2001/2002 õa keemiaolümpiaadi piirkonnavooru
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8. klass

1.

1 – paukhappe elavhõbeda soolaga
ртутная соль гремучей кислоты

2 – jahuti; холодильник

3 – kooniline kolb; коническая колба

4 – benseeni; бензол

5 – karbamiidi; карбамид

6 – mineraalväetisi;
минеральное удобрение

7 – fosforväetist;
фосфорное удобрение

8 – $Ca_3(PO_4)_2$
9 – $Ca(H_2PO_4)_2$
10 – $CaHPO_4$
11 – K_2CO_3
12 – KCl
13 – K_2SO_4
14 – $CO(NH_2)_2$
15 – $(NH_4)_2SO_4$
16 – $NaNO_3$

2. a) **m =** $1{,}34 \cdot 10^9\ \text{km}^3 \cdot \left(\frac{10^3\ \text{m}}{1\ \text{km}}\right)^3 \cdot 1{,}03 \cdot 10^3\ \frac{\text{kg}}{\text{m}^3} \cdot \frac{1\ \text{tonn}}{10^3\ \text{kg}} =$ **$1{,}38 \cdot 10^{18}$ tonni**

b) m(Au) = $1{,}38 \cdot 10^{18}$ tonni $\cdot\ 3{,}00 \cdot 10^{-4}$ g/tonnis $\cdot \frac{1\ \text{kg}}{10^3\ \text{g}}$ **= $4{,}14 \cdot 10^{11}$ kg**

c) $\mathbf{m_{keskm}(Au)} = \frac{4{,}14 \cdot 10^{11}\ \text{kg}}{6{,}50 \cdot 10^9\ \text{inimest}}$ **= 63,7 kg/inimese kohta**

3. a) $C_9H_6O_2$

b) $\mathbf{M_r\ (kumariin)} = 9 \cdot 12{,}01 + 6 \cdot 1{,}008 + 2 \cdot 16.00 \approx$ **146,14**

c) $\%(O_2) = \frac{32{,}00}{146{,}1} \cdot 100 =$ **21,90**

4. a) i) 1 – kristallisaator; 3 – mõõtesilinder või mõõtudega keeduklaas
ii) puidust või vahtplastist

b) X – P, fosfor
c) Nivoo asub jaotise 8 juures, sest õhus on hapnikku 1/5 ruumalast.

d) i) $4P + 5O_2 = P_4O_{10}$;
ii) $P_4O_{10} + 6H_2O = 4H_3PO_4$

e) Joonisel A peaks gaasi ruumala olema suurem, sest seal on tasakaalustamata vee nivoo, mis põhjustab anumas 3 õhurõhust pisut väiksema rõhu. Rõhu vähenemisel gaasi ruumala suureneb.

5. **a)** **i)** sool **C**
ii) sool **A**

b)

49°C	sool **C** ja sool **A**	~27 g
55 °C	sool **C** ja sool **B**	~27 g
45 °C	sool **A** ja sool **B**	~23 g

c) Välja kristalliseerus ~19 g, lahusesse jäi ~11 g soola **A**.

6. a) **X** – H, vesinik
Y – C, süsinik
b) i) **X** +1 |)-1
Y +6 |)-2)-4
ii) **H** – 1 prooton ja 1 elektron
C – 6 prootonit, 6 neutronit ja 6 elektroni

c) -III I
A – C_2H_6

-II I
B – C_2H_4

-I I
C – C_2H_2

0
Z – N_2

0
G – H_2

d) **G**(2 g/mol) **<** **C**(26 g/mol) **<** **B**(28 g/mol) **<** **A**(30 g/mol)

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9. klass

1. a) **X** – Ca, kaltsium
Y – C, süsinik
A – CaO, kaltsiumoksiid
B – $Ca(OH)_2$, kaltsiumhüdroksiid
C – CO_2, süsinikdioksiid
D – H_2CO_3, süsihape
E – $CaCO_3$, kaltsiumkarbonaat
F – H_2O, vesi
K – $CaCl_2$, kaltsiumkloriid
L – $Ca(HCO_3)$, kaltsiumvesinikkarbonaat

b) i) $2Ca + O_2 = 2CaO$
ii) $CaO + H_2O = Ca(OH)_2$
iii) $C + O_2 = CO_2$
iv) $CO_2 + H_2O = H_2CO_3$
v) $H_2CO_3 + Ca(OH)_2 \overset{^{o}t^{o}t}{=} CaCO_3\downarrow + 2H_2O$
vi) $CaCO_3 = CaO + CO_2\uparrow$
vii) $CaCO_3 + 2HCl = CO_2\uparrow + CaCl_2 + H_2O$
viii) $2HCl + CaO = CaCl_2 + H_2O$
ix) $CaCO_3 + H_2O + CO_2 = Ca(HCO_3)_2$

2. a) **i)** karastusjook “Fanta”; **ii)** pudeli avamine.
b) **A** – CO_2, süsinikdioksiid, süsihappegaas
B – H_2O, vesi
C – H_2CO_3, süsihape
D – $C_{12}H_{22}O_{11}$, sahharoos
c) **i)** **$CaCO_3 \cdot MgCO_3$**, kaltsiumkarbonaat-magneesiumkarbonaat
ii) dolomiit

