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8. klass

1. a) i) Hg, elavhõbe
ii) Br_2, broom

b) i) $1\ g/cm^3 \cdot \frac{1\ kg}{1000\ g} \cdot \frac{1000\ cm^3}{1\ dm^3} = 1\ kg/dm^3$

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

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

c) L(aine) = $\frac{20\ g\ (aine)}{80\ g\ (lahusti)} \cdot 100\ g\ (lahusti) =$ **25 g**

d) Aatomis on elektronide arv võrdne prootonite arvuga. Et prootoneid ja neutroneid on võrdselt, siis
i) A_r(**A**) = 2 + 2 = 4
A_r(**B**) = 3 · 2 + 3 · 2 = 12
ii) A – He, heelium
B – C, süsinik

e) CaF_2 – kaltsiumfluoriid; vesi – H_2O, (di)vesinikoksiid;
CaO – kaltsiumoksiid; Na_2S – naatriumsulfiid; $AlCl_3$ - alumiiniumkloriid.

2. a) A – S, väävel, tahke
B – O_2, hapnik, gaas
C – H_2, vesinik, gaas
D – K, kaalium, tahke

b) i) $S + O_2 = SO_2\uparrow$
ii) $O_2 + 2H_2 = 2H_2O$
iii) $2H_2O + 2K = 2KOH + H_2\uparrow$

3. a) $M_r(B_{12})$ = 63·12 + 90·1 + 14·16 + 14·14 + 31+ 59 = **1356**

b) i) %(Co) = $\frac{59}{1356} \cdot 100 = 4{,}35 \approx$ **4,4**

ii) %(H) = $\frac{90}{1356} \cdot 100 = 6{,}64 \approx$ **6,6**

c) Neutraalses molekulis võrdub kõikide aatomite oksüdatsiooniastmete summa nulliga
o.a.(**C**) ⇔ x·63 + 90·I + 14·(-II) + 14·(-III) + 1·V + 1·III = 0
63x = -90 + 28 + 42 - 5 - 3
63x = -28

$$\mathbf{x = -\frac{28}{63} = -\frac{4}{9}}$$

d) 59 g (Co) $\Leftrightarrow$ 1356 g (B_{12})

$$\mathbf{m(Co)} = 0{,}003\ \text{g} \cdot \frac{59\ \text{g}}{1356\ \text{g}} \cdot 365 = 0{,}0476\ \text{g} \approx \mathbf{0{,}05\ g}$$

4. a) i) $C + O_2 = CO_2$

ii) $2H_2 + O_2 = 2H_2O$

b) i) $P_4 + 5O_2 = P_4O_{10}$

ii) $4Al + 3O_2 = 2Al_2O_3$

c) i) $CH_4 + 2O_2 = CO_2 + 2H_2O$

ii) $2C_3H_6 + 9O_2 = 6CO_2 + 6H_2O$

5. a) $\mathbf{m(H_2O)}$ = 1008,7 g - 8,71 g = **1000,0 g**

b) m(õhk) = 10,00 g - 8,71 g = 1,29 g

$$\mathbf{\rho(õhk)} = \frac{1{,}29\ \text{g}}{1\ \text{dm}^3} = \mathbf{1{,}29\ g/dm^3}$$

c) H_2 lendub, sest on õhust kergem, CO_2 ei lendu, sest on õhust raskem.

d) $m(CO_2)$ = 10,67 g - 8,71 g = 1,96 g

$$\mathbf{\rho(CO_2)} = \frac{1{,}96\ \text{g}}{1\ \text{dm}^3} = \mathbf{1{,}96\ g/dm^3}$$

e) m(Hg) = 12560 + 1000 g (väljatõrjutud vee mass) - 10 g (anuma mass) = **13550 g**

6. a) Ained eralduvad keemistemperatuuri tõusu järjekorras. Esmalt eraldub benseen, siis vesi, järgneb jood, seejärel elavhõbe. Potas jääb tahke jäägina destillatsiooninõusse.

b) Jaotuslehtri abil saab puhta ainena kätte ainult elavhõbeda.

c) i) Jaotuslehtri abil eraldame elavhõbeda, seejärel potase vesilahuse. Jaotuslehtrisse jääb joodi lahus benseenis. Aurustame ettevaatlikult benseeni. Jäägiks on puhas jood.

ii) Eraldame jaotuslehtri abil algul elavhõbeda, seejärel potase vesilahuse. Aurutame vesilahuse kuivaks, saame puhta potase.

d)

Esimene seisak on	-39 ^{0}C, kus sulab elavhõbe;
teine	0 ^{0}C, kus sulab jää;
kolmas	5,5^{0}C, kus sulab benseen;
neljas	80^{0}C, kus aurustub benseen;
viies	100^{0}C, kus aurustub vesi;
kuues	357^{0}C, kus aurustub elavhõbe.

