2005/2006 õa keemiaolümpiaadi lõppvooru ülesannete lahendused
11. klass

1. a) i) $p \cdot V = n \cdot R \cdot T$

$$\mathbf{V}=0{,}06\ \text{mol} \cdot 0{,}08205 \frac{\text{atm} \cdot \text{dm}^3}{\text{mol} \cdot \text{K}} \cdot 323\,\text{K} \cdot \frac{1}{1\text{atm}} = 1{,}590\ \text{dm}^3 \approx \mathbf{1{,}59\ dm^3}$$

ii) Limiteerivaks reagendiks on SO_2

b) $n(SO_2) = 0$

$n(O_2) = \frac{1}{2} \cdot 0{,}03\ \text{mol} = 0{,}015\ \text{mol}$

$n(SO_3) = 0{,}03\ \text{mol}$

$\Sigma n = 0{,}045\ \text{mol}$

$$\mathbf{V_{(lõpus)}} = \frac{0{,}045}{0{,}06} \cdot 1{,}590\ \text{dm}^3 = 1{,}193\ \text{dm}^3 \approx \mathbf{1{,}19\ dm^3}$$

c) i) $w = -p \cdot \Delta V$

$\mathbf{w} = -101325\ \text{N/m}^2 \cdot (0{,}00119\ \text{m}^3 - 0{,}00159\ \text{m}^3) = +40{,}53\ \text{J} \approx \mathbf{+41\ J}$

ii) Tööd tehti süsteemi suhtes.

d) i) $\Delta \mathbf{H_r} = 0{,}03\ \text{mol}\ [-395\ \text{kJ/mol} - (-296\ \text{kJ/mol}] = \mathbf{-2{,}97\ kJ}$

ii) Soojus lahkub süsteemist.

2. a) $m(\mathbf{Y}, a) = 197{,}39 \cdot 0{,}1796 = 35{,}45$

$m(\mathbf{Y}, b) = 147{,}37 \cdot 0{,}2406 = 35{,}45$

$m(\mathbf{Y}, g) = 480{,}74 \cdot 0{,}4424 = 212{,}7$

$N(\mathbf{Y}) = \frac{212{,}7}{35{,}45} = 6$

Y – Cl, kloor

Eeldusel, et molekulis a on igat elementi üks aatom

$m(\mathbf{X} + \mathbf{Y}) = 197 - (35+31+32) = 99$

$19 + 80 = 99$

X – F, fluor

Z – Br, broom

b) i) $PSFClBr \Leftrightarrow 31 + 32 + 19 + 35 + 80 = 197$

ii) $HCFClBr \Leftrightarrow 1 + 12 + 19 + 35 + 80 = 147$

iii) $N(O) = 480{,}74 \cdot 0{,}1664 \cdot \frac{1\,\text{aatom}}{16} = 5$ aatomit

$N(Cl) = 6$ aatomit

$m(P+S) = 480{,}7 - 212{,}7 - 80 = 188$

$A_r(P) = 31$ ja $A_r(S) = 32$

$188 : 31 = 6{,}06$

Olgu N(P) = x, siis N(O) = 6 – x

$x \cdot 31 + (6 - x) \cdot 32 = 188$

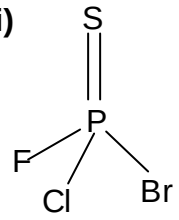
x = 4

N(P) = 4 aatomit

N(S) = 2 aatomit

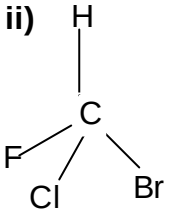
$P_4S_2Cl_6O_5$

c) i)



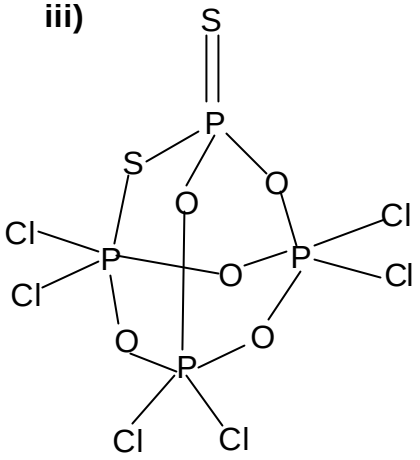
a

ii)



b

iii)



g

iv) bromofluorokloorometaan

3. a) i) $^{14}_{7}N + ^{1}_{0}n \rightarrow ^{14}_{6}C + ^{1}_{1}H$ (prootonit võib tähistada ka p või $^{1}_{1}p$)

ii) $^{14}_{6}C \rightarrow ^{14}_{7}N + ^{0}_{-1}e$ (beetaosakest võib ka tähistada β või β^-)

b) Kiiruskonstant on esimest järku kineetika korral seotud poolestusajaga järgmiselt:

k = $\frac{\ln 2}{\tau} = \frac{0{,}6931}{5715\ \text{a}} \cdot \frac{1\ \text{a}}{8766\ \text{h}}$ = **$1{,}384 \times 10^{-8}\ \text{h}^{-1}$**

c) Radioaktiivne lagunemine allub esimest järku kineetikale, kus mingil hetkel lagunemata osakeste arv N sõltub radioaktiivsete osakeste alghulgast N_o järgmiselt:

$N = N_0 \cdot e^{-kt}$, kust avaldades $t = -\frac{1}{k}\ln\left(\frac{N}{N_0}\right) = -\frac{\tau}{\ln 2}\ln\left(\frac{N}{N_0}\right)$.