3. a) i) **A** – $Ca(H_2PO_4)_2 \cdot CaSO_4$
ii) **B** – $Ca(H_2PO_4)_2$
iii) **C** – $CaHPO_4$
b) $M_r(P_2O_5) = 2 \cdot 31{,}0 + 5 \cdot 16{,}0 = 142$
M_r(**A**) = 234 + 136 = 37<u>0</u>
i) **A** $\Leftrightarrow$ P_2O_5
%(P_2O_5,A) = $\frac{142}{370} \cdot 100$ = **38,3**
ii) **B** $\Leftrightarrow$ P_2O_5

%(P_2O_5,B) = $\frac{142}{234} \cdot 100$ = **60,7**

iii) 2**C** = P_2O_5

%(P_2O_5,C) = $\frac{142}{276} \cdot 100$ = **51,4**

c) i) m(**A**) = 1,00 kg $\cdot \frac{100\%}{38{,}3\%}$ = **2,86 kg**

ii) m(**B**) = 1,00 kg $\cdot \frac{1}{0{,}607}$ = **1,65 kg**

iii) m(**C**) = 1,00 kg $\cdot \frac{1}{0{,}514}$ = **1,95 kg**

4. a) M(A) = 2,016 g/mol · 106,35 **= 214,4 g/mol**

b) i) m(Cl) = 214,4 g · 0,6617 = 141,9 g

n(Cl) = $141{,}9\ \text{g} \cdot \frac{1\ \text{mol}}{35{,}45\ \text{g}}$ = 4,003 mol ≈ **4 mol**

ii) m(**X**) = 214,4 g - 141,9 g = 72,5 g

Kloriidides on kloori oksüdatsiooniaste -I. Kloriidide valemid on **X**Cl_n, millest järeldub, et ühendis **A** on üks elemendi **X** aatom oksüdatsiooniastmega IV.

A_r(X) = **72,5**

iii) X – Ge, germaanium

iv) 4 elektroni

v) N = 72,61 - 32 ≈ **41 neutronit**

c) i) $Ge + 2Cl_2 \xrightarrow[^{o}t]{^{o}t} \underset{\mathbf{A}}{GeCl_4}$

ii) $Ge + O_2 = \underset{\mathbf{B}}{GeO_2}$

iii) $\underset{\mathbf{B}}{GeO_2} + 4HCl = \underset{\mathbf{A}}{GeCl_4} + 2H_2O$

Märkus: $GeCl_4$ juurde ei tohi lenduvuse noolt kirjutada, sest see keeb toatemperatuurist kõrgemal temperatuuril

5. a) i) n(gaas) = 9,77 $dm^3 \cdot \frac{1\ \text{mol}}{22{,}4\ dm^3}$ = 0,436 mol

ii) Mõlemas reaktsioonis saab eraldunud gaasiks olla H_2, vesinik.

b) Lahuse massi kasv võrdub metalli massi ja eraldunud vesiniku massi vahega.

6,97 g = m(**X**) - m(H_2)

m(H_2) = 9,77 $dm^3 \cdot \frac{1\ \text{mol}}{22{,}4\ dm^3} \cdot$ 2,02 g/mol = 0,881 g

m(**X**) = 6,97 g + 0,88 g = **7,85 g**

c) i) Al, alumiinium

ii) $2Al \Leftrightarrow 3H_2$

$n(Al) = \frac{2}{3} \cdot 0{,}436 \text{ mol} = 0{,}2906 \text{ mol} \approx 0{,}291 \text{ mol}$

M(Al) = $\frac{7{,}85 \text{ g}}{0{,}2906 \text{ mol}}$ = **27,0 g/mol**

d) i) $2Al + 6HCl = 2AlCl_3 = 2AlCl_3 + 3H_2\uparrow$

ii) $2Al + 6NaOH + 6H_2O = 2Na_3[Al(OH)_6] + 3H_2\uparrow$

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

ii) $2C_2H_5SH + 9O_2 = 4CO_2 + 6H_2O + 2SO_2$

b) i) m(C_2H_5SH) = $\frac{21 \text{ kg}}{1000 \text{ kg}} \cdot 20{,}0 \text{ g}$ = **0,42 g**

ii) 0,42 g V

$2C_2H_5SH \Leftrightarrow 1SO_2$

62 g/mol 24 dm^3/mol

V(SO_2) = $0{,}42 \text{ g} \cdot \frac{1 \text{ mol}}{62 \text{ g}} \cdot 24{,}0 \text{ dm}^3/mol$ = **0,163 dm^3**

c) $21 \cdot 10^3$ g v·0,21

$C_3H_8 \Leftrightarrow 5O_2$

44 g/mol 24 dm^3/mol

V(õhk) = $\frac{5}{1} \cdot 21 \cdot 10^{3\text{ g}} \cdot \frac{1 \text{ mol}}{44 \text{ g}} \cdot 24{,}0 \text{ dm}^3/\text{mol} \cdot \frac{1}{0{,}21}$ = **$2{,}73 \cdot 10^5$ dm^3**

%vol(SO_2) = $\frac{0{,}163 \text{ dm}^3}{2{,}73 \cdot 10^5 \text{ dm}^3} \cdot 100$ = **$5{,}97 \cdot 10^{-5}$**

