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9. klass

1. a) **Hapet tuleb kallata vette**, sest vastasel juhul võib lahuse keema minemisel hape välja pritsida.

b) $\mathbf{M} = \frac{134\ \text{mg}}{\text{dm}^3} \cdot \frac{22{,}4\ \text{dm}^3}{1\ \text{mol}} \cdot \frac{1\ \text{g}}{1000\ \text{mg}} = \mathbf{3{,}00\ g/mol}$

Sellisele molaarmassile vastavad gaasid: ^{3}He, ^{3}H, HD. ^{3}H ehk triitium (T) pole toatemperatuuril stabiilne, kuna ühineb T_2-ks ning on ka radioaktiivne.

^{3}**He**, **HD**

c) O_2 (nt) < CO_2 (nt) < H_2O (tahke) < H_2O (vedel, nt) < NaCl < Hg

d) Al:+13|2)8)3) Br:+35|2)8)18)7)
S^{2-}:+16|2)8)8) Cd^{2+}:+48|2)8)18)18)

e) $\mathbf{m(Na_2SO_4)} = \frac{3}{7} \cdot 5{,}3\ \text{g} \cdot \frac{1\ \text{mol}}{44\ \text{g}} \cdot \frac{142\ \text{g}}{1\ \text{mol}} = \mathbf{7{,}3\ g}$

2. a) Kuna **A** tekib veega reageerimisel, siis on tegemist hüdroksiidiga $\mathbf{X}(OH)_n$

$\mathbf{X} + nH_2O = \mathbf{X}(OH)_n + n/2H_2\uparrow$

$M(X) = \frac{1}{1} \cdot \frac{8{,}0\ \text{g}}{0{,}2\ \text{mol}} = 40\ \text{g/mol}$ **X** – Ca, kaltsium

A – $Ca(OH)_2$, kaltsiumhüdroksiid

b) $\mathbf{m} = \frac{1}{1} \cdot 1{,}5\ \text{g} \cdot \frac{1\ \text{mol}}{40\ \text{g}} \cdot \frac{74\ \text{g}}{1\ \text{mol}} = \mathbf{2{,}8\ g}$

c) i) $Ca + 2H_2O = Ca(OH)_2 + H_2\uparrow$

ii) $2Ca + O_2 = 2CaO$

$CaO + 3C \overset{t^\circ}{=} CaC_2 + CO\uparrow$

$CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2\uparrow$

iii) $Ca(OH)_2 + Cl_2 = CaOCl_2 + H_2O$

3. a)

1. kiht (kolvi põhjas):	tahke	kruus
2. kiht:	vedel	$Ca(HCO_3)_2$ ja metanooli vesilahus
3. kiht:	vedel	tolueen
4. kiht:	gaas	vesinik

b) i) Kõigepealt lendub vesinik.

ii) Kolvist kallatakse kogu vedelik jaotuslehtrisse. Kolvi põhja jääb kruus. Jaotuslehtrist vedeliku välja laskmisel eraldub $Ca(HCO_3)_2$ ja metanooli vesilahus, seejärel tolueen.

iii) $Ca(HCO_3)_2$ ja metanooli vesilahusest eraldub destilleerimisel kõigepealt metanool ja siis vesi, kolvi põhja jääb sool.

c) $Ca(HCO_3)_2$ laguneb vee välja keetmisel

$Ca(HCO_3)_2 \overset{t^\circ}{=} CaCO_3 + H_2O + CO_2\uparrow$

4. a) $\mathbf{m} = 10{,}0\ \text{m}^3 \cdot \frac{1000\ \text{dm}^3}{1\ \text{m}^3} \cdot \frac{1{,}03\ \text{kg}}{1\ \text{dm}^3} \cdot \frac{35\ \text{g}}{1\ \text{kg}} \cdot \frac{1\ \text{kg}}{1000\ \text{g}} = 360{,}5\ \text{kg} = \mathbf{361\ kg}$

b) $\mathbf{m(Cl^-)} = 360{,}5\ \text{kg} \cdot 0.553 = 199{,}4\ \text{kg} = \mathbf{199\ kg}$

$\mathbf{m(Na^+)} = 110{,}3\ \text{kg} \approx \mathbf{110\ kg}$ $\mathbf{m(SO_4^{2-})} = 28{,}1\ \text{kg} \approx \mathbf{28\ kg}$

$\mathbf{m(Mg^{2+})} = 13{,}3\ \text{kg} \approx \mathbf{13\ kg}$ $\mathbf{m(Ca^{2+})} = \mathbf{4{,}3\ kg}$ $\mathbf{m(K^+)} = \mathbf{4{,}0\ kg}$

$m(\text{ioonid}) = (199{,}4 + 110{,}3 + 28{,}1 + 13{,}3 + 4{,}3 + 4{,}0)\ \text{kg} = 359{,}4\ \text{kg}$

c) $\mathbf{m(KCl)} = 4{,}0\ \text{kg} \cdot \frac{1\ \text{kmol}}{39{,}1\ \text{kg}} \cdot \frac{74{,}6\ \text{kg}}{1\ \text{kmol}} = \mathbf{7{,}6\ kg}$

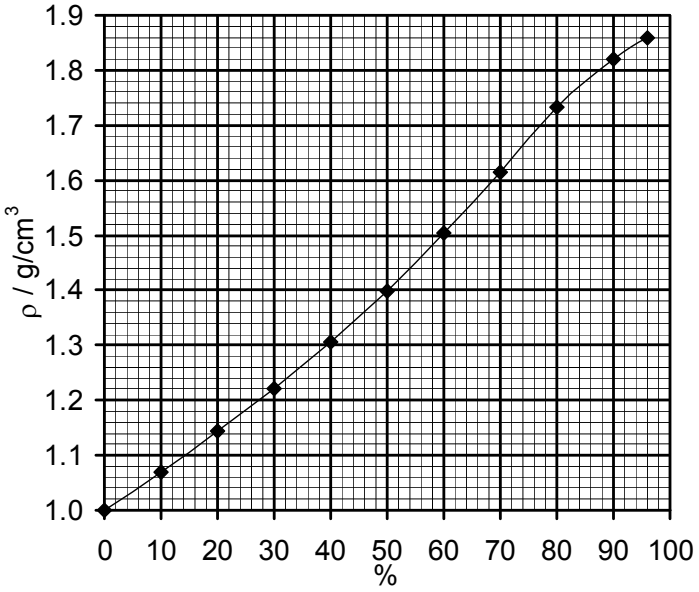
$\mathbf{m(CaCl_2)} = 4{,}3\ \text{kg} \cdot \frac{1\ \text{kmol}}{40{,}1\ \text{kg}} \cdot \frac{111\ \text{kg}}{1\ \text{kmol}} = 11{,}9\ \text{kg} = \mathbf{12\ kg}$