Eelduste kohaselt N/N_0 vastab vanaaegse ja kaasaegse proovi radioaktiivse kiirguse intensiivsuste suhtele ehk

t = $-\frac{5715\ \text{a}}{\ln 2} \cdot \ln\left(\frac{14000}{18400}\right)$ = **2300 aastat**

4. a) $4s^2 3d^6 4p^0$

b) Ühendis **G** on Fe oa –II. Seega on molekulis 2 vesiniku aatomit. Ühendis **H** on Fe oa II, sest molekulis on 2 joodi aatomit.

G – H_2FeLig_x $M_r(\mathbf{G}) = 55{,}85/0{,}3287 = 169{,}91$

H - I_2FeLig_y $M_r(\mathbf{H}) = 2 \cdot 126{,}9/0{,}6019 = 421{,}66$

$M_r(Lig_x,\mathbf{G}) = 169{,}91 - 55{,}85 - 2 \cdot 1{,}01 = 112{,}0$

$M_r(Lig_y,\mathbf{H}) = 421{,}66 - 2 \cdot 126{,}9 - 55{,}85 = 112{,}0$

$\mathbf{X} \approx \mathbf{Y}$

Elektronide arvust leiame

$$x = \frac{18-8-2}{2} = 4$$

$$M_r(Lig) = \frac{112}{4} = 28$$

B = Lig – CO, süsinikmonooksiid

c) **A** – $Fe(CO)_5$, (18-8)/2 = 5

$$N(CO,\mathbf{C}) = \left(\frac{2 \cdot 55{,}85}{0{,}3070} - 2 \cdot 55{,}85\right)\frac{1\ \text{molek}}{28} = 9\ \text{molekuli}$$

$$N(Lig) = \frac{2 \cdot 18 - 2 \cdot 8 - 2}{2} = 9$$

C – $Fe_2(CO)_9$

D – $NaH[Fe(CO)_4]$ $N(Lig) = \frac{18-8-2}{2} = 4$

$Na_2[Fe(CO)_4]$

E – Na_2CO_3 **G** – $H_2[Fe(CO)_4]$ Σ 18 elektroni

F – NaCl **H** – $I_2[Fe(CO)_4]$ Σ 18 elektroni

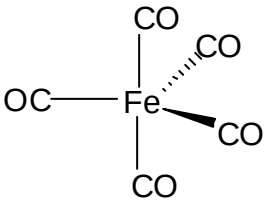
d) **i)** $2Fe(CO)_5 = Fe_2(CO)_9 + CO$

ii) $Fe(CO)_5 + 4NaOH = Na_2[Fe(CO)_4] + Na_2CO_3 + 2H_2O$

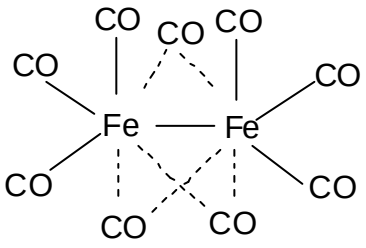
iii) $Na_2[Fe(CO)_4] + 2HCl = H_2[Fe(CO)_4] + 2NaCl$

iv) $Fe(CO)_5 + I_2 = I_2[Fe(CO)_4] + CO$

e)



A



C

5. a) m(ioone) = $\left(\frac{0{,}32}{23{,}0}+\frac{0{,}04}{24{,}3}+\frac{0{,}01}{40{,}1}+\frac{0{,}57}{35{,}5}+\frac{0{,}06}{96{,}0}\right)\frac{\text{mol}}{\text{g}}\cdot 34\,\frac{\text{g}}{\text{kg}}\cdot\frac{1\,\text{kg}}{0{,}966\,\text{kg}}=$

1,14 mol/kg = **1,1 mol/kg**

b) $\Delta T = 1{,}86\,\frac{\text{K}\cdot\text{kg}}{\text{mol}}\cdot 1{,}10\,\frac{\text{mol}}{\text{kg}}$ = 2,1 K

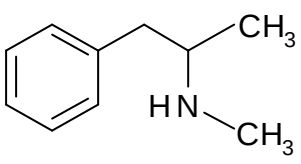
t(külm) = 0 ^{0}C – 2,1 ^{0}C = **-2,1 ^{0}C**

c) Ioonide molaalne kontsentratsioon

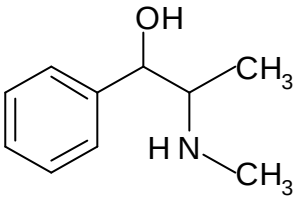
m(ioonid) = $\frac{5{,}0\ \text{K}}{1{,}86\,\frac{\text{K}\cdot\text{kg}}{\text{mol}}}$ = 2,69 mol/kg

m(NaCl) = $\frac{1}{2}\cdot(2{,}69-1{,}14)\frac{\text{mol}}{\text{kg}}\cdot 0{,}966\,\text{kg}\cdot 58{,}5\,\text{g/mol}$ = 43,8 g **~ 44 g**

