 2 \cdot 5 \cdot 35{,}45\ \text{g/mol}}$

0,4072[M(**Z**)+ 5 · 35,45 g/mol] = M(**Z**)

0,5928 M(**Z**) = 72,18 g/mol

M(**Z**) = 121,8 g/mol

Z – Sb, antimon

X – As, arseen, mis asub fosfori ja antimoni vahel.

3. a) i) $CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2\uparrow$

ii) $ZnO + 2HCl = ZnCl_2 + H_2O$

$ZnCl_2$ eemaldatakse pesemisega

$Zn + 2HCl = ZnCl_2 + H_2\uparrow$

b) $M(ZnSO_4) = 287{,}54 - 7 \cdot 18{,}02 = 161{,}40$ g/mol

$x = \frac{287{,}54 \cdot 0{,}6240 - 161{,}40}{18{,}02} = 1{,}000$

Q - $ZnSO_4 \cdot H_2O$; m(Q) = 179,42 g/mol

c) i) c(EDTA, lahus **A**)= $10 \cdot \frac{1{,}0104\ \text{g}}{100{,}089\ \text{g/mol}} \cdot \frac{1}{\text{dm}^3} \cdot \frac{10\ \text{cm}^3}{10{,}44\ \text{cm}^3} = 0{,}09670\ \text{mol/dm}^3$

ii) c(EDTA, lahus **B**) = $10 \cdot \frac{1{,}3554\ \text{g}}{65{,}39\ \text{g/mol}} \cdot \frac{1}{\text{dm}^3} \cdot \frac{10\ \text{cm}^3}{21{,}44\ \text{cm}^3} = 0{,}09668\ \text{mol/dm}^3$

iii) c(EDTA, lahus **C**) = $10 \cdot \frac{1{,}8450\ \text{g}}{179{,}42\ \text{g/mol}} \cdot \frac{1}{\text{dm}^3} \cdot \frac{10\ \text{cm}^3}{10{,}63\ \text{cm}^3} = 0{,}09674\ \text{mol/dm}^3$

4. a) i) $2Cr^{3+} + 3IO_4^- + 10\ OH^- = 2CrO_4^{2-} + 3IO_3^- + 5H_2O$

ii) $2CrO_4^{2-} + 2H^+ = Cr_2O_7^{2-} + H_2O$

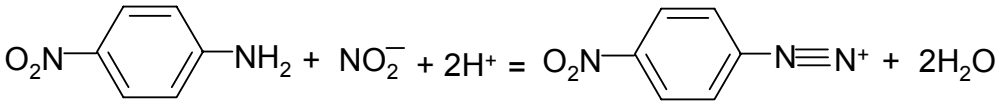
$Cr_2O_7^{2-} + 6I^- + 14H^+ = 3I_2 + 2Cr^{3+} + 7H_2O$

iii) $IO_3^- + 5I^- + 6H^+ = 3I_2 + 3H_2O$

iv) $I_2 + SO_3^{2-} + H_2O = 2I^- + SO_4^{2-} + 2H^+$

v) $I^- + 3Br_2 + 3H_2O = IO_3^- + 6Br^- + 6H^+$

vi) $2IO_3^- + 3NH_2OH = 2I^- + 3H^+ + 3H_2O + 3NO_2^-$

vii) 

b) Avaldame, mitu korda erineb Cr^{3+} hulk I_2 hulgast

$Cr^{3+} = \frac{2}{2} \cdot \frac{2}{1} \cdot \frac{1}{3} I_2 = \frac{2}{3}\ I_2$ võrrandid **i)** ja **ii)**

$Cr^{3+} = \frac{2}{3} \cdot \frac{1}{3} I_2 = \frac{2}{9}\ I_2$ võrrandid **i)** ja **iii)**

$Cr^{3+} \Leftrightarrow 6I_2$

Summaarses reaktsioonivõrrandis on kroomi ja kloori koefitsiendid vastavalt 1 ja 6.