$\mathbf{m(MgCl_2)} = 13{,}3\ \text{kg} \cdot \frac{1\ \text{kmol}}{24{,}3\ \text{kg}} \cdot \frac{95{,}2\ \text{kg}}{1\ \text{kmol}} = 52{,}1\ \text{kg} \approx \mathbf{52\ kg}$

$\mathbf{m(Na_2SO_4)} = 28{,}1\ \text{kg} \cdot \frac{1\ \text{kmol}}{96{,}1\ \text{kg}} \cdot \frac{142\ \text{kg}}{1\ \text{kmol}} = 41{,}5\ \text{kg} \approx \mathbf{42\ kg}$

$\mathbf{m(NaCl)} = [359{,}4 - (7{,}6 + 11{,}9 + 52{,}1 + 41{,}5)]\ \text{kg} = 246{,}1\ \text{kg} = \mathbf{246\ kg}$

5. a)



b) $m(H_2SO_4\ \text{lahus}) = 450\ \text{cm}^3 \cdot \frac{1{,}399\ \text{g}}{1\ \text{cm}^3} = 629{,}55\ \text{g}$

$m(H_2SO_4) = 629{,}55\ \text{g} \cdot 0{,}5 = 314{,}78\ \text{g}$

$m(96\ \%\ H_2SO_4) = 314{,}78\ \text{g} \cdot \frac{1}{0{,}96} = 327{,}89\ \text{g}$

$$\mathbf{V(96\ \%\ H_2SO_4)} = 327{,}89\ \text{g} \cdot \frac{1\ \text{cm}^3}{1{,}86\ \text{g}} = \mathbf{176{,}3\ cm^3}$$

$$\mathbf{V(H_2O)} = (629{,}55 - 327{,}89)\text{g} \cdot \frac{1\ \text{cm}^3}{0{,}999\ \text{g}} = \mathbf{302{,}0\ cm^3}$$

c) i) $\mathbf{\rho(36\ \%\ H_2SO_4)} = \mathbf{1{,}27\ g/cm^3}$

ii) $\begin{cases} 0{,}36 \cdot m(36\ \%\ H_2SO_4) + 0{,}96 \cdot m(96\ \%\ H_2SO_4) = 314{,}78\ \text{g} \\ m(36\ \%\ H_2SO_4) + m(96\ \%\ H_2SO_4) = 629{,}55\ \text{g} \end{cases}$

$m(36\ \%\ H_2SO_4) = 629{,}55\ \text{g} - m(96\ \%\ H_2SO_4)$

$0{,}36 \cdot (629{,}55\ \text{g} - m(96\ \%\ H_2SO_4)) + 0{,}96 \cdot m(96\ \%\ H_2SO_4) = 314{,}78\ \text{g}$

$\mathbf{m(96\ \%\ H_2SO_4)} = \mathbf{146{,}90\ g}$

$\mathbf{m(36\ \%\ H_2SO_4)} = 629{,}55\ \text{g} - 146{,}90\ \text{g} = \mathbf{482{,}6\ g}$

d) $SO_3 + H_2O = H_2SO_4$

$$\mathbf{V(SO_3)} = \frac{1}{1} \cdot 314{,}78\ \text{g} \cdot \frac{1\ \text{mol}}{98{,}078\ \text{g}} \cdot \frac{22{,}41\ \text{dm}^3}{1\ \text{mol}} = \mathbf{71{,}92\ dm^3}$$

6. a) **A** – H_2O_2, vesinikperoksiid
B – I_2, jood

$$N(Na) = \frac{270{,}2 \cdot 0{,}17}{22{,}99} = 2{,}00 \qquad N(O) = \frac{270{,}2 \cdot 0{,}355}{16{,}00} = 6{,}00$$

$$N(S) = \frac{270{,}2 \cdot 0{,}475}{32{,}06} = 4{,}00$$

D – KOH, kaaliumhüdroksiid
E – NaI, naatriumjodiid
F – $Na_2S_4O_6$, naatriumtiosulfaat

b) i) $H_2O_2 + 2KI = 2KOH + I_2$

ii) $KOH + HCl = KCl + H_2O$

iii) $I_2 + 2Na_2S_2O_3 = 2NaI + Na_2S_4O_6$

c) $\mathbf{n(D)} = n(HCl) = 14{,}3\ \text{cm}^3 \cdot \frac{1\ \text{dm}^3}{1000\ \text{cm}^3} \cdot \frac{0{,}526\ \text{mol}}{1\ \text{dm}^3} = \mathbf{0{,}00752\ mol}$

$$\mathbf{n(A, katse\ (I))} = \frac{1}{2} n(\mathbf{D}) = \frac{1}{2} \cdot 0{,}00752\ \text{mol} = \mathbf{0{,}00376\ mol}$$

d) $\mathbf{n(B)} = \frac{1}{2} n(Na_2S_2O_3) = \frac{1}{2} \cdot 16{,}0\ \text{cm}^3 \cdot \frac{1\ \text{dm}^3}{1000\ \text{cm}^3} \cdot \frac{0{,}472\ \text{mol}}{1\ \text{dm}^3} = \mathbf{0{,}00378\ mol}$

$\mathbf{n(A, katse\ (II))} = n(\mathbf{B}) = \mathbf{0{,}00378\ mol}$

e) Aine **A** hulk on suurem katse **(II)** andmete kohaselt.

$n(\mathbf{A}, \text{üld}) = 2n(\mathbf{A}, \text{katse (II)}) = 2 \cdot 0{,}00378\ \text{mol} = 0{,}00756\ \text{mol}$

$$\mathbf{\%(A)} = 0{,}00756\ \text{mol} \cdot 34{,}01 \frac{\text{g}}{\text{mol}} \cdot \frac{1}{5{,}10\ \text{g}} \cdot 100 = \mathbf{5{,}04}$$

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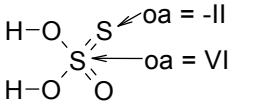
10. klass