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10. klass

1. a) **A** – CO_2, süsinikdioksiid, *atmosfääris* [1] .
B – N_2, lämmastik, *atmosfääris.*
C – $(C_6H_{10}O_5)_n$, tselluloos; *ei lahustu vees, tekib fotosünteesil.*
D – CH_4, metaan, *kõige kergem orgaaniline gaas, mis tekib seedimisel.*
E – O_2, hapnik
F – H_2O, vesi, *esineb atmosfääris veeaurune, rahena, vihmepiiskadena.*
G – $Ca(OH)_2$, kaltsiumhüdroksiid, kustutatud lubi.
H – $CaCO_3$, kaltsiumkarbonaat

b) **i)** $CH_4 + 2O_2 = CO_2 + 2H_2O$
D E A F
ii) $Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$
G A H F

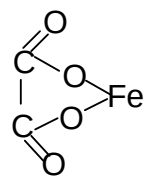
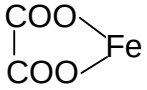
2. a) **i)** **X** - Fe, raud
ii) $2Fe + O_2 = 2FeO$
$4Fe + 3O_2 = 2Fe_2O_3$
$3Fe + 2O_2 = Fe_3O_4$

b) **i)** $Fe + H_2SO_4 = FeSO_4 + H_2\uparrow$
X C
ii) $FeSO_4 + (COOK)_2 = K_2SO_4 + (COO)_2Fe$
C B A
iii) $(COO)_2Fe{\cdot}2H_2O \xrightarrow{^{o}t} 2CO_2\uparrow + 2H_2O + Fe$

c) **i)** $(COO)_2Fe{\cdot}2H_2O$, raud(II)oksalaat-kaks-vesi
ehk raud(II)oksalaat-kaks-hüdraat

ii) $FeSO_4{\cdot}7H_2O$, raud(II)sulfaat-seitse-vesi ehk raud(II)sulfaat-hepta-hüdraat
ehk raud(II)vitriol; *raud(II)ioon annab turnbulli sinise.*

iii) K_2SO_4, kaaliumsulfaat

d)  ehk 

[1] *- kursiivis antud seletust pole õpilastelt nõutud.*

e) i) Rauapulbri reageerimisel lahjendatud happe lahusega, mis küllasta- takse hapnikuga.

ii) $4Fe + 6H_2SO_4 + 3O_2 = 2Fe_2(SO_4)_3 + 6H_2O$

D *Raud(III) ioon annab berliini sinise.*

iii) Raudoksalaadi kuumutamisel saadakse tolmpeen (suure eripinnaga – pindala/mass) pulber.

3. a) i) $n(karbonaat) \Leftrightarrow n(CO_2)$

n(karbonaat) = $\frac{1}{1} \cdot 2{,}62\ dm^3 \cdot \frac{1\ mol}{22{,}4\ dm^3}$ = **0,117 mol**

ii) $n(hüdroksiid) \Leftrightarrow n(H_2O)$

$n(H_2O) \cdot 18{,}0\ g/mol + n(CO_2) \cdot 44{,}0\ g/mol = 7{,}25\ g$

$m(H_2O) = 7{,}25\ g - 0{,}117\ mol \cdot 44{,}0\ g/mol = 2{,}10\ g$

n(hüdroksiid) = $\frac{1}{1} \cdot 2{,}10\ g \cdot \frac{1\ mol}{18{,}0\ g}$ = **0,117 mol**

iii) n(oksiid) = 0,351 mol - 0,117 mol - 0,117 mol = **0,117 mol**

b) $M(oksiid) = \frac{17{,}9\ g}{0{,}117\ mol}$ = 153 g/mol

M(**X**) = 153 g/mol - 16 g/mol = 137 g/mol

X – Ba, baarium

c) $M[Ba(OH)_2]$ = 171 g/mol

$M(BaCO_3)$ = 197 g/mol

i) m[Ba(OH)$_2$] = 0,117 mol ·171 g/mol = **20,0 g**

ii) m(BaCO$_3$) = 0,117 mol · 197 g/mol = **23,0 g**

d) i) $BaCO_3 + 2HCl = BaCl_2 + CO_2\uparrow + H_2O$

$Ba(OH)_2 + 2HCl = BaCl_2 + 2H_2O$

$BaO + 2HCl = BaCl_2 + H_2O$

ii) $BaCO_3 \xrightarrow{^{o}t^{o}t} BaO + CO_2\uparrow$

$Ba(OH)_2 \xrightarrow{^{o}t^{o}t} BaO + H_2O\uparrow$

4. a) M(**A**) = 29,0 g/mol · 9,79 = 283,9 g/mol ≈ 284 g/mol

m(**X**) = 283,9 g · 0,4366 = 123,95 g ≈ 124 g

m(O) = 284 g - 124 g = 160 g

n(O) = 160 g · $\frac{1\ mol}{16\ g}$ = 10 mol

n(**X**) ⇔ 1 2 ja 3 ei sobi, sest elemendi oksüdatsiooniaste ei saa olla 20 ega 10 ja tavaliselt pole see ka murdarv.