Avaldame, mitu korda erineb I_2 hulk aine **X** hulgast

$I_2 = \frac{1}{2} \cdot \frac{1}{1} \cdot \frac{2}{3} \cdot \frac{1}{1} \cdot \frac{1}{1} \cdot \mathbf{x} = \frac{1}{3}\mathbf{x}$ võrrandid **iv), v), vi), vii)** ja tekst

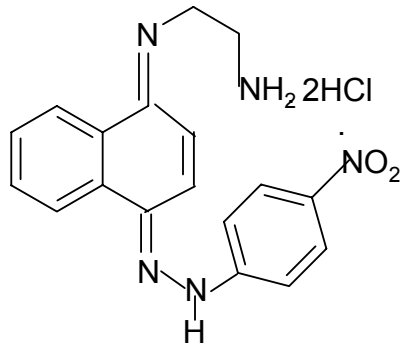
$I_2 \Leftrightarrow 3X$

$Cr^{3+} \Leftrightarrow 6 \cdot 3X$

$Cr^{3+} \Leftrightarrow 18\ X$

Summaarses reaktsioonivõrrandis on koefitsiendid vastavalt 1 ja 18.

c)



5. a) i) $CaCl_2 + (NH_4)_2C_2O_4 = CaC_2O_4\downarrow + 2NH_4Cl$

ii) **B** – CO, süsinikmonooksiid

C – CO_2, süsinikdioksiid

D – CaO, kaltsiumoksiid

b) $CaC_2O_4 \Leftrightarrow CaO$

128,1 g/mol 56,1 g/mol

$$m(CaC_2O_4)\frac{1}{1} \cdot 5{,}61\,g \cdot \frac{1\,mol}{56{,}1\,g} \cdot 128{,}1\,g/mol = 12{,}81\,g$$

Kuna esmalt eraldus vesi, siis peab kaltsiumoksalaat sisaldama kristallvett

$n(H_2O) = (14{,}61 - 12{,}81\ g) \cdot \frac{1\,mol}{18\,g} = 0{,}100\ mol$

A – $CaC_2O_4 \cdot H_2O$, kaltsiumoksalaat vesi (1:1)

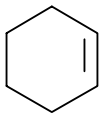
c) i) $CaC_2O_4 \cdot H_2O \xrightarrow{135\ ^0C} CaC_2O_4 + H_2O$

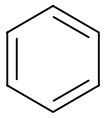
ii) $CaC_2O_4 \xrightarrow{400\ ^0C} CaCO_3 + CO\uparrow$

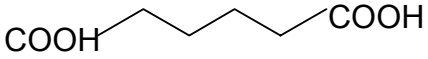
iii) $CaCO_3 \xrightarrow{850\ ^0C} CaO + CO_2\uparrow$

iv) $BaSO_4 \xrightarrow{1500\ ^0C} BaO + SO_3\uparrow$

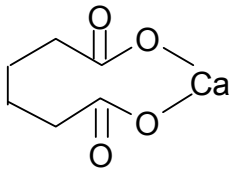
d) $\%(CaCl_2) = \frac{0{,}1\,mol \cdot 111\,g/mol}{12{,}00\,g} \cdot 100 = 92{,}5$

6. a) **A** —  , tsüklohekseen

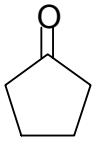
B —  , benseen

D — 

heksaandihape

E — 

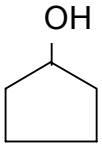
, heksaandihappe kaltsiumi sool

F — 

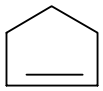
, tsüklopentanoon

G — $CaCO_3$

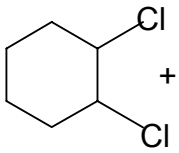
kaltsiumkarbonaat

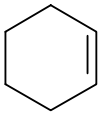
I — 

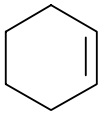
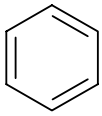
tsüklopentanool

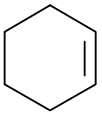
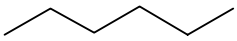
K — 

tsüklopenteen

b) **i)** 

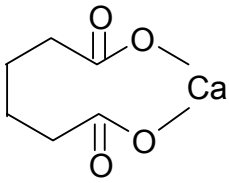
+ Mg =  + $MgCl_2$

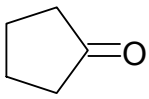
ii)  $\overset{^{o}t}{=}$  + $2H_2$

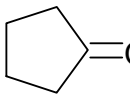
iii) 5  + $8KMnO_4$ + $12H_2SO_4$ = $5HOOC$ 

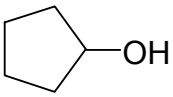
+

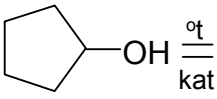
+ $4K_2SO_4$ + $8MnSO_4$ + $12H_2O$

iv) 

$\overset{^{o}t}{=}$ $CaCO_3$ + 

v) 

+ H_2 $\overset{kat}{=}$ 

vi) 

$\overset{^{o}t}{\underset{kat}{=}}$  + H_2O