1. a) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6\ 3d^{10} 4s^2 4p^6\ 4d^5 5s^1$

b) i) kõik sidemed (H-O, Cl=O, Cl-O) on polaarsed kovalentsed

ii) polaarne kovalentne side: Cl=O ja Cl-O, iooniline side: $Na^+ClO_4^-$

iii) metalliline side



c) oa(H) = I oa(O) = -II

d) i) $\mathbf{c} = m \cdot 0{,}06 \cdot \frac{1\,mol}{36{,}5\,g} \cdot \frac{1}{m} \cdot \frac{1{,}028\,g}{1\,cm^3} \cdot \frac{1000\,cm^3}{1\,dm^3} = 1{,}69\,\frac{mol}{dm^3} = \mathbf{1{,}69\ M}$

ii) $\mathbf{c_m} = m \cdot 0{,}06 \cdot \frac{1\,mol}{36{,}5\,g} \cdot \frac{1}{m} \cdot \frac{1}{1-0{,}06} \cdot \frac{1000\,g}{1\,kg} = 1{,}75\,\frac{mol}{kg} = \mathbf{1{,}75\ m}$

m – lahuse mass

e) $R = \frac{pV}{nT} = 760\,Torr \cdot 22{,}4\,dm^3 \cdot \frac{1000\,cm^3}{1\,dm^3} \cdot \frac{1}{1\,mol} \cdot \frac{1}{273\,K} = 62360\,\frac{Torr \cdot cm^3}{mol \cdot K}$

$$\mathbf{N} = \frac{pV}{RT} \cdot N_A = 1\,Torr \cdot 1\,cm^3 \cdot \frac{1\,mol \cdot K}{62360\ Torr\ cm^3} \cdot \frac{1}{293\,K} \cdot 6{,}02 \cdot 10^{23}\,\frac{1}{mol} = 3 \cdot 10^{16}$$

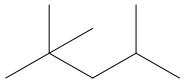
2. a) $\mathbf{Q} = 10^9\ bakterit \cdot \frac{1\,mol}{6{,}02 \cdot 10^{23}\ bakterit} \cdot \frac{10^7}{1\,min} \cdot \frac{20000\,J}{1\,mol} = \mathbf{3 \cdot 10^{-4}\ J/min}$

b) $c(H^+) = 10^9\ bakterit \cdot \frac{1\,mol}{6{,}02 \cdot 10^{23}\ bakterit} \cdot 10^7 \cdot \frac{1}{70\,dm^3} + 10^{-7}\ M =$

$$= 1{,}002 \cdot 10^{-7}\ M$$

$\mathbf{\Delta pH} = -\log(1{,}002 \cdot 10^{-7}) - 7 = \mathbf{-10^{-3}}$

c) $\mathbf{t} = \frac{2}{1} \cdot 1\,dm^3 \cdot \frac{17.5\,mol}{1\,dm^3} \cdot \frac{20000\,J}{1\,mol} \cdot \frac{1\,s}{100\,J} \cdot \frac{1\,min}{60\,s} = \mathbf{120\ min}$

3. a)  2,2,4-trimetüülpentaan

b) $2CH_3OH\ (v) + 3O_2\ (g) = 2CO_2\ (g) + 4H_2O\ (v)$

$2C_8H_{18}\ (v) + 25O_2\ (g) = 16CO_2\ (g) + 18H_2O\ (v)$

$$\mathbf{\Delta_{põlemis}H°(CH_3OH)} = \frac{1}{2} \cdot [2 \cdot (-393{,}5) + 4 \cdot (-285{,}8) - 2 \cdot (-238{,}4)] =$$

$$= \mathbf{-726{,}7\ kJ/mol}$$

$$\mathbf{\Delta_{põlemis}H°(C_8H_{18})} = \frac{1}{2} \cdot [16 \cdot (-393{,}5) + 18 \cdot (-285{,}8) - 2 \cdot (-259{,}3)] =$$

$$= \mathbf{-5460{,}9\ kJ/mol}$$

$$\mathbf{\Delta_{põlemis}H°(CH_3OH)} = \frac{-726{,}7\,kJ}{1\,mol} \cdot \frac{1\,mol}{32{,}04\,g} = \mathbf{-22{,}68\ kJ/g}$$

$$\mathbf{\Delta_{põlemis}H°(C_8H_{18})} = \frac{-5460{,}9\,kJ}{1\,mol} \cdot \frac{1\,mol}{114{,}2\,g} = \mathbf{-47{,}82\ kJ/g}$$

c) Võrreldes isooktaani põlemisentalpiat metanooli omaga selgub, et massiühiku kohta on isooktaani põlemisentalpia kaks korda suurem. Selle põhjal võiks järeldada, et kütusena tuleks kasutada isooktaani, sest see on oluliselt ekonoomsem. Samas kasutatakse metanooli, sest

i) metanooli oktaaniarv on kõrgem ja seetõttu ei detoneeru see nii kergesti. Kõrgefektiivses mootoris toimub metanooli põlemine seega sujuvamalt ja mootori töö efektiivsus on suurem.

ii) metanooli oksüdeerimiseks kulub vähem hapnikku võrreldes isooktaaniga. Seega konstantsel ruumalal tarbitakse ühe põlemistsükli käigus rohkem metanooli kui isooktaani ja seega eraldub metanooli põlemisel rohkem energiat ühe tsükli jooksul.

4. Soolhappega reaktsioon: **1** ja **3** on Au ja Hg. Seda kinnitab ka amalgaami moodustumine. Hg on kõige madalama sulamistemperatuuriga metall. Kuna metall **2** sulab madalamal temperatuuril kui **3**, siis **3 peab olema Au** ning **1 on Hg**. Tormiliselt veega reageerivad nimetatud reast Na ja Ca (seega **4** ja **6**). Leelise vesilahusega reageerivad Na ja Ca (**4** ja **6**, reaktsioon veega) ning Al ja Sn (**2** ja **5**) amfoteersuse tõttu. Kõrgemat temperatuuri vajab **Sn - metall 2**, ja **5 on seega Al**. 1000 °C juures on vedelad Sn, Ca ja Al (kuna Na ja Ca mõlemad pole vedelad, Na aga sulab madalamal temperatuuril, siis järelikult üks neist - Na - on gaasiline: Na keemistemperatuur ongi 883 °C), seega **metall 4 on Ca ja 6 on Na**. Hg on ka 1000 °C juures gaasiline, Au ja Fe on tahked. **Metall 7** reageerib HCl lahusega, kuid ei reageeri leelisega, **vastab Fe**. Fe on väiksema tihedusega kui Au (7,9 < 19,3 g/cm³), kuid sulab kõrgemal temperatuuril (1538 > 1064 °C). Sn on väiksema tihedusega kui Fe (7,3 < 7,9 g/cm³), sulab madalamal temperatuuril kui Au (232 < 1064 °C).