Kui n(**X**) = 4, siis M(**X**) = $\frac{124\ \text{g}}{4\ \text{mol}}$ = 31 g/mol,

mis vastab **fosforile**.

b) P_4O_{10} – tetrafosfordekaoksiid

c) i) $P_4O_{10} + 6H_2O = 4H_3PO_4$

284 g/mol 98,0 g/mol

ii) m(H_3PO_4) = $\frac{4}{1} \cdot 5{,}00\ \text{g} \cdot \frac{1\ \text{mol}}{284\ \text{g}} \cdot 98{,}0\ \text{g/mol}$ = 6,90 g

%(H_3PO_4) = $\frac{6{,}90\ \text{g}}{5{,}00\ \text{g} + 100\ \text{g}} \cdot 100$ = **6,57**

iii) ortofosforhappe lahus

5. a) Peamisteks põlemise saadusaineteks on CO_2, H_2O, N_2 ja oksiidid.

b) i) $2H \Leftrightarrow H_2O$

m(H_2O) = 16,8 g - 6,0 g = 10,8 g

n(H) = $\frac{2}{1} \cdot 10{,}8\ \text{g} \cdot \frac{1\ \text{mol}}{18\ \text{g}}$ = 1,2 mol

Et kõikides ainetes vesiniku hulgad olid võrdsed, siis iga aine 0,1 moolis oli $\frac{1{,}2\ \text{mol}}{3}$ = 0,4 mol. Seega iga aine molekulis on **4 vesiniku aatomit**.

ii) M(X;Y;Z) = $4 \cdot \frac{1{,}0\ \text{g}}{\text{mol}} \cdot \frac{1}{0{,}125}$ = **32 g/mol**

c) i) Aine **A** on vees lahustumatu oksiid.

M(**A**)=$\frac{6{,}0\ \text{g}}{0{,}1\ \text{mol}}$= 60 g/mol. Selleks oksiidiks on **SiO_2** - ränidioksiid

M(Si)=32 g/mol - 4·1 g/mol = 28 g/mol

ii) Aine **A** saadakse aine **X** põlemisel, sest aine **X** on gaas (SiH_4).

d) i) M(gaasid) = 1,6 g/dm^3 · 22,4 dm^3/mol = 35,8 g/mol ≈ 36 g/mol

Kui oletada, et üheks gaasiks on CO_2 [M(CH_3OH) = 32 g/mol], siis

0,5 mol · 44 g/mol + 0,5 mol [M(teine gaas)] = 36 g

M(teine gaas) = $\frac{36\ \text{g} - 22\ \text{g}}{0{,}5\ \text{mol}}$ = 28 g/mol

Selline molaarmass on **lämmastikul (N_2)**

ii) Aine **Y** põlemisel tekib **CO_2** (CH_3OH on vedelik).

Aine **Z** põlemisel tekib **N_2** (NH_2–NH_2 on madalal temperatuuril tahke aine).

e) **X** – SiH_4, silaan (gaas)

Y – CH_3OH, metanool (vedelik) M(C+O) = 32 g/mol-4·1 g/mol=28 g/mol

Z – NH_2–NH_2, hüdrasiin (tahke) M(N+N) = 32 g/mol-4·1 g/mol=28 g/mol

6. a) $2NaHCO_3 \xrightarrow{^{o}t} Na_2CO_3 + CO_2\uparrow + H_2O$

b) i) Taignas sisalduvas vees dissotsieeruvad mõlemad soolad. Sool **B** peab andma happelise keskkonna, mille toimel soolast **A** moodustub süsihape, mis laguneb veeks ja gaasiks.

ii) Eraldub CO_2 (süsihappe gaas ehk süsinikdioksiid)

c) $m(\mathbf{A}) = 20{,}0\ g \cdot 0{,}35 = 7{,}00\ g$

$m(\mathbf{B}) = 20{,}0\ g \cdot 0{,}25 = 5{,}00\ g$

$n(CO_2) = 0{,}200\ dm^3 \cdot \frac{100\%}{10\%} \cdot \frac{1\ mol}{24{,}0\ dm^3} = 0{,}0833\ mol$

i) $\mathbf{A} \Leftrightarrow CO_2$

$n(\mathbf{A}) = \frac{1}{1} \cdot n(CO_2) = 0{,}0833\ mol$

$M(\mathbf{A}) = \frac{7{,}00\ g}{0{,}0833\ mol} = 84{,}0\ g/mol = M(NaHCO_3)$

A – $NaHCO_3$, naatriumvesinikkarbonaat

ii) $\mathbf{B} \Leftrightarrow CO_2$

$M(\mathbf{B}) = \frac{5{,}00\ g}{0{,}0833\ mol} = 60{,}0\ g/mol$ (ei sobi, sest pole kahelaengulist aniooni, mille molaarmass oleks

60 g/mol - 23 g/mol - 1 g/mol = 36 g/mol).