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9. klass

1. a) i) $3Fe + 4H_2O \xrightarrow{^0t^0t} Fe_3O_4 + 4H_2\uparrow$

ii) $Mg + H_2O(aur) \xrightarrow{^0t^0t} MgO + H_2\uparrow$

iii) $2Al + Cr_2O_3 \xrightarrow{^0t^0t} 2Cr + Al_2O_3$

b) i) Lämmastikhappega reageerimisel ei moodustu vesinik.

ii) $Zn + 2HCl = ZnCl_2 + H_2\uparrow$
$Zn + H_2SO_4 = ZnSO_4 + H_2\uparrow$

c) Au, kuld

d) proov(Ag) = $\frac{100}{125} \cdot 1000\,‰$ **= 800‰**

e) Üks mool ($6{,}02 \cdot 10^{23}$ tk) a.m.ü.-sid moodustavad massi 1 gramm.
$6{,}02 \cdot 10^{23}$ a.m.ü. $\cdot$ $1{,}66 \cdot 10^{-24}$ g/a.m.ü. = 0,999 g $\approx$1,00 g

f) $\mathbf{V_m(Fe)}$ **=** 56 g/mol $\cdot \frac{1\ cm^3}{7{,}9\ g}$ = 7,088 cm^3/mol $\approx$ **7,1 cm^3/mol**

g) Temperatuuri tõustes gaasi molaarruumala **suureneb**, sest gaas paisub.

2. a) i) Happelahus muudab indikaatorpaberi punaseks, leeliselahus siniseks

ii) A – $\mathbf{H_2SO_4}$ lahus
B – $\mathbf{Ba(OH)_2}$ lahus

iii) $H_2SO_4 + Ba(OH)_2 = BaSO_4\downarrow + 2H_2O$

b) i) $\mathbf{AgNO_3}$, hõbenitraat

ii) $AgNO_3 + NaCl = AgCl\downarrow + NaNO_3$
$2AgNO_3 + H_2SO_4 = Ag_2SO_4\downarrow + 2HNO_3$
$2AgNO_3 + Ba(OH)_2 = 2AgOH\downarrow + Ba(NO_3)_2$

c) NaCl

d) KNO_3

3. a) $\mathbf{D_{õhk}(NH_3)} = \frac{17\ g/mol}{29\ g/mol} = 0{,}586 \approx \mathbf{0{,}59}$

b) $\mathbf{V(NH_3)} = 550\ cm^3 \cdot 0{,}682\ g/cm^3 \cdot \frac{1\ mol}{17\ g} \cdot 24\ dm^3/mol = 529\ dm^3 \approx \mathbf{530\ dm^3}$

c) V(labor) = 6,0 m x 4,0 m x 3,0 m = 72 m^3
$m(NH_3) = 550\ cm^3 \cdot 0{,}682\ g/cm^3 = 375{,}1\ g$
$m(NH_3/m^3) = \frac{375{,}1\ g}{72\ m^3} \cdot \frac{1000\ mg}{g} \approx 5200\ mg/m^3$
$\frac{5200\ mg/m^3}{36\ mg/m^3} = 144 \approx \mathbf{140\ korda}$

d) $\mathbf{V(H_2O)} = 375{,}1\ g \cdot \frac{1}{5{,}0\ \%} \cdot 95\ \% \cdot \frac{1\ liiter}{1000\ g} = 7{,}13\ l \approx \mathbf{7{,}1\ l}$

4. a) $\mathbf{\%(karbamiid)} = \frac{108}{108+100} \cdot 100 = \mathbf{51{,}9}$

b) $0{,}0050 = \frac{m(lahus) \cdot 0{,}519}{m(lahus) + 1000\ g}$
$0{,}005m(lahus) + 5{,}0\ g = 0{,}519\ m(lahus)$
$\mathbf{m(lahus)} = \frac{5{,}0\ g}{0{,}514} = 9{,}73\ g \approx \mathbf{9{,}7\ g}$

c) $\mathbf{\%(karbamiid)} = \frac{1{,}0\ l \cdot 1{,}40\ kg/l \cdot 0{,}519}{1{,}0\ l \cdot 1{,}40\ kg/l + 15\ l \cdot 1{,}00\ kg/l} \cdot 100 = 4{,}43 \approx \mathbf{4{,}4}$

5. a) Vesiniku aatomid on lähteainetes ainult vesinikkloriidis ja hapniku aatomid on lähteainetes ainult kaaliumpermanganaadis. Nii tuleb HCl ette koefitsient 16 ja $KMnO_4$ ette koefitsient 2. Puuduolevad koefitsiendid saadusainete ees leitakse lähteainete koefitsientide järgi.