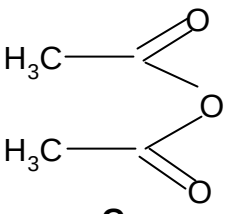
6. a) i)



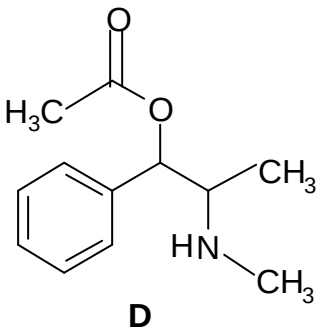
A



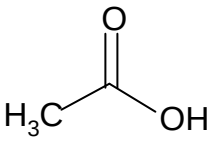
B



C



D



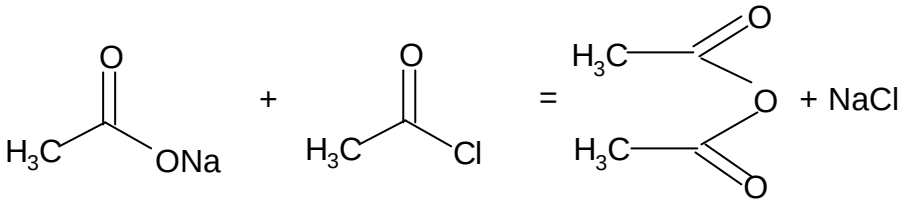
E

ii) B – 2-(N-metüülamino)-1-fenüül-1-hüdroksüpropaan

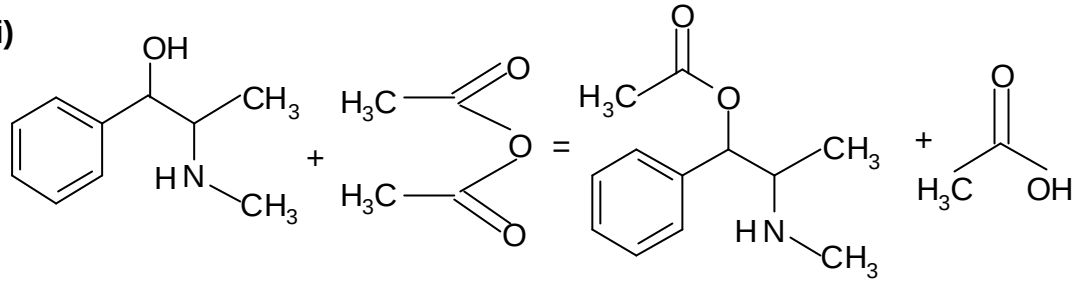
C – äädikhappe e. etaanhappe anhüdriid

E – äädikhape e etaanhape

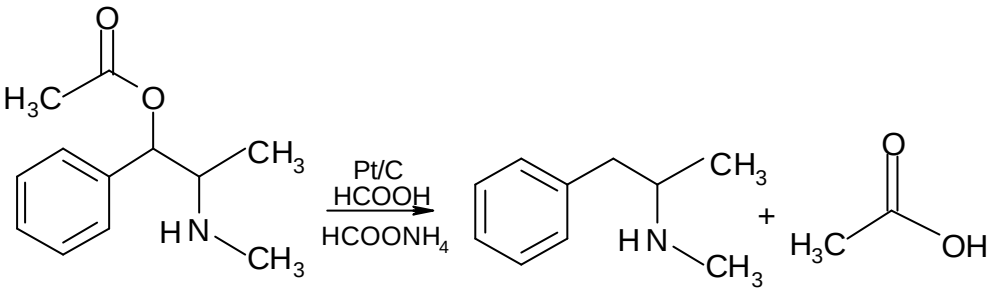
b) i)


O
H3C
ONa
+
O
H3C
Cl
=
O
H3C
O
H3C
O
+ NaCl

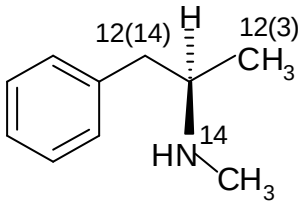
ii)


OH
CH3
HN
CH3
+
O
H3C
O
H3C
O
=
O
H3C
O
CH3
HN
CH3
+
O
H3C
OH

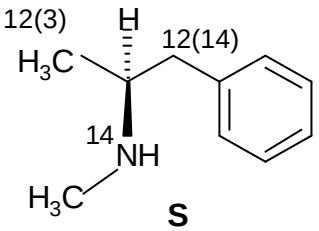
iii)


O
H3C
O
CH3
HN
CH3
Pt/C
HCOOH
HCOONH4
CH3
HN
CH3
+
O
H3C
OH

c)


12(14)
H
12(3)
CH3
14
HN
CH3

R


12(3)
H
H3C
12(14)
14
NH
H3C

S