$\mathbf{B} \Leftrightarrow 2CO_2$

$n(\mathbf{B}) = \frac{1}{2} \cdot 0{,}0833\ mol$

$M(\mathbf{B}) = \frac{5{,}00\ g \cdot 2}{0{,}0833\ mol} = 120\ g/mol = M(NaH_2PO_4)$

$M(PO_4^{3-}) = 120\ g/mol - 23\ g/mol - 2 \cdot 1\ g/mol = 95\ g/mol$

B – NaH_2PO_4 (naatriumdivesinikfosfaat)

d) i) $2NaHCO_3 + NaH_2PO_4 = Na_3PO_4 + 2H_2O + 2CO_2\uparrow$

ii) $2HCO_3^- + 2H^+ = 2H_2O + 2CO_2\uparrow$

e) i) Reaktsioon toimub ioonide vahel, mis moodustuvad soolade dissotsieerumisel vesilahuses. **ii)** Tärklis imab niiskust, mis takistab soolade dissotsiatsiooni.

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1. a) i) **n(HCOONa)** = $0{,}500\ \text{dm}^3 \cdot 1012\ \text{g/dm}^3 \cdot 0{,}05 \cdot \frac{1\ \text{mol}}{68{,}0\ \text{g}}$ = **0,372 mol**

n(HCl) = $1{,}20\ \text{dm}^3 \cdot 1003\ \text{g/dm}^3 \cdot 0{,}01 \cdot \frac{1\ \text{mol}}{36{,}5\ \text{g}}$ = **0,329 mol**

ii) c(HCOONa) = $\frac{0{,}372\ \text{mol}}{0{,}500\ \text{dm}^3}$ = **0,744mol/dm³**

c(HCl) = $\frac{0{,}329\ \text{mol}}{1{,}20\ \text{dm}^3}$ = **0,275 mol/dm³**

b) alglahustes	0,372 mol		0,329 mol	–	–	
	HCOONa	+	HCl	= HCOOH	+	NaCl
lõpplahuses	**0,043 mol**		–	**0,329 mol**		**0,329 mol**

c) i) $HCOOH \rightleftharpoons H^+ + HCOO^-$

ii) $K_a = \frac{[H^+] \cdot [HCOO^-]}{[HCOOH]}$

d) $[H^+] = K_a \cdot \frac{c_{hape}}{c_{sool}} \Rightarrow K_a \cdot \frac{n(hape)}{n(sool)}$

$[H^+]$ = $1{,}80 \cdot 10^{-4}\ \text{mol/dm}^3 \cdot \frac{0{,}329}{0{,}043}$ = **$1{,}38 \cdot 10^{-3}$ M**

e) pH = -lg $1{,}38 \cdot 10^{-3}$ = 2,86 **~ 2,9**

2. a) **i)** $4HCl + 1MnO_2 = 1Cl_2 + 1MnCl_2 + 2H_2O$
A

ii) n(Cl_2) = $\frac{1}{4} \cdot 75{,}0\ \text{cm}^3 \cdot 1{,}15\ \text{g/cm}^3 \cdot 0{,}8 \cdot 0{,}3 \cdot \frac{1\ \text{mol}}{36{,}5\ \text{g}}$ = 0,1418 mol ≈ **0,142 mol**

b) **i)** $2KBr + Cl_2 = 2KCl + Br_2$
B **A** **C**

ii) **A** – Cl_2, kloor
B – KBr, kaaliumbromiid
C – Br_2, broom

c) **i) n(Br_2)** = $\frac{1}{1} \cdot 0{,}142\ \text{mol}$ = **0,142 mol**

ii) n(KBr) = $\frac{2}{1} \cdot 0{,}142\ \text{mol} =$ **0,284 mol**

d) m(KBr) = 0,284 mol·119 g/mol = 33,796 g

m(lahus) = 33,796 g·$\frac{100\%}{5\%}$ = 675,92

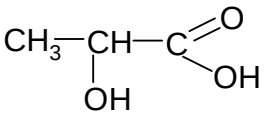
m(H_2O) = 675,92 g - 33,796 g = 642,12 ≈ **642 g**

e) **i)** $H_2O + Cl_2 \Leftrightarrow HCl + HClO$

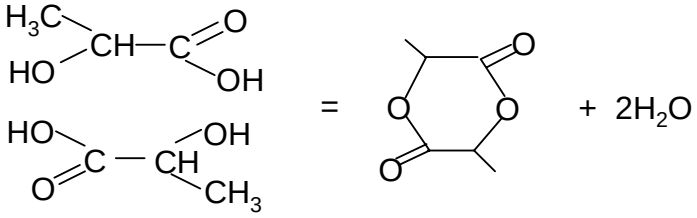
ii) HCl, vesinikkloriid
HClO, hüpokloorishape

f) %(HCl+HClO) = $\frac{0{,}015mol \cdot 36{,}5g/mol + 0{,}015mol \cdot 52{,}5g/mol}{100g + 0{,}015mol \cdot 71g/mol} \cdot 100 = 1{,}3$

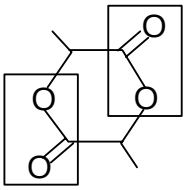
3. a) i) $CH_3CH(OH)COOH$;

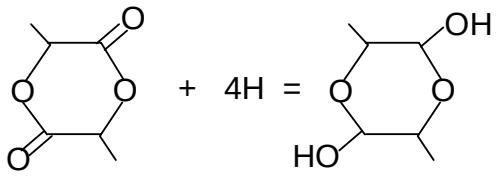
ii) 

2-hüdroksüpropaanhape

b) 

2A **B** **D**

c) 

d) 