$2KMnO_4 + 16HCl = 2KCl + 2MnCl_2 + 5Cl_2 + 8H_2O$

b) i) n($KMnO_4$) = $79{,}0\ \text{g} \cdot \frac{1\ \text{mol}}{158\ \text{g}}$ **= 0,500 mol**

ii) n(HCl) = $1000\ \text{g}\ \ 0{,}365 \cdot \frac{1\ \text{mol}}{36{,}5\ \text{g}}$ **= 10,0 mol**

c) $2KMnO_4 \Leftrightarrow 16HCl$

n($KMnO_4$ kulub) = $\frac{2}{16} \cdot 10{,}0\ \text{mol}$ **= 1,25 mol**

d) $KMnO_4$ on vähem, kui kogu HCl jaoks kulub. Seega HCl on liias.
Arvutada tuleb $KMnO_4$ järgi.

79,0 g V
$2KMnO_4 \Leftrightarrow 5Cl_2$
158 g/mol 22,4 dm^3/mol

V(Cl_2) = $\frac{5}{2} \cdot 79{,}0\ \text{g} \cdot \frac{1\ \text{mol}}{158\ \text{g}} \cdot 22{,}4\ \text{dm}^3/\text{mol}$ **= 28,0 dm^3**

Kloori ruumala saame leida ka varemarvutatud $KMnO_4$ hulga järgi.

$V(Cl_2) = \frac{5}{2} \cdot 0{,}500\ \text{mol} \cdot 22{,}4\ \text{dm}^3/\text{mol} = 28{,}0\ \text{dm}^3$

6. a) Liitainete lahustamisel annavad leelise lahuse leelismetallide ja leelismuldmetallide hüdroksiidid ja oksiidid.

b) Leelismuldmetallide karbonaadid on vees lahustumatud.

c) i) $X(OH)_2 + CO_2 = XCO_3 + H_2O$ $Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$

ii) $XCO_3 \xrightarrow{t^0} XO + CO_2\uparrow$; $CaCO_3 \xrightarrow{t^0} CaO + CO_2\uparrow$
A **B** **A** **B**

d) i) $m(CO_2) = 1{,}190\ \text{g} - 0{,}667\ \text{g} = 0{,}523\ \text{g}$

Reaktsioonis **c) ii)** on osalevate ainete moolide suhe 1 : 1 : 1

$M(\mathbf{B}) = 44\ \text{g/mol} \cdot \frac{1}{0{,}523\ \text{g}} \cdot 0{,}667\ \text{g} = 56{,}1\ \text{g/mol}$

M(CaO) = 56,1 g/mol. Sama molaarmass peab olema ka teisel lahustatud ainel

ii) Aine **B** – **CaO**, kaltsiumoksiid on esimene lahustatud aine, sest esimene lahustatav aine saadi teistkordselt moodustunud $CaCO_3$ kuumutamisel.

iii) CaO lisamisel filtraadile **F** moodustus $CaCO_3$. Filtraat **F** peab sisaldama ekvivalentse koguse karbonaatioone, mis said tekkida leelismetalli hüdroksiidi lahuses ekvivalentse koguse CO_2 neeldumisel. teine lahustatud aine on **KOH**. M(KOH) = 56,1 g/mol.

e) $2KOH + CO_2 = K_2CO_3 + H_2O$

$K_2CO_3 + CaO + H_2O = CaCO_3 + 2KOH$

$^{0}t^{0}t$

$2KOH + CaCO_3 = 2KOH + CaO + CO_2\uparrow$

f) $2KOH \Leftrightarrow CaO$

Et molaarmassid on võrdsed, siis

m(KOH) = $\frac{2}{1} \cdot 0{,}667 \approx$ **1,33 g**

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10. klass

1. a) gaasilise

b) kristallvõre lõhkumine ja hüdraatide (solvaatide) moodustumine.

-III V
c) $\mathbf{NH_4NO_3}$

d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$

e) i) $2H_2 + O_2 = 2H_2O$ $\Delta H < 0$, eksotermiline

ii) $2H_2O = 2H_2 + O_2$ $\Delta H > 0$, endotermiline

f) i) Na, pH>7, moodustub alus
Cl_2, pH<7, moodustub (kaks) hapet
S_8, pH=7, ei lahustu vees

ii) SiO_2, pH=7, ei lahustu vees
CaO, pH>7, moodustub alus
SO_2; pH<7, moodustub hape

iii)

$Fe(OH)_3$,	pH=7,	ei lahustu vees
HCl,	pH<7,	vees lahustuv hape
NaOH,	pH>7,	vees lahustuv alus
CH_3COOH,	pH<7,	vees lahustuv hape

iv)

NH_4Cl,	pH<7,	tugeva happe ja nõrga aluse sool
NaCl,	pH=7,	tugeva happe ja tugeva aluse sool
Na_2CO_3,	pH>7,	tugeva aluse ja nõrga happe sool

