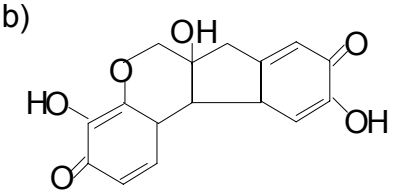
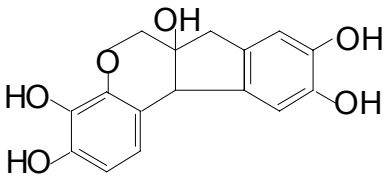
1996/97 õa keemiaolümpiaadi lõppvooru ülesannete lahendused
12. klass

1. a) Fenoolseid hüdroksüüle on kaks.

b)

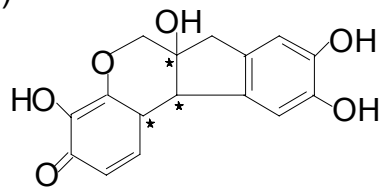


f. hüdroksüüle 0



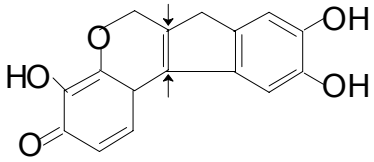
f. hüdroksüüle 4

c)

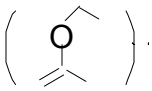


f. hüdroksüüle 2

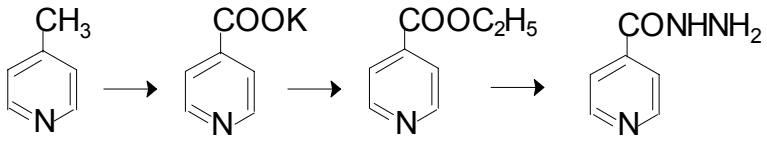
d)



f. hüdroksüüle 2

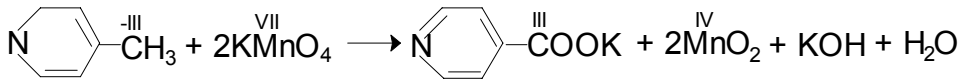
e) ühend on eetriks  .

2. a)



A B C

b)



-III III VII IV

$C - 6e \rightarrow C$ 1

$Mn + 3e \rightarrow Mn$ 6 2

9,3 g m·0,75

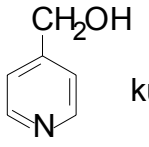
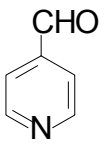
A $\Leftrightarrow$ $2KMnO_4$

93 g/mol 158 g/mol

$$m(KMnO_4) = \frac{2}{1} \cdot \frac{9{,}3\ g}{93\ g/mol} \cdot 158\ g/mol \cdot \frac{1}{0{,}75} = 42{,}1 \sim 42\ g$$

c) $RCOOK + C_3H_7OH \longrightarrow R{-}C(=O){-}OC_3H_7$

$R{-}C(=O){-}OC_3H_7 + H_2NNH_2 \longrightarrow R{-}C(=O){-}NHNH_2 + C_3H_7OH$

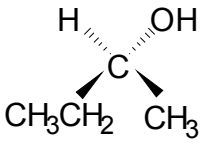
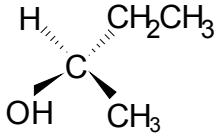
d) Lähteaineteks kõlbavad nii  kui 

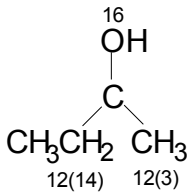
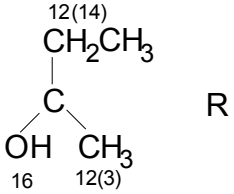
3. a) R_1 on etüülrühm ja R_2 on metüülrühm