B

e) $H_2O \rightleftharpoons H^+ + OH^-$

D

4. a) i) m($CuSO_4$) = $3{,}82\ \text{g (kr - h)} \cdot \frac{160\ \text{g (vv)}}{250\ \text{g (kr - h)}}$ = **2,44 g**

ii) m(H_2O) = 3,82 g - 2,44 g = **1,38 g**

b) m($CuSO_4$, küllastunud lahusest) = 2,44 g - 2,00 g = 0,44 g

L($CuSO_4$) = $\frac{0{,}44\ \text{g}}{1{,}38\ \text{g}} \cdot 100\ \text{g}$ = **32 g**

c) %($CuSO_4$, **B**) = $\frac{17{,}5\ \text{g}}{117{,}5\ \text{g}} \cdot 100$ = 14,9

$$0{,}149 = \frac{75\ \text{g} \cdot 0{,}1 + X \cdot \frac{160}{250}}{75\ \text{g} + X}$$

X = **7,5 g ($CuSO_4 \cdot 5H_2O$)**

5. a) i) Moodustunud karbiidi **A** valemist ja ühendi **D** amfoteersusest järeldub:

X – Al, alumiinium
A – Al_4C_3, alumiiniumkarbiid
B – CH_4, metaan
D – $Al(OH)_3$, alumiiniumhüdroksiid
E – C_2H_2, etüün
F – C_2H_4, eteen
G – C_2H_6, etaan
I – C_6H_6, benseen

ii) $Al{\equiv}C{-}Al{=}C{=}Al{-}C{\equiv}Al$

b) i) $4Al + 3C = Al_4C_3$
X **A**

ii) $Al_4C_3 + 12H_2O = 3CH_4 + 4Al(OH)_3$
A **B** **D**

iii) $Al(OH)_3 + 3HCl = AlCl_3 + 3H_2O$
D

iv) $Al(OH)_3 + 3NaOH = Na_3[Al(OH)_6]$ või $Na[Al(OH)_4]$
D

v) $2CH_4 \xrightarrow{^{o}t\,^{o}t} C_2H_2 + 3H_2$
B **E**

vi) $C_2H_2 + H_2 = C_2H_4$
E **F**

vii) $C_2H_2 + 2H_2 = C_2H_6$
E **G**

viii) $C_2H_2 + H_2O = CH_3CHO$
E **etanaal**

ix) $C_2H_4 + HOH = CH_3CH_2OH$
F **etanool**

x) $3C_2H_2 = C_6H_6$;

c) $M(CH_4) = 16$ g/mol, kõige kergem orgaaniline molekul

$M(C_2H_2) = 16 \text{ g/mol} \cdot 1{,}625 = 26 \text{ g/mol}$

$M(C_2H_4) = (26 \text{ g} + 2 \text{ g})\frac{1}{\text{mol}} = 28 \text{ g/mol}$

$M(C_2H_6) = (26 \text{ g} + 4 \text{ g})\ \frac{1}{\text{mol}} = 30 \text{ g/mol}$

6. a) m(**Y**) ⇔ 2,03 (Ag)

107,9 + **A** ⇔ 107,9 $\qquad \frac{m}{107{,}9 + \mathbf{A}} = \frac{2{,}03}{107{,}9}$

m(**X**) ⇔ 2,00 (Hg)

200,6 + 2**A** ⇔ 200,6 $\qquad \frac{m}{200{,}6 + 2\mathbf{A}} = \frac{2{,}00}{200{,}6}$

$$\frac{200{,}6 + 2A}{107{,}9 + A} = \frac{2{,}03}{107{,}9} \cdot \frac{200{,}6}{2{,}00}$$

$$\frac{200{,}6 + 2A}{107{,}9 + A} = 1{,}887$$

$200{,}6 + 2A = 203{,}6 + 1{,}887A$

$0{,}113A = 3{,}0$

$A = 26{,}5$

$M_r(\mathbf{A}) = \mathbf{26}$

Märkus: Valemmass (molekulmass) on suhteline mass, kus ühikud taanduvad. Seepärast pole vaja untse ümber teisendada.

b) i) HA – HCN, vesiniktsüaniidhape

ii) $M(\mathbf{B}) = 44 \text{ g/mol} \cdot 1{,}182 = 52 \text{ g/mol}$

B – $(CN)_2$, ditsüaan

c) i) $Hg(CN)_2 \xrightarrow{t^\circ} Hg + (CN)_2$

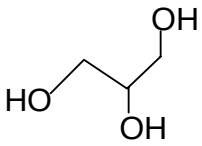
ii) $2AgCN \xrightarrow{t^\circ} 2Ag + (CN)_2$

iii) $(CN)_2 + 2NaOH = NaCN + NaOCN + H_2O$

d) $Cl_2 + 2NaOH = NaCl + NaOCl + H_2O$

2001/2002 õa keemiaolümpiaadi piirkonnavooru
ülesannete lahendused
12. klass

1. a)