2. a) i) $Ca(OH)_2 + 2HCl = CaCl_2 + 2H_2O$
$CaCO_3 + 2HCl = CaCl_2 + CO_2\uparrow + H_2O$

ii) SiO_2

b) $Ca^{2+} \Leftrightarrow$ EDTA

$$c(Ca^{2+}) = \frac{1}{1} \cdot 0{,}0250\ \text{mol/dm}^3 \cdot 20{,}0\ \text{cm}^3 \cdot \frac{1}{5{,}00\ \text{cm}^3} = 0{,}100\ \text{mol/dm}^3$$

$$n(Ca^{2+}) = 100\ \text{ml} \cdot \frac{1\ \text{dm}^3}{1000\ \text{ml}} \cdot 0{,}100\ \text{mol/dm}^3 = 0{,}0100\ \text{mol}$$

i) $Ca^{2+} \Leftrightarrow CaO$

$m(CaO) = 0{,}0100\ mol \cdot 56{,}1\ g/mol = 0{,}561\ g$

%(CaO) = $\frac{0{,}561\ g}{3{,}00\ g} \cdot 100$ = **18,7**

ii) $Ca^{2+} \Leftrightarrow CaCO_3$

$m(CaCO_3) = 0{,}0100\ mol \cdot 100\ g/mol = 1{,}00\ g$

%($CaCO_3$) = $\frac{1{,}00\ g}{3{,}00\ g} \cdot 100$ = **33,3**

c) i) $C + O_2 = CO_2$

ii) $Ca(OH)_2 + CO_2 = CaCO_3\downarrow + H_2O$

3. a) A – $K_2Cr_2O_7$, kaaliumdikromaat
B – $Cr_2(SO_4)_3$, kroom(III)sulfaat
C – $Cr(OH)_3$, kroom(III)hüdroksiid
D – K_2CrO_4, kaaliumkromaat

b) i) $K_2Cr_2O_7 + 2KOH = 2K_2CrO_4 + H_2O$

ii) $2Cr(OH)_3 + 3H_2SO_4 = Cr_2(SO_4)_3 + 6H_2O$

c)

$$\overset{VI}{2K_2Cr_2O_7} + 3\overset{-II}{C_2H_5OH} + 8H_2SO_4 = \overset{III}{2Cr_2(SO_4)_3} + 2K_2SO_4 + 3\overset{0}{CH_3COOH} + 11H_2O$$

$2 \cdot VI \ (-) \ 2 \cdot III$
$Cr_2 + 6e^- \rightarrow 2Cr$ | 2
$2 \cdot (-II) \ (-) \ 2 \cdot 0$
$C_2 - 4e^- \rightarrow C_2$ | 3

4. a) Ühendi **A** valem on $\mathbf{X}_2O_2$

M(**X**) = $32\ g/mol \cdot \frac{1}{41\%} \cdot 59\% \cdot \frac{1}{2} =$ 23 g/mol

X – Na, naatrium

Ühendi **B** valem on $Y\mathbf{O_2}$

M(**Y**) = $32\ g/mol \cdot \frac{1}{45\%} \cdot 55\%$ = 39 g/mol

Y – K, kaalium

b) **A** – Na_2O_2, naatriumperoksiid
B – KO_2, kaaliumhüperoksiid

c) i) $2\ Na_2O_2 + 2CO_2 = 2Na_2CO_3 + \ O_2$

ii) $4KO_2 + 2CO_2 = \ 2K_2CO_3 \ + 3O_2$

d) i) $2Na_2O_2 \Leftrightarrow 2CO_2$ $\qquad$ $4KO_2 \Leftrightarrow 2CO_2$
$M(Na_2O_2) = 78{,}0$ g/mol $\qquad$ $M(KO_2) = 71{,}1$ g/mol

$n(CO_2) = \frac{2}{2} \cdot \frac{1000\ \text{g}}{78{,}0\ \text{g/mol}} = 12{,}8$ mol

$\mathbf{m(KO_2)} = \frac{4}{2} \cdot 12{,}8\ \text{mol} \cdot 71{,}1\ \text{g/mol} = 1820$ g = **1,82 kg**

ii) $2Na_2O_2 \Leftrightarrow O_2$ $\qquad$ $4KO_2 \Leftrightarrow 3O_2$

$\mathbf{m(KO_2)} = \frac{4}{3} \cdot \frac{1}{2} \cdot \frac{1000\ \text{g}}{78{,}0\ \text{g/mol}} \cdot 71{,}1\ \text{g/mol} = 607{,}6$ g $\approx$ **0,608 kg**

5. a) **A** – HCOOH, sipelghape
B – CO, süsinikmonooksiid
C – H_2O, vesi

b) $(COOH)_2$

i) $HCOOH \xrightarrow{^0t} CO + H_2O$

ii) $2NaOH + (COOH)_2 = (COONa)_2 + 2H_2O$

6. a) Metalli **X** oksüdatsiooniaste soolas **D** on I ja soolas **E** on III. Seda tõestavad järgmised andmed: 1**B** $\Leftrightarrow$ 2**D**; 1**E** $\Leftrightarrow$ $3AgNO_3$. Sama vooluga sama koguse metalli saamiseks soolast **E** kulub aega kolm korda rohkem kui soolast **D**.