A - $CH_3CH_2CH{=}CH_2$ 1-buteen; B - $CH_3CH_2COCH_3$ etüülmetüülketoon e. butanoon; C - $CH_3CH_2CHClCH_3$ 2-klorobutaan, D - CH_3CHO etanaal

b) $CH_3CH_2CH(OH)CH_3$ 2-butanool

c)


S

R

d) $CH_3CH_2CH{=}CH_2 \xrightarrow{H_2O} CH_3CH_2CH(OH)CH_3$

$CH_3CH_2COCH_3 \xrightarrow[NaBH_4]{[H]} CH_3CH_2CH(OH)CH_3$

$CH_3CH_2CHClCH_3 \xrightarrow{KOH} CH_3CH_2CH(OH)CH_3$

$CH_3CHO \xrightarrow{CH_3CH_2MgBr} CH_3CH_2CH(OH)CH_3$

4. a) $N_2O_5(g) \rightarrow N_2O_4(g) + 0{,}5\ O_2\ (g)$

$N_2O_5(g) \rightarrow 2NO_2(g) + 0{,}5\ O_2\ (g)$

b) $\tau = \frac{\ln 2}{k} = \frac{0{,}693}{1{,}42 \cdot 10^{-3}} = 488\ \text{s} = 8{,}13\ \text{min} = 8\ \text{min}\ 8\ \text{s}$

c) Osarõhk on võrdeline kontsentratsiooniga

$$t = \frac{1}{k} \ln \frac{p_o}{p} = \frac{1}{1{,}42 \cdot 10^{-3}} \ln \frac{2{,}84}{0{,}355} = 1464\ \text{s} \sim 24{,}4\ \text{min} \sim 24\ \text{min}\ 20\ \text{s}$$

Võib arvutada ka järgmiselt:

$\frac{2{,}84}{0{,}355} = 8{,}00$ (kontsentratsioon väheneb 8 korda, selleks kulus järelikult kolm poolestusaega) $t = 3 \cdot 488 = 1464\ \text{s} = 24{,}4\ \text{min}$

d) $n^{t_o}(N_2O_5) = \dfrac{2{,}84\ \text{atm} \cdot 10{,}0\ \text{dm}^3}{0{,}08206\ \dfrac{\text{atm} \cdot \text{dm}^3}{\text{mol} \cdot \text{K}} \cdot 323\ \text{K}} = 1{,}071\ \text{mol}$

$n^{t}(N_2O_5) = \dfrac{0{,}355 \cdot 10{,}0}{0{,}08206 \cdot 323} = 0{,}1339 \sim 0{,}134\ \text{mol}$

$n^{t_o}(N_2O_5) - n^{t}(N_2O_5) = 1{,}071 - 0{,}134 = 0{,}937\ \text{mol}$

$n^{t}(NO_2) = \dfrac{2}{1} \cdot 0{,}937 + \dfrac{2}{1} \cdot 0{,}01 = 1{,}87 + 0{,}02 = 1{,}89\ \text{mol}$

$n^{t}(O_2) = \dfrac{0{,}5}{1} \cdot 0{,}937 + \dfrac{0{,}5}{1} \cdot 0{,}01 = 0{,}4685 + 0{,}005 = 0{,}474\ \text{mol}$

5. a) (**-**)Sn(t) + Pb^{2+}(l) $\rightarrow$ Sn^{2+}(l) + Pb(t) (**+**)

$$E_{Me^{2+}/Me} = E^{o}_{Me^{2+}/Me} + \frac{RT}{zF} \ln\left[Me^{2+}\right]$$

b) Elektroodireaktsioonis Me^{2+} + 2e $\rightleftharpoons$ Me on Me redutseerijaks ja [Me]=1

$$\frac{RT}{zF} \ln\left[Me^{2+}\right] = \frac{2{,}3 \cdot 8{,}314\ \dfrac{\text{A} \cdot \text{V} \cdot \text{s}}{\text{mol} \cdot \text{K}} \cdot 298\ \text{K}}{2 \cdot 96500\ \text{A} \cdot \text{s} / \text{mol}} \cdot \lg\left[Me^{2+}\right] = 0{,}0295\ \lg\left[Me^{2+}\right]$$