	ρ / g/cm³	St / °C	Kt / °C
Hg	13,5	-39	357
Na	0,97	98	883
Sn	7,3	232	2602
Al	2,7	660	2519
Ca	1,5	842	1484
Au	19,3	1064	2856
Fe	7,9	1538	2861

a) **1** – Hg **2** – Sn **3** – Au **4** – Ca **5** – Al **6** – Na **7** – Fe

i) Na < Ca < Al < Sn < Fe < Hg < Au

ii) Hg < Na < Sn < Al <Ca<Au<Fe

b) i) $M + 2HCl = MCl_2 + H_2\uparrow$, kus M = Sn, Ca, Fe

$2Na + 2HCl = 2NaCl + H_2\uparrow$

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

ii) $Sn + 2NaOH + 2H_2O = Na_2[Sn(OH)_4] + H_2\uparrow$

naatriumtetrahüdroksostannaat (II)

$Ca + 2H_2O = Ca(OH)_2 + H_2\uparrow$

$2Na + 2H_2O = 2NaOH + H_2\uparrow$

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

naatriumheksahüdroksoaluminaat

$2Al + 2NaOH + 6H_2O = 2Na[Al(OH)_4] + 3H_2\uparrow$

naatriumtetrahüdroksoaluminaat

c) amalgaamid

5. a) i) $Cl^- + AgNO_3 = AgCl\downarrow + NO_3^-$

ii) $2Ag^+ + K_2CrO_4 = Ag_2CrO_4 + 2K^+$

Peale tiitrimise stöhhiomeetriapunkti reageerivad hõbeioonid kromaatioonidega ja tekib punane hõbekromaat.

b) $n(Cl^-) = \frac{1}{1} \cdot \frac{100\ cm^3}{10\ cm^3} \cdot 29{,}60\ cm^3 \cdot \frac{1\,dm^3}{1000\ cm^3} \cdot \frac{0{,}05\ mol}{1\,dm^3} = 0{,}0148\ mol$

$\frac{m(KCl)}{74{,}56} + \frac{1 - m(KCl)}{58{,}44} = 0{,}0148 \qquad m(KCl) = 0{,}625\ g$

%(KCl) $= \frac{0{,}625\ g}{1\,g} \cdot 100 =$ **62,5**

c) Erinevus $= (66{,}6 - 62{,}5)\ \% =$ **4,1 %**

6. a) i) Soola **A** üldvalem on $\mathbf{YX}_n$. $M_r(\mathbf{Y}) = \frac{n \cdot M_r(\mathbf{X})}{0{,}546} \cdot (1 - 0.546)$

Kuna halogeen on gaasiline, siis on tegu kas fluoriidi või kloriidiga. Arvutused näitavad, et ükski raua triaadi fluoriid ei rahulda valemit. Sobib $CoCl_2$.

$M_r(\mathbf{Y}) = \frac{2 \cdot 35{,}5}{0{,}546} \cdot (1 - 0.546) = 59$

Y – Co

ii) A - $CoCl_2$, koobalt(II)kloriid

B – Na_2CO_3, naatriumkarbonaat

C – $CoCO_3$, koobalt(II)karbonaat

D – $Co(NO_3)_2$, koobalt(II)nitraat

E – $Co(CH_3COO)_2$, koobalt(II)etanaat

F – $(NH_2)_2CO$, karbamiid e uurea

$\mathbf{X}_2$ – Cl_2, kloor

Y – Co, koobalt

b) i) $2NaHCO_3 \xrightarrow{t^\circ} Na_2CO_3 + H_2O + CO_2\uparrow$

ii) $Co + Cl_2 = CoCl_2$

iii) $CoCl_2 + Na_2CO_3 = CoCO_3\downarrow + 2NaCl$

iv) $2NH_3 + CO_2 = (NH_2)_2CO + H_2O$

c) i) Oksiidi **O** üldvalem $\mathbf{Z}_2O_n$

$\%(\mathbf{Z}) = \frac{2 \cdot M_r(\mathbf{Z})}{2 \cdot M_r(\mathbf{Z}) + n \cdot 16} = 0{,}6319 \qquad M_r(\mathbf{Z}) = 13{,}73n$

Lahendiks sobib n = 4. Mn_2O_4 ehk MnO_2 **Z** – Mn

Katioon **K** koostis:

$N(Mn) = \frac{75{,}28}{54{,}94} = 1{,}37$

$N(N) = \frac{19{,}2}{14} = 1{,}37 \qquad N(H) = \frac{5{,}52}{1{,}01} = 5{,}47$

N(Mn) : N(N) : N(H) = 1 : 1 : 4

Pigmendi katioonne osa on $[\overset{III}{Mn}(\overset{-III}{N}\overset{I}{H_4})]^{4+}$

Arvestades, et **K** aniooni koostises on veel fosfor ja hapnik, tuleb valida neile indeksid vastavalt oa-dele.

K – $Mn(NH_4)P_2O_7$

ii) M – H_3PO_4, fosforhape

N – $NH_4H_2PO_4$, ammooniumdivesinikfosfaat $\%(N) = \frac{14}{115} = 12{,}18$

O – MnO_2, mangaandioksiid

Z – Mn, mangaan

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11. klass

1. a) $\mathbf{m(CuSO_4)} = 12\text{ g} + \frac{1}{3}\cdot 12\text{ g}\cdot\frac{1\text{ mol}}{159{,}5\text{ g}}\cdot\frac{5}{1}\cdot\frac{18\text{ g}}{1\text{ mol}} = \mathbf{14{,}26\text{ g}}$

b) $\mathbf{\%(CuSO_4)} = \frac{12\text{ g}}{14{,}26\text{ g} + 90\text{ cm}^3\cdot 1\text{ g/cm}^3}\cdot 100 = \mathbf{11{,}51}$

c) $CuSO_4 + 5H_2O = CuSO_4\cdot 5H_2O$ vask(II)sulfaat-vesi(1:5)

$CuSO_4 + 2NaOH = Cu(OH)_2\downarrow + Na_2SO_4$ vask(II)hüdroksiid

$Cu(OH)_2 \overset{t^\circ}{=} CuO + H_2O\uparrow$ vask(II)oksiid

$n(CuSO_4) = 12\text{ g}\cdot\frac{1\text{ mol}}{159{,}5\text{ g}} = 0{,}07524\text{ mol}$

$n(CuSO_4, \text{NaOH järgi}) = \frac{1}{2}\cdot 300\text{ cm}^3\cdot\frac{1\text{ dm}^3}{1000\text{ cm}^3}\cdot\frac{0{,}04\text{ mol}}{1\text{ dm}^3} = 0{,}00600\text{ mol}$

$CuSO_4$ on liias.