b) i) $2\mathbf{X} + H_2SO_4 = \mathbf{X}_2SO_4 + H_2$

ii) $\mathbf{X}_2SO_4 + BaCl_2 = 2\mathbf{X}Cl + BaSO_4\downarrow$

iii) $\mathbf{X}Cl_3 + 3AgNO_3 = 3AgCl + \mathbf{X}(NO_3)_3$

c) i) **G** – X_2O_3

$$\mathbf{M(X)} = 16\ \text{g/mol} \cdot 3 \cdot \frac{1}{10{,}53\%} \cdot 89{,}47\% \cdot \frac{1}{2} = 203{,}9\ \text{g/mol} \approx \mathbf{204\ g/mol}$$

ii) 9,11 g 0,50$\underline{0}$ dm^3

2**X** $\Leftrightarrow$ H_2

M 22,4 dm^3/mol

$$9{,}11\ \text{g} = \frac{2}{1} \cdot 0{,}50\underline{0}\ \text{dm}^3 \cdot \frac{1\ \text{mol}}{22{,}4\ \text{dm}^3} \cdot \text{M}(\mathbf{X})$$

M(**X**) = **204 g/mol**

iii) 10,0 g 10,0 A·473 s

X $\Leftrightarrow$ e^-

M 96500 A·s/mol

$$10{,}0\ \text{g} = \frac{1}{1} \cdot \frac{10{,}0\ \text{A} \cdot 473\ \text{s}}{96500\ \text{A} \cdot \text{s/mol}} \cdot \text{M}(\mathbf{X})$$

M(**X**) = **204 g/mol**

d) X– Tl, tallium

A – H_2SO_4, väävelhape

B – Tl_2SO_4, tallium(I)sulfaat

C – $BaCl_2$, baariumkloriid

D – TlCl, tallium(I)kloriid

E – $TlCl_3$, tallium(III)kloriid

F - AgCl, hõbekloriid

G – Tl_2O_3, tallium(III)oksiid

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11. klass

1. a) $M(SCl_2) = 103$ g/mol

$n(SCl_2)$ $= 15{,}5\ \text{g} \cdot \frac{1\ \text{mol}}{103\ \text{g}} \approx$ **0,150 mol**

b) n(Cl) $= 15{,}5\ \text{g} \cdot \frac{1\ \text{mol}}{103\ \text{g}} \cdot 2 \approx$ **0,301 mol**

c) N(S) $= 15{,}5\ \text{g} \cdot \frac{1\ \text{mol}}{103\ \text{g}} \cdot 1 \cdot 6{,}02 \cdot 10^{23}$ aatomit / mol **= $9{,}06 \cdot 10^{22}$ aatomit**

d) II

e) $V_M = 22{,}4\ \text{dm}^3/\text{mol} \cdot \frac{300\ \text{K}}{273\ \text{K}} \cdot \frac{1\ \text{atm}}{0{,}100\ \text{atm}} = 246{,}15\ \text{dm}^3/\text{mol}$

$\rho(SCl_2)$ $= 103\ \text{g/mol} \cdot \frac{1\ \text{mol}}{246{,}15\ \text{dm}^3} \approx$ **0,418 g/dm^3**

f) $SCl_2 \Leftrightarrow Cl_2$

$V(Cl_2)$ $= 15{,}5\ \text{g} \cdot \frac{1\ \text{mol}}{103\ \text{g}} \cdot 22{,}4\ \text{dm}^3/\text{mol} \approx$ **3,37 liitrit**

g) $4HCl + MnO_2 = MnCl_2 + Cl_2 + 2H_2O$

h) **$m(MnO_2)$** $= \frac{1}{1} \cdot 0{,}150\ \text{mol} \cdot \frac{100\%}{92{,}0\%} \cdot 86{,}9\ \text{g/mol} \approx$ **14,2 g**

i) $16SCl_2 + 24H_2O = 1S_8 + 8H_2SO_3 + 32HCl$

$8 \cdot 0$ (-) $8 \cdot II$

$S_8 - 16e^- \rightarrow 8S$ | 1

IV (-) II |

$S + 2e^- \rightarrow S$ | 8

2. a) A – HF, vesinikfluoriid, gaas
B – HCl, vesinikkloriid, gaas
C – HBr, vesinikbromiid, gaas
D – HI, vesinikjodiid, gaas
E – $KMnO_4$, kaaliumpermanganaat, tahke
F – Br_2, broom, vedelik

b) i) $HCl + NaOH = NaCl + H_2O$

ii) $16HBr + 2KMnO_4 = 2KBr + 2MnBr_2 + 5Br_2 + 8H_2O$

II (-) VII

$Mn - 5e^- \rightarrow Mn$ | 2

$2\cdot 0$ (-) $2\cdot(-I)$ |

$Br_2 + 2e^- \rightarrow 2Br$ | 5

iii) $6HF + Na_2SiO_3 = Na_2SiF_6 + 3H_2O$

3. a) i) X – N, lämmastik
Y – H, vesinik
Z – O, hapnik

ii) $\mathbf{X_2Y_4}$ – $NH_2–NH_2$, hüdrasiin
$\mathbf{Y_2}Z_2$ – H–O–O–H, vesinikperoksiid
$\mathbf{X_3H}$ – HN_3, vesiniklämmastikhape, азотистоводородная кислота
$\mathbf{X_2Z}$ – N_2O, naerugaas, dilämmastikmonooksiid