-I 0 -I

b) $C_3H_8O_3$ $CH_2OH–CHOH–CH_2OH$

3x+8-6=0 $x = -\frac{2}{3}$

c) i) 3·(-2/3) (-) 3·IV

$3C^{VII} + 14e^{-} = 3C^{III}$ | 4

$Mn^{VII} + 4e^{-} = Mn^{III}$ | 14

ii) $4C_3H_8O_3 + 14KMnO_4 = 7K_2CO_3 + 7Mn_2O_3 + 5CO_2 + 16H_2O$

d) $\mathbf{V(C_3H_8O_3)} = \frac{4}{14} \cdot 100\ \text{g} \cdot \frac{1\ \text{mol}}{158\ \text{g}} \cdot 92{,}0\ \text{g/mol} \cdot \frac{1\ \text{cm}^3}{1{,}26\ \text{g}} = \mathbf{0{,}132\ cm^3}$

e) $\mathbf{V(CO_2)} = \frac{5}{14} \cdot 100\ \text{g} \cdot \frac{1\ \text{mol}}{158\ \text{g}} \cdot 22{,}4\ \text{dm}^3/\text{mol} \cdot \frac{293\text{K}}{273\text{K}} = 0{,}0543\ \text{dm}^3 \approx \mathbf{54{,}3\ cm^3}$

2. a) i) veripunane;

ii) $[Fe(H_2O)_5CSN]^{2+}$; $[Fe(H_2O)_4(CSN)_2]^{+}$; $[Fe(H_2O)_3(CSN)_3]$; $[Fe(H_2O)_2(CSN)_4]^{-}$; $[Fe(H_2O)(CSN)_5]^{2-}$; $[Fe(CSN)_6]^{3-}$

iii) $Fe(NO_3)_3 + KCSN + 5H_2O = [Fe(H_2O)_5(CSN)](NO_3)_2 + KNO_3$

b) i) Lahus lahjeneb ja värvuse intensiivsus väheneb.

ii) Raua värviliste komplekside arv väheneb ja värvuse intensiivsus kahaneb

$6F^{-} + Fe^{3+} = [FeF_6]^{3-}$

iii) Raua komplekside arv väheneb ja värvuse intensiivsus kahaneb

$Ag^{+} + CSN^{-} = AgCSN\downarrow$

$Ag^{+} + 2CSN^{-} = [Ag(CSN)_2]^{-}$

iv) Raua komplekside arv suureneb ja värvuse intensiivsus suureneb

$Fe^{3+} + CSN^{-} + 5H_2O = [Fe(H_2O)_5(CSN)]^{2+}$.

3. a) i) $C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6$

sahharoos **glükoos** **fruktoos**

ii) aldehüüdrühm on glükoosi molekulis – aldoos (aldoosheksoos)
ketorühm on fruktoosi molekulis – ketoos (ketoosheksoos)

b) i) $C_6H_{12}O_6 + O_2 = 2CH_3COCOOH + 2H_2O$

2-oksopropaanhape ehk

α-oksopropaanhape (püroviinamarihape)

ii) $C_6H_{12}O_6$ = $2CH_3CHOHCOOH$

2-hüdroksopropaanhape ehk

α-hüdroksopropaanhape (piimhape)

c) i) $C_{12}H_{22}O_{11} + 12O_2 = 12CO_2 + 11H_2O$

ii) $\mathbf{V(CO_2)} = \frac{12}{1} \cdot 5 \cdot 200\ cm^3 \cdot 1{,}017\ g/cm^3 \cdot 0{,}0305 \cdot \frac{1\,mol}{342\ g} \cdot$

$\cdot 22{,}4\ dm^3/mol \cdot \frac{293K}{273K} = 26{,}16\ dm^3 \approx \mathbf{26{,}2\ dm^3}$

d) **1** $C_{12}H_{22}O_{11}$ ⇔ **4** $CH_3CHOHCOOH$

sahharoos **B**

$n(CH_3CHOHCOOH) = \frac{4}{1} \cdot 5 \cdot 200\ cm^3 \cdot 1{,}017\ g/cm^3 \cdot 0{,}0305 \cdot \frac{1\,mol}{342\ g} = 0{,}3628\ mol$

$c(CH_3CHOHCOOH) = \frac{0{,}3628 mol}{7{,}50\ dm^3} = 0{,}04837\ mol/dm^3$

$[H^+] = \sqrt{1{,}38 \cdot 10^{-4} \cdot 0{,}04837} = 0{,}002584\ mol/dm^3$

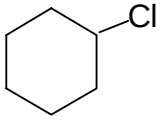
pH = -lg 0,002584 = **2,59**

4. a) i) $M_r(\mathbf{B}) = 35{,}45 \cdot \frac{1}{0{,}299} = 118{,}6\ g$

$N(C) = 118{,}6 \cdot 0{,}608 \cdot \frac{1}{12} = 6$

$N(H) = 118{,}6 \cdot (1 - 0{,}608 - 0{,}299) \cdot \frac{1}{1} = 11$

B – $C_6H_{11}Cl$. Et süsiniku aatomite vahel on ainult σ–sidemed, siis see ühend peab olema tsükliline.



ii) $M(\mathbf{E}) = 80{,}07\ g/mol \cdot 1{,}455 = 116{,}5\ g/mol$ $M_r(\mathbf{E}) = 116{,}5$