$\mathbf{m(CuO)} = \frac{1}{1}\cdot\frac{1}{1}\cdot 0{,}006\text{ mol}\cdot\frac{79{,}5\text{ g}}{1\text{ mol}} = \mathbf{0{,}477\text{ g}}$

2. a) $M(C_xH_y) = \frac{x\cdot 12{,}01}{0{,}8727} = 13{,}76x$

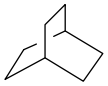
$y = 13{,}76x - 12{,}01x = 1{,}75x$

x : y = x : 1,75x = 1 : 1,75 = 4 : 7

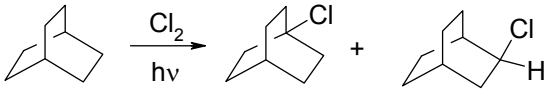
Lihtsaim brutovalem on C_4H_7.

$\rho_{H_2} = 75 < \frac{M(C_xH_y)}{2}$

Võttes arvesse, et $\rho_H = 75 < \frac{M(C_xH_y)}{2}$ ja struktuuris sisaldub vähemalt kaks kuuelülilist tsüklit on süsivesiniku valemiks C_8H_{14}.



b) Tekib kaks erinevat monokloorderivaati, millest üks võib esineda kahe enantiomeerina.



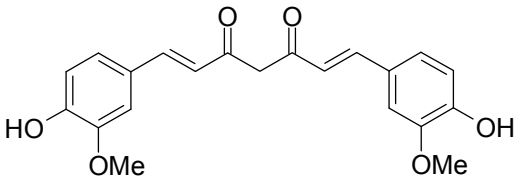
2 enantiomeeri

3. Tabel

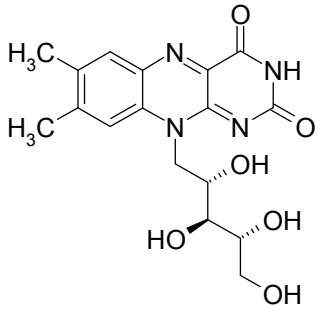
	1	2	3	4	5
Värvus	Tume punane	Kollane	Sinine	Punane	Kollakas-oranž
Nimetus	Lükopeen	Riboflaviin	Indigokarmiin	Karmoisiin	Kurkumiin
Struktuur, rühm	-CH_3 (10 tk)	-OH (4 tk)	N-H·····O=C	E-isomeer	C=O
Aineklass	Karotinoid	Vitamiin	Sool	Asoühend	Polüfenool
Toiduaine	Arbuus	Mandlid	Limonaad	**Martsipan**	Kurkum

Martsipanis sisaldub karmoisiin

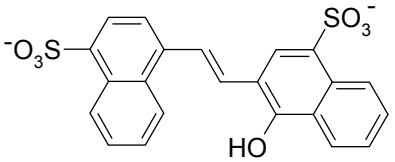
E100 kurkumiin



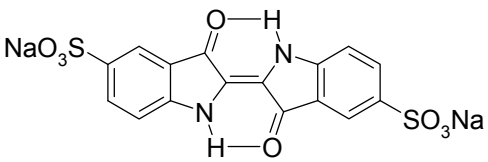
E101 Riboflaviin



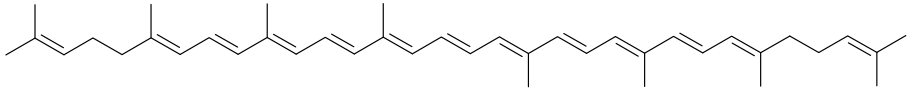
E122 Karmoisiin



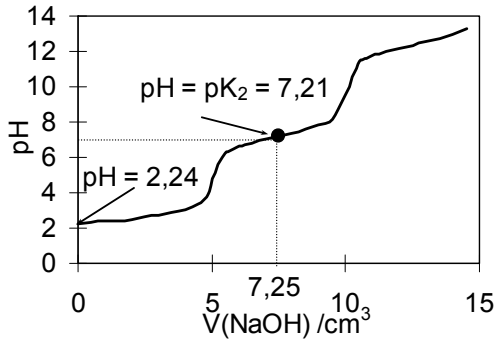
E132 Indigokarmiin



E160d Lükopeen



4. a) Fosforhappe tiitrimiskõver. Kuna fosforhape on kolmeprootoniline hape, siis on tiitrimiskõveral kolm astet.



b) NaOH lahus $\mathbf{pH} = 14 - \mathrm{pOH} = 14 + \log[OH^-] = 14 + \log 0{,}1 = \mathbf{13}$

H_3PO_4 lahus

$H_3PO_4 = H_2PO_4^- + H^+ \qquad K_1 = \dfrac{[H^+][H_2PO_4^-]}{[H_3PO_4]}$

Massibilanss: $c_{hape} = [H_3PO_4] + [H_2PO_4^-]$

Laengubilanss: $[H^+] = [H_2PO_4^-]$

Avaldame eelmistest seostest: $[H_3PO_4] = c_{hape} - [H_2PO_4^-] = c_{hape} - [H^+]$

$$K_1 = \frac{[H^+]^2}{c_{hape} - [H^+]} \quad \Rightarrow \quad [H^+] = -\frac{K_1}{2} + \sqrt{\frac{K_1^2}{4} + K_1 c_{hape}}$$

$$[H^+] = -0{,}0076/2 + \sqrt{0{,}0076^2/4 + 0{,}0076 \cdot 0{,}01} = 0{,}0243$$

$\mathbf{pH} = -\log 0{,}0571 = \mathbf{2{,}24}$

c) Tekkinud puhverlahuses võib vaadelda nõrga happena NaH_2PO_4 ja vastav sool Na_2HPO_4.

d) $\mathrm{pH} = \mathrm{p}K_2 + \log\dfrac{[\text{vastav sool}]}{[\text{nõrk hape}]}$

$[NaH_2PO_4] = [Na_2HPO_4] \quad \Rightarrow \quad \mathbf{pH} = \mathrm{p}K_2 = -\log(7.6 \cdot 10^{-3}) = \mathbf{7.21}$

Lahuses toimuvad reaktsioonid:

$NaOH + H_3PO_4 = NaH_2PO_4 + H_2O$

$NaH_2PO_4 + NaOH = Na_2HPO_4 + H_2O$

$$\mathbf{V(NaOH)} = \left(\frac{1}{1} + \frac{1}{2}\right) \cdot 50\ \mathrm{cm^3} \cdot 0{,}01\ \mathrm{M} \cdot \frac{1}{0{,}1\ \mathrm{M}} = \mathbf{7{,}5\ cm^3}$$

e) $$n(NaH_2PO_4)_{alg} = n(Na_2HPO_4)_{alg} = \frac{1}{2} \cdot 50\ \mathrm{cm^3} \cdot \frac{1\ \mathrm{dm^3}}{1000\ \mathrm{cm^3}} \cdot 0{,}01\ \frac{\mathrm{mol}}{\mathrm{dm^3}} =$$

$$= 2{,}5 \cdot 10^{-4}\ \mathrm{mol} = 0{,}25\ \mathrm{mmol}$$

$$n(NaOH)_{lisatud} = 0{,}005\ \mathrm{g} \cdot \frac{1\ \mathrm{mol}}{40\ \mathrm{g}} = 1{,}25 \cdot 10^{-4}\ \mathrm{mol} = 0{,}125\ \mathrm{mmol}$$

$$\mathrm{pH} = 7{,}21 + \log\frac{(0{,}25 + 0{,}125)\ \mathrm{mmol}}{(0{,}25 - 0{,}125)\ \mathrm{mmol}} = 7{,}69$$

$\mathbf{\Delta pH} = 7{,}69 - 7{,}21 = \mathbf{0{,}48}$

5. a) $Ag_nX \qquad \%(Ag) = \dfrac{n \cdot A_r(Ag)}{n \cdot A_r(Ag) + A_r(\mathbf{X})} = 0{,}7526 \quad \Rightarrow \quad A_r(\mathbf{X}) = 35{,}46n$

Lahendiks sobib n = 1, siis **X** – Cl. Valge sade on **AgCl**.

Happe **A** koostises on H, Cl ja tundmatu element **Y**.

$$N(Cl) = N(AgCl) = 25{,}81\ \mathrm{g} \cdot \frac{1\ \mathrm{mol}}{143{,}3\ \mathrm{g}} = 0{,}18\ \mathrm{mol}$$

$$N(H) = 2N(H_2) = 2 \cdot 0{,}672\ \mathrm{dm^3} \cdot \frac{1\ \mathrm{mol}}{22{,}4\ \mathrm{dm^3}} = 0{,}06\ \mathrm{mol}$$

Kuna N(H) : N(Cl) = 1 : 3, siis **A** – $H_xY_yCl_{3x}$

Üldine reaktsioonivõrrand:

m $H_xY_yCl_{3x}$ + 3x M = mx/2 H_2 + 3x MCl_m + my Y

$$M(\mathbf{A}) = 75\ \mathrm{g} \cdot 0{,}164 \cdot \frac{x}{0{,}06\ \mathrm{mol}} = 205x\ \mathrm{g/mol}$$

Kui x = 1, siis $A_r(\mathbf{Y}) = \dfrac{205 - 1{,}008 - 3 \cdot 35{,}45}{y} = \dfrac{97{,}642}{y}$

y = 1 korral on **Y** – Tc, y = 2 korral on **Y** – Ti, ...

Mitte ükski variant ei sobi ülesande tingimusega.

Kui x = 2, siis $A_r(\mathbf{Y}) = \dfrac{2 \cdot 97{,}642}{y} = \dfrac{195{,}284}{y}$

y = 1 korral on **Y** – **Pt**, y – 2 korral on **Y** – Tc, y – 3: Zn, ...

A – $H_2[PtCl_6]$ (teised variandid ei sobi samuti ülesande tingimusega)

b) $6M + mH_2[PtCl_6] = 6MCl_m + mH_2\uparrow + mPt\downarrow$

Kuna teostatud reaktsioonide tagajärjel plaadi mass ei muutunud, siis

$$m(M) = m(Pt) = \frac{1}{2} \cdot 0{,}06\ \mathrm{mol} \cdot \frac{195{,}08\ \mathrm{g}}{1\ \mathrm{mol}} = 5{,}8524\ \mathrm{g}$$

$$M(M) = 5{,}8524\ \mathrm{g} \cdot \frac{1}{6/m \cdot 0{,}03\ \mathrm{mol}} = 32{,}51m\ \mathrm{g/mol}$$

m = 2 korral M – **Zn** (teised väärtused ei sobi ülesande tingimusega)

c) $3Zn + H_2[PtCl_6] = 3ZnCl_2 + H_2\uparrow + Pt\downarrow$

$ZnCl_2 + 2AgNO_3 = Zn(NO_3)_2 + 2AgCl\downarrow$

6. a) i) $$\mathbf{M}_{ideaal} = 1398 \cdot \frac{28\ \mathrm{g}}{1\ \mathrm{mol}} + 466 \cdot \frac{118\ \mathrm{g}}{1\ \mathrm{mol}} + 699 \cdot \frac{42\ \mathrm{g}}{1\ \mathrm{mol}} = \mathbf{123\ 500\ \frac{g}{mol}}$$

ii) E : P : S 1398 : 699 : 466 6 : 3 : 2

6E-3P-2S

iii) $$\mathbf{M}_{lüli} = 6 \cdot \frac{28\ \mathrm{g}}{1\ \mathrm{mol}} + 2 \cdot \frac{118\ \mathrm{g}}{1\ \mathrm{mol}} + 3 \cdot \frac{42\ \mathrm{g}}{1\ \mathrm{mol}} = \mathbf{530\ \frac{g}{mol}}$$

$$\textbf{Lülide arv} = \frac{123\ 500\ \mathrm{g/mol}}{530\ \mathrm{g/mol}} = \mathbf{233}$$

b) $$\frac{\Pi}{RT} = \frac{55{,}68\ \mathrm{N}}{\mathrm{m^2}} \cdot \frac{1\ \mathrm{mol} \cdot 1\ \mathrm{K}}{8{,}314\ \mathrm{N \cdot m}} \cdot \frac{1}{(273{,}15 + 25)\ \mathrm{K}} = 0{,}0225\ \frac{\mathrm{mol}}{\mathrm{m^3}}$$

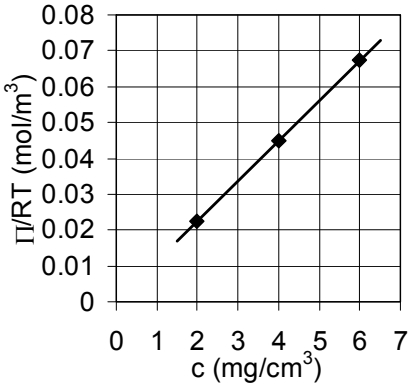
Π (Pa)	55,68	111,4	167,0
c (mg/cm^3)	2	4	6
Π/RT	0,0225	0,0449	0,0674

$$\textbf{Tõus} = (0{,}0449 - 0{,}0225)\frac{\mathrm{mol}}{\mathrm{m^3}} \cdot$$

$$\cdot \frac{1\ \mathrm{cm^3}}{(4-2)\ \mathrm{mg}} \cdot \frac{1\ \mathrm{m^3}}{10^6\ \mathrm{cm}} \cdot \frac{10^3\ \mathrm{mg}}{1\ \mathrm{g}} =$$

$$= \mathbf{1{,}12 \cdot 10^{-5}\ mol/g}$$

$$\mathbf{M}_{arv} = \frac{1\ \mathrm{g}}{1{,}12 \cdot 10^{-5}\ \mathrm{mol}} = \mathbf{89300\ g/mol}$$