b) i)
I $2N_2H_4 + 2H_2O_2 = HN_3 + NH_3 + 4H_2O$
II $2NO_2 + H_2O = HNO_3 + HNO_2$
III $2NO + O_2 = 2NO_2$
IV $NO + NO_2 = N_2O_3$
V $NH_4NO_3 = N_2O + 2H_2O$
VI $NH_4NO_2 = N_2 + 2H_2O$
VII $4NH_3 + 5O_2 = 4NO + 6H_2O$
VIII $4NH_3 + 3O_2 = 2N_2 + 6H_2O$

ii) Reaktsioon VII toimub Pt katalüsaatoril.

4. a)

propadieen	$CH_2=C=CH_2$	C_3H_4
propeen	$CH_3CH=CH_2$	C_3H_6
1,4-pentadieen	$CH_2=CHCH_2CH=CH_2$	C_5H_8
4-hepteen-1-üün	$CH_3CH_2CH=CH–CH_2C\equiv CH$	C_7H_{10}

b)
$C_3H_4 + \mathbf{2}H_2 = C_3H_8$
$C_3H_6 + \mathbf{1}H_2 = C_3H_8$
$C_5H_8 + \mathbf{2}H_2 = C_5H_{12}$
$C_7H_{10} + \mathbf{3}H_2 = C_7H_{16}$

c)
$C_3H_4 + 4O_2 = \mathbf{3}CO_2 + 2H_2O$
$\mathbf{2}C_3H_6 + 9O_2 = \mathbf{6}CO_2 + 6H_2O$
$C_5H_8 + 7O_2 = \mathbf{5}CO_2 + 4H_2O$

$$\mathbf{2}C_7H_{10} + 19O_2 = \mathbf{14}CO_2 + 10H_2O$$

d) 4-hepteen-1-üünis on kolmiksideme juures olevad süsiniku aatomid sp–hübriidses olekus.

e) Olgu $n(C_3H_4)$ = a mooli
$n(C_3H_6)$ = b mooli
$n(C_5H_8)$ = c mooli
$n(C_7H_{10})$ = d mooli, siis
$n(H_2) = 2a + 1b + 2c + 3d$
$n(CO_2) = 3a + 3b + 5c + 7d$
Et $2n(H_2) = n(CO_2)$, siis
$2(2a + 1b + 2c + 3d) = 3a + 3b + 5c + 7d$, millest
$a = b + c + d$ (võrrand I)
$a + b + c + d = 100\%vol$, siis
$100\%vol - a = b + c + d$ (võrrand II)
Võrranditest I ja II
$a = 100\%vol - a$
a = 50%vol

5. a) i) $2I^- = I_2 + 2e^-$
ii) anoodil

b) $H_2S + I_2 = S + 2HI$

c) i) $I_2 \Leftrightarrow 2e^-$

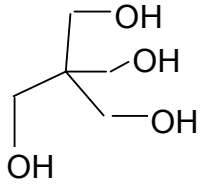
$$\mathbf{n(I_2)} = \frac{1}{2}\cdot(2\cdot 60\ \text{s} + 50\ \text{s})\cdot 0{,}018\ \text{A}\cdot\frac{1\ \text{mol}}{96500\ \text{A}\cdot\text{s}} = 1{,}59\cdot10^{-5}\ \text{mol} \approx \mathbf{1{,}6\cdot10^{-5}\ mol}$$

ii) $n(I_2) \Leftrightarrow n(H_2S)$
$\mathbf{m(H_2S)} = 1{,}58\cdot10^{-5}\ \text{mol}\cdot 34\ \text{g/mol} = 5{,}39\cdot10^{-4}\ \text{g} \approx \mathbf{5{,}4\cdot10^{-4}\ g}$

d) sisaldus $(H_2S) = 5{,}4\cdot10^{-4}\ \text{g}\cdot\frac{1000\ \text{mg}}{1\ \text{g}}\cdot\frac{1}{2\ \text{l}} = 0{,}27\ \text{mg/l}$

sisaldus (H_2S) ületab lubatud normi $\frac{0{,}27\ \text{mg/l}}{0{,}01\ \text{mg/l}}$ = **27 korda**