%(Cl) + %(S) + %(O) = 30,43 + 27,52 + 41,19 = 99,14

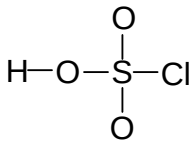
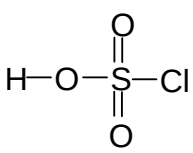
Puuduv 0,86% kuulub vesinikule (kloroväävelhape)

$N(H) = 116{,}5 \cdot 0{,}0086 \cdot \frac{1}{1} = 1$

$N(Cl) = 116{,}5 \cdot 0{,}3043 \cdot \frac{1}{35{,}45} = 1$

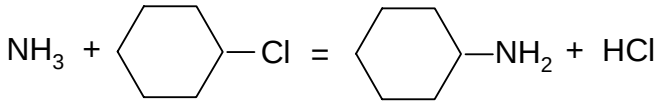
$N(S) = 116{,}5 \cdot 0{,}2752 \cdot \frac{1}{32{,}07} = 1$

$N(O) = 116{,}5 \cdot 0{,}4119 \cdot \frac{1}{16{,}0} = 3$

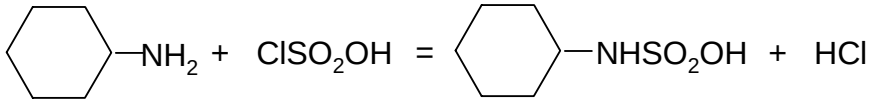
E — HSO_3Cl  või 

b) i) $NH_4Cl + NaOH = NH_3\uparrow + NaCl + H_2O$
D **A**

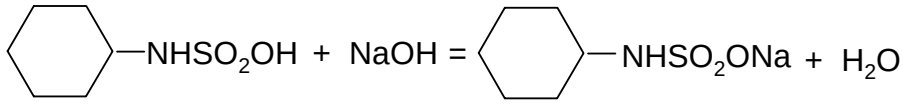
ii) $SO_3 + HCl = HOSO_2Cl$
K **E**

iii) 

A **B** **L** **K**

iv) 

L **E** **M** **K**

v) 

M **X** **F**

vi) $HCl + NH_3 = NH_4Cl$
K **A** **D**

vii) $SO_3 + H_2O = H_2SO_4$

c) A – NH_3, ammoniaak
D – NH_4Cl, ammooniumkloriid
K – HCl, vesinikkloriid
F – H_2O, vesi

5. Lahustunud aineks on väävelhape ja üheks ülesande lahendamise võimaluseks on protsentarvutus lahendusvalemi järgi.

x – võetud ooleumi mass

(480 g - x) – võetud 60,0% väävelhappe mass

$\frac{m(H_2SO_4)}{m(SO_3)} = \frac{98,1}{80,1} = 1,225$ – üleminekutegur ooleumis sisaldunud "vaba SO_3" massilt moodustunud H_2SO_4 massile

$$0,900 = \frac{x \cdot 0,100 \cdot 1,225 + x \cdot 0,9 + (480\text{ g} - x) \cdot 0,600}{480\text{ g}}$$

$432\text{ g} = 0,1225x + 0,900x + 288\text{ g} - 0,600x$

$0,4225x = 144\text{ g}$

$x = 340,8\text{ g} \approx 341\text{ g}$

m(ooleum) = **341 g**

m(60% H_2SO_4) = 480 g - 341 g = **139 g**

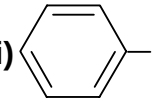
6. a) i) $^{\oplus}SO_2OH$

ii) $^{\oplus}NO_2$

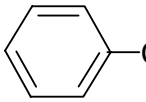
iii) aktiivsem on $^{\oplus}NO_2$, mis on tugevam elektrofiil

b) i)  , benseen

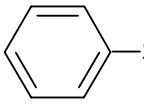
A

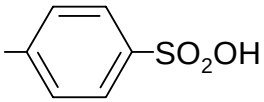
ii)  , fenüülmetaan e. metüülbenseen e. tolueen

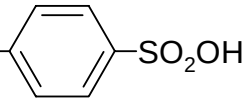
B

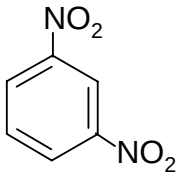
iii)  OH , hüdroksübenseen e. fenool

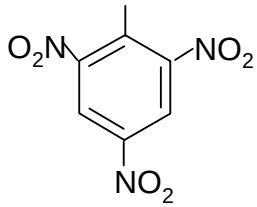
C

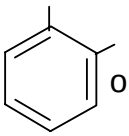
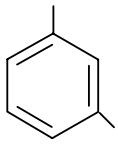
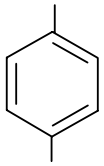
c) i)  + $HOSO_2OH$ =  + H_2O

ii) 

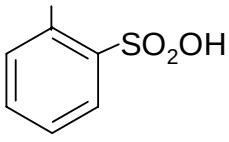
iii) HO 

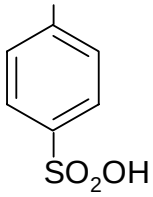
d) i) 

ii) 

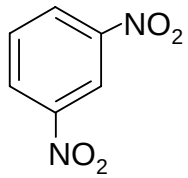
e) i)  orto-  meta-  para-

ii) kas orto- või para-asend





iii) meta-asend



f) H_2O Vett ei tohi valada väävelhappesse, seda enam ei tohi valada vett ooleumisse!