Keskmine polümeri ahel on **lühem** võrreldes ideaalsega.

c) Süsiniku aatomite arv korduvas lülis on (6 + 2 + 3) · 2 = 22.

$$\text{Lülide arv} = \frac{89\,300\ \text{g/mol}}{530\ \text{g/mol}} = 168$$

N(C) $= 168 \cdot 22 =$ **3710**

2007/2008 õ.a. keemiaolümpiaadi lõppvooru ülesannete lahendused
12. klass

1. 1. $(Cu,Zn)O + KHSO_4 = (Cu,Zn)SO_4 + KOH$

$Fe_2O_3 + 3KHSO_4 = Fe_2(SO_4)_3 + 3KOH$

2. **i)** $2CuSO_4 + 2NH_4OH = (CuOH)_2SO_4\downarrow + (NH_4)_2SO_4$

$ZnSO_4 + 2NH_4OH = Zn(OH)_2\downarrow + (NH_4)_2SO_4$

$Fe_2(SO_4)_3 + 6NH_4OH = 2Fe(OH)_3 + 3(NH_4)_2SO_4$

ii) $(CuOH)_2SO_4 + (NH_4)_2SO_4 + 6NH_4OH = 2[Cu(NH_3)_4]SO_4 + 8H_2O$

$Zn(OH)_2 + (NH_4)_2SO_4 + 2NH_4OH = 2[Zn(NH_3)_4]SO_4 + 4H_2O$

3. $[(Zn,Cu)(NH_3)_4]SO_4 + 4HCl = (Cu,Zn)SO_4 + 4NH_4Cl$

4. $Fe(OH)_3 + (NH_4)_2HPO_4 = FePO_4\downarrow + 2NH_4OH + H_2O$

5. $2CuSO_4 + 2Na_2S_2O_3 + 2H_2O = Cu_2S\downarrow + S\downarrow + 2H_2SO_4 + 2Na_2SO_4$

$ZnSO_4 + Na_2S_2O_3 \neq$

6. $3ZnSO_4 + 2K_4[Fe(CN)_6] = \mathbf{K_2Zn_3[Fe(CN)_6]_2}\downarrow + 3K_2SO_4$

7. $Cu_2S + 6$ konts. $HNO_3 = 2Cu(NO_3)_2 + H_2S\uparrow + 2NO_2\uparrow + 2H_2O$

8. $2Cu(NO_3)_2 + K_4[Fe(CN)_6] = \mathbf{Cu_2[Fe(CN)_6]}\downarrow + 4KNO_3$

9. $FePO_4 + 3HCl = FeCl_3 + H_3PO_4$

10. $4FeCl_3 + 3K_4[Fe(CN)_6] = \mathbf{Fe_4[Fe(CN)_6]_3}\downarrow + 12KCl$

2. a) i) $Ag^+ + KSCN = AgSCN + K^+$

$Fe^{3+} + 3KSCN = Fe(SCN)_3 + 3K^+$

$$\mathbf{n(Ag)} = (\frac{1}{1}\cdot 100\ cm^3 \cdot \frac{0{,}01\ mol}{1\ dm^3} - \frac{3}{1}\cdot 9{,}69\ cm^3 \cdot \frac{0{,}01\ mol}{1\ dm^3})\frac{1\ dm^3}{1000\ cm^3} = \mathbf{0{,}00709\ mol}$$

$$\mathbf{m(Ag)} = 0{,}007093\ mol \cdot \frac{107{,}9\ g}{1\ mol} = \mathbf{0{,}765\ g}$$

ii) $SO_2 + Ba(OH)_2 = BaSO_3\downarrow + H_2O$

$$\mathbf{n(S)} = \frac{1}{1}\cdot 1{,}156\ g \cdot \frac{1\ mol}{217{,}4\ g} = \mathbf{0{,}00532\ mol}$$

$$\mathbf{m(S)} = 0{,}005317\ mol \cdot \frac{32{,}06\ g}{1\ mol} = \mathbf{0{,}171\ g}$$

b) Leiame Ag_2S hulga argürodiidis ja järgi jäänud väävli hulga:

$$n(Ag_2S) = \frac{n(Ag)}{2} = \frac{0{,}007093\ mol}{2} = 0{,}003547\ mol$$

$$n(S,\ jääk) = 0{,}005317\ mol - 0{,}003547\ mol = 0{,}001770\ mol$$

Otsitav element peab olema positiivse oa-ga.

$$m(X) = 1\ g - 0{,}7653\ g - 0{,}1705\ g = 0{,}06420\ g$$

Elemendi X aatommass ühendis XiSj on leitav:

$$A(X) = \frac{m(X)}{i/j \cdot n(S,\ jääk)} = \frac{j}{i}\cdot\frac{0{,}06420\ g}{0{,}001770\ mol} = 36{,}27\frac{j}{i}\ g/mol$$

Võimalikes ühendites on $\mathbf{X}_2S$, $\mathbf{X}S$, $\mathbf{X}_2S_3$, $\mathbf{X}S_2$ jne on j/i suhtes 0,5, 1, 1,5, 2 jne. Võimalikud **X** aatommassid on 18,1 (oa = I), 36,3 (II), 54,4 (III), 72,5 (IV), 90,6 (V) jne. Sobib vaid neljavalentne Ge so GeS_2.

$$n(GeS_2) = \frac{0{,}001770\ mol}{2} = 0{,}0008850\ mol$$

$Ag_2S : GeS_2 = 0{,}003547 : 0{,}0008850 = 4 : 1$

Argürodiidi valem on Ag_8GeS_6.

c) i) $GeO_2 + 4HCl = GeCl_4 + 2H_2O$

ii) $GeO_2 + 2NaOH = Na_2GeO_3 + H_2O$

Germaanium (nimetusest Germany) sarnanes omadustelt Mendelejevi poolt ennustatud elemendi ekaräniga ja see kinnitas lõplikult perioodilisusseaduse olemasolu.