6. a) i)



ii) $C(CH_2OH)_4 + 4HNO_3 = C(CH_2ONO_2)_4 + 4H_2O$

b) $C(CH_2ONO_2)_4 = 2N_2\uparrow + 4H_2O\uparrow + 3CO_2\uparrow + 2CO\uparrow$

c) n(pentriit) = $15\ \text{dm} \cdot 0{,}10 \cdot 0{,}10\ \text{dm}^2 \cdot 1{,}7\ \text{g/cm}^3 \cdot \frac{1000\ \text{cm}^3}{1\ \text{dm}^3} \cdot \frac{1\ \text{mol}}{316\ \text{g}}$ = 0,81 mol

n(gaasid pentriidist) = $\frac{11}{1} \cdot 0{,}81\ \text{mol}$ = 8,91mol ≈ 9 mol

n(CO_2) = $15\ \text{dm} \cdot 0{,}90 \cdot 0{,}10\ \text{dm}^2 \cdot 1{,}5\ \text{g/cm}^3 \cdot \frac{1000\ \text{cm}^3}{1\ \text{dm}^3} \cdot \frac{1\ \text{mol}}{44\ \text{g}}$ = 46 mol

Σn(gaasid) = 46 mol + 9 mol = 55 mol

p = $55\ \text{mol} \cdot 0{,}082 \frac{\text{atm} \cdot \text{dm}^3}{mol \cdot K} \cdot 833\ K \cdot \frac{1}{1{,}5\ \text{dm}^3}$ ≈**2500 atm**

d) V = $55\ \text{mol} \cdot 22{,}4\ \text{dm}^3 / mol \cdot \frac{283}{273}$ = 1277 dm^3 ≈ **1300 dm^3**

2002/2003 õa keemiaolümpiaadi piirkonnavooru
ülesannete lahendused
12. klass

1. a) i) Pb elektrood on (-), sest sellel on elektronide liig, PbO_2 elektrood on (+), sest sellel on elektronide defitsiit. **ii)** Aku tühjenemisel toimub (-) elektroodil anoodprotsess ja (+) elektroodil toimub katoodprotsess. **iii)** Aku laadimisel toimub (-) elektroodil katoodprotsess ja (+) elektroodil toimub anoodprotsess.

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

$2\cdot(-I)$ (-) $2\cdot IV$ | $S_2 - 10e^- \rightarrow 2S$ | II (-) III | $Fe - 1e^- \rightarrow Fe$ | $2\cdot 0$ (-) $2\cdot(-II)$ | $O_2 + 4e^- \rightarrow O$ | $-11e^-$ | $+4e^-$

c) $O_2 \Leftrightarrow 4e^-$

$n(e^-) = \frac{4}{1}\cdot 3\ \text{mol} = 12\ \text{mol}$ $\qquad$ $1F \Leftrightarrow 1\ \text{mol}(e^-) \Leftrightarrow 96500\ A\cdot s$

n(F) = 12

d) $2C_2H_5OH \xrightarrow{H_2SO_4} C_2H_5OC_2H_5 + H_2O$ või
$C_2H_5ONa + C_2H_5I = C_2H_5OC_2H_5 + NaI$

e) Al mass on suurem, sest väiksema tiheduse tõttu “tõrjutakse” rohkem õhku välja, mille arvelt Al "kaotab oma kaalus".

f) Saadusainete mass on endotermilise reaktsiooni korral ($\Delta H>0$) suurem, sest saadusained on energiarikkamad.

g) m(tooraine, 99% niiskust) = $\frac{75\ \text{kg}\cdot 0{,}02}{0{,}01}$ **= 150 kg**

2. a) i) **X** – Pd, pallaadium
Y – Pt, plaatina

ii) **A** – $HC{\equiv}CH$, etüün
B – H_2O, vesi
C – $H_2C{=}CH_2$, eteen
D – CuCl, vask(I)kloriid
E – H_2, vesinik

b) i) $HC{\equiv}CH + H_2O \xrightarrow{HgO} CH_3CHO$

ii) $H_2C{=}CH_2 + H_2O + PdCl_2 = CH_3CHO + Pd + 2HCl$

iii) $Pd + 2CuCl_2 = PdCl_2 + 2CuCl$

iv) $2CuCl + 2HCl + 0{,}5O_2 = 2CuCl_2 + H_2O$

v) $HC{\equiv}CH + H_2 \xrightarrow{Pt} H_2C{=}CH_2$

vi) $CO + PdCl_2 + H_2O = CO_2 + Pd + 2HCl$

c) N(neutronid, Pt) = 195 - 78 = **117**
N(neutronid, Pd) = 106 - 46 = **60**

$$\frac{117}{60} = 1{,}95$$

3. a) i) M(süsivesinik) = 28,0 g/mol · 2,00 = **56,0 g/mol**

$$N(C) = 56{,}0\ \text{g/mol} \cdot 0{,}856 \cdot \frac{1\ \text{mol}}{12\ \text{g}} = 4$$

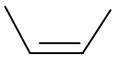
$$N(H) = 56{,}0\ \text{g/mol} \cdot 0{,}144 \cdot \frac{1\ \text{mol}}{1\ \text{g}} = 8$$

C_4H_8

b) $C_4H_8 + Br_2 = C_4H_8Br_2$

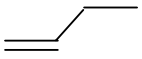
c)