3. a) $\mathbf{N} = 6\cdot\frac{1}{2} + 8\cdot\frac{1}{8} = 3 + 1 = \mathbf{4}$

b) $\mathbf{V_{ühikrakk}} = a^3 = (3{,}62\cdot 10^{-8}\ cm)^3 = \mathbf{4{,}70\cdot 10^{-23}\ cm^3}$

Leiame seose võrekonstandi a ja aatomi raadiuse r vahel:

$$(r + 2r + r) = \sqrt{a^2 + a^2} = \sqrt{2a^2} = \sqrt{2}a \quad \Rightarrow \quad r = \frac{\sqrt{2}a}{4}$$

$$\mathbf{V_{aatom}} = 4\cdot\frac{4}{3}\pi r^3 = \frac{16}{3}\pi(\frac{\sqrt{2}a}{4})^3 = \frac{16}{3}\cdot\frac{2\sqrt{2}}{64}\pi a^3 = \frac{\sqrt{2}}{6}\pi a^3 =$$

$$= \frac{\sqrt{2}}{6}\pi\cdot 4{,}70\cdot 10^{-23}\ cm^3 = \mathbf{3{,}48\cdot 10^{-23}\ cm^3}$$

$$\mathbf{\%_{hõivatud}} = \frac{\sqrt{2}}{6}\pi a^3\cdot\frac{1}{a^3}\cdot 100 = \mathbf{74{,}0\ \%}$$

c) $m_{ühikrakk} = V_{ühikrakk}\cdot\rho \qquad M = \frac{m_{ühikrakk}}{n_{ühikrakk}} = \frac{m_{ühikrakk}}{N/N_A}$

$$M = 4{,}7\cdot 10^{-23}\ cm^3\cdot\frac{8{,}92\ g}{cm^3}\cdot\frac{1}{4}\cdot\frac{6{,}02\cdot 10^{23}}{1\ mol} = 63{,}1\ g/mol$$

Element on **vask**. Kaheksajala veri on **sinist värvi**.

4. $E(Eesti) = 10000\ GWh\cdot\frac{10^9\ Wh}{1\ GWh}\cdot\frac{3600\ s}{1\ h}\cdot\frac{1\ J}{1\ W\cdot 1\ s} = 3{,}6\cdot 10^{16}\ J$

a) $\mathbf{h} = 3{,}6\cdot 10^{16}\ J\cdot\frac{1\ m\ kg}{9{,}8\ J}\cdot\frac{1}{25\ km^3}\cdot\frac{km^3}{10^9\ m^3}\cdot\frac{1\ m^3}{10^3\ kg} = 147\ m = \mathbf{150\ m}$

b) $\mathbf{\Delta T} = 3{,}6\cdot 10^{16}\ J\cdot\frac{1\ kg\ K}{4181\ J}\cdot\frac{1}{25\ km^3}\cdot\frac{km^3}{10^9\ m^3}\cdot\frac{1\ m^3}{10^3\ kg} = \mathbf{0{,}34\ K}$

c) $H_2 + 1/2O_2 = H_2O$

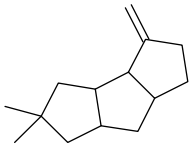
$$\mathbf{m(H_2)} = 3{,}6 \cdot 10^{16}\ \text{J} \cdot \frac{1\,\text{mol}}{286{,}6\,\text{kJ}} \cdot \frac{1\,\text{kJ}}{10^3\,\text{J}} \cdot \frac{2\,\text{g}}{1\,\text{mol}} \cdot \frac{1\,\text{kg}}{10^3\,\text{g}} = \mathbf{2{,}5 \cdot 10^8\ kg}$$

d) $^3\text{H} + {}^2\text{H} = {}^4\text{He} + {}^1\text{n} \qquad E = \Delta mc^2$

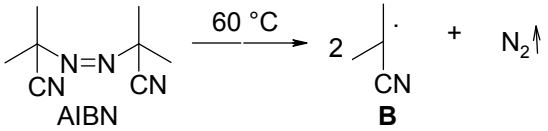
$$\Delta m = 3{,}6 \cdot 10^{16}\ \text{J} \cdot \frac{1\,\text{s}^2}{(3 \cdot 10^8\ \text{m})^2} = 0{,}4\ \text{kg}$$

$$\mathbf{m(^3H + {}^2H)} = 0{,}4\ \text{kg} \cdot \frac{2{,}0141 + 3{,}0160}{2{,}0141 + 3{,}0160 - 4{,}0026 - 1{,}0087} = 107\ \text{kg} = \mathbf{110\ kg}$$

5. a)



b)



6. a) $C_nH_{2n+2}O \rightarrow C_nH_{2n}O \rightarrow C_nH_{2n}O_2$

$n(C_nH_{2n}O) = n(C_nH_{2n}O_2) \qquad \frac{75}{14n+16} = \frac{115}{14n+32} \qquad \Rightarrow \qquad n = 1$

A – CH_3OH, metanool

$RCOOH + NaOH = RCOONa + H_2O$

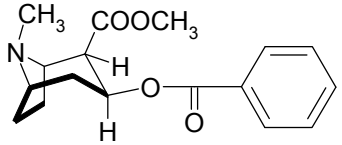
$$n(\text{RCOOH}) = \frac{1}{1} \cdot 20\ \text{g} \cdot 0{,}3 \cdot \frac{1\,\text{mol}}{40\ \text{g}} = 0{,}15\ \text{mol}$$

$$M(\text{RCOOH}) = \frac{18{,}3\ \text{g}}{0{,}15\ \text{mol}} = 122\ \text{g/mol}$$

$M(R) = (122 - 45)\ \text{g/mol} = 77\ \text{g/mol}$ R on benseeni tuum (C_6H_5-)

B – C_6H_5COOH, bensoehape

Kokaiini võib vaadelda ekoniini kahekordse esterdamise saadust: metanool reageerib karboksüülrühmaga ja bensoehape hüdroksüülrühmaga.

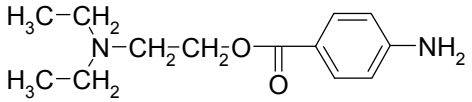


b) $R_2NCH_2CH_2OH \qquad \%(N) = \frac{14}{2M(R) + 59} = 0{,}12 \quad \Rightarrow \quad M(R) = 29$

R on etüülrühm (C_2H_5-)

$(C_2H_5)_2NCH_2CH_2OH$

Aminoalkoholi reageerimisel aminobensoehappega saadakse novokaiin



c) Kokaiini ja novokaiini struktuuri võrdlemine näitab, et tõenäoline anestesiofoori struktuur on