2-metüül-1-propeen

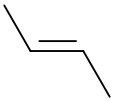


cis-2-buteen

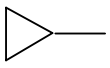
tsüklobutaan



1-buteen

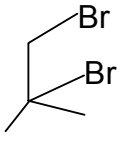


trans-2-buteen

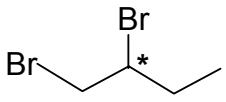


metüültsüklopropaan

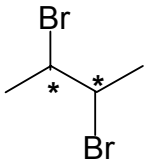
d)



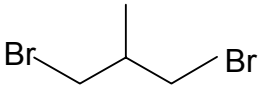
1,2-dibromo-2-metüülpropaan



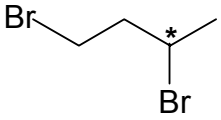
1,2-dibromobutaan



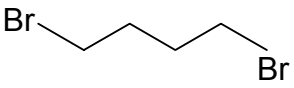
2,3-dibromobutaan



1,3-dibromo-2-metüülpropaan

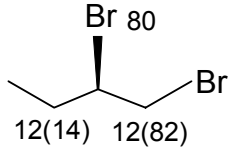


1,3-dibromobutaan

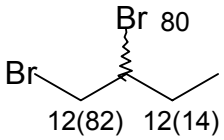


1,4-dibromobutaan

e)



R



S

4. a) A – K_2CrO_4, kaaliumkromaat
B – K_2WO_4, kaaliumvolframaat
C – CrO_3, kroom(VI)oksiid, kroomtrioksiid
D – WO_3, volfram(VI)oksiid, volframtrioksiid
E – $(NH_4)_2Cr_2O_7$, ammooniumdikromaat

b) i) $W + 3KNO_3 + 2KOH = K_2WO_4 + 3KNO_2 + H_2O$

ii) $W + 3KNO_3 + K_2CO_3 = K_2WO_4 + 3KNO_2 + CO_2$

iii) $W + 2KO_2 = K_2WO_4$

iv) $W + 3Ca(Cl)OCl + K_2CO_3 = K_2WO_4 + 3CaCl_2 + CO_2$
v) $W + 6KMnO_4 + 4K_2CO_3 = K_2WO_4 + 6K_2MnO_4 + 4CO_2$

vi) $2K_2CrO_4 + H_2SO_4 = K_2SO_4 + K_2Cr_2O_7 + H_2O$
$K_2Cr_2O_7 + H_2SO_4 = K_2SO_4 + 2CrO_3 + H_2O$

vii) $W + 3H_2O \overset{^0t^0t}{=} WO_3 + 3H_2\uparrow$

viii) $(NH_4)_2Cr_2O_7 = N_2\uparrow + Cr_2O_3 + 4H_2O\uparrow$

5. a) i) $C_3H_6O_3$, piimhape

ii) $C_4H_6O_4$, merivaikhape

iii) $C_2H_4O_2$, äädikhape

iv) $C_4H_8O_2$, butaanhape

v) $C_6H_8O_7$, sidrunhape

vi) $C_2H_2O_4$, oblikhape

b) II $3C_4H_6O_4 = 2C_4H_8O_2 + 4CO_2 + H_2$

III $2C_3H_6O_3 = C_4H_8O_2 + 2CO_2 + 2H_2$

IV $C_6H_8O_7 + 6[O] = 3C_2H_2O_4 + H_2O$

V $2C_6H_8O_7 = 2C_4H_8O_2 + 4CO_2 + O_2$

c) 0 0,5 0 0

$C_3H_6O_3 \rightarrow C_4H_6O_4 + C_2H_4O_2 + H_2$

3x+6-6=0 4x+6-8=0 2x+4-4=0

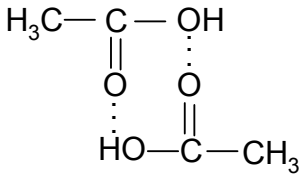
4·0,5 (-) 4·0

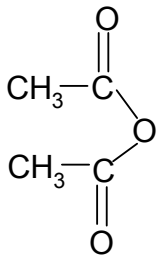
$C_4 + 2e^- = 4C$

2·0 (-) 2·I

$H_2 - 2e^- = 2H$

$2C_3H_6O_3 = C_4H_6O_4 + C_2H_4O_2 + H_2$

d) i) 

ii) 

6. a) $Pb(OCN)_2 + 2NH_3 + 2H_2O = 2NH_2CONH_2 + Pb(OH)_2$

b) $6HCHO \xrightarrow{Ca(OH)_2} CHOCHOHCHOHCHOHCHOHCHOHCHOH$ $(C_6H_{12}O_6)$

c) i) $H_2 + 2C \xrightarrow{\text{voltakaar}} HC{\equiv}CH$

ii) $CS_2 + 2H_2S + 8Cu = 4Cu_2S\downarrow + CH_4$

d)