$E = E_{Pb^{2+}/Pb} - E_{Sn^{2+}/Sn}$ = -0,125 + 0,0295 lg 0,550 - (-0,137 + 0,0295·lg 0,150) =

$$= 0{,}012 + 0{,}0295\ \lg\frac{0{,}550}{0{,}150} = 0{,}012 + 0{,}017 = 0{,}029\ \text{V}$$

c) Voolu tarbimisel Sn^{2+} ioonide kontsentratsioon suureneb ja Pb^{2+} ioonide kontsentratsioon väheneb. Et EMJ võrrandis kontsentratsioonide logaritmid on vastupidise märgiga, siis EMJ pidevalt väheneb.

d) Kui Pb^{2+} ioonide kontsentratsioon väheneb 0,500 mol/dm^3-ni, siis Sn^{2+} ioonide kontsentratsioon suurenes 0,200 mol/dm^3-ni.

$$E = 0{,}012 + 0{,}0295\ \lg\frac{0{,}500}{0{,}200} = 0{,}012 + 0{,}012 = 0{,}024\ \text{V}$$

e) Elemendi töö lakkab, kui elektroodide vaheline elektromotoorjõud võrdub nulliga

$$0 = 0{,}012 + 0{,}0295\ \lg\frac{\left[Pb^{2+}\right]}{\left[Sn^{2+}\right]}, \text{ millest } \lg\frac{\left[Pb^{2+}\right]}{\left[Sn^{2+}\right]} = \frac{-0{,}012}{0{,}0295} = -0{,}4068$$

Sellest avaldame suhte $[Pb^{2+}]/[Sn^{2+}]$=0,40. Et elemendis potentsiaali määravate ioonide üldkontsentratsioon on konstantne, saame teise võrrandi $[Pb^{2+}]+[Sn^{2+}]$ = 0,70 mol/dm^3, mis koos eelmise suhtega võimaldab leida mõlema iooni kontsentratsiooni.

$$\frac{\left[Pb^{2+}\right]}{0{,}70 - \left[Pb^{2+}\right]} = 0{,}40 \qquad [Pb^{2+}] = 0{,}20 \text{ mol/dm}^3;\ [Sn^{2+}] = 0{,}50 \text{ mol/dm}^3$$

6. a) A - Cu; B - Fe; C - Hg; D - Cu(Hg) vaskamalgaam; E - $Cu(NO_3)_2$; F - $FeCl_3$

b) 1) $Cu + Hg \rightarrow Cu(Hg)$; 2) $Cu(Hg) \xrightarrow{t^o} Cu + Hg\uparrow$; 3) $Cu + 4HNO_3 \rightarrow$ $\rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$; 4) $2Fe + 3Cl_2 \rightarrow 2FeCl_3$

c) $\underset{63{,}54\text{ g}}{\overset{m\text{ g}}{Cu}} \Leftrightarrow \underset{242\text{ g/mol}}{\overset{3{,}80\text{ g}}{Cu(NO_3)_2 \cdot 3H_2O}}$

$$m(Cu) = \frac{3{,}80\text{ g}}{242\text{ g/mol}} \cdot 63{,}5\text{ g/mol} = 0{,}997 = 1{,}00\text{ g}$$

$$V(NO_2) = \frac{2}{1} \cdot \frac{3{,}80}{242} \cdot 22{,}4\text{ dm}^3\text{/mol} = 0{,}703\text{ dm}^3$$

$M(Cu(NO_3)_2) = 187{,}6$ g/mol; $M(Cu) = 187{,}6 \cdot 0{,}339 = 63{,}6$ g/mol

d) Kui raud reageerib Cl_2-ga, siis peab tekkima $FeCl_3$ (M=162 g/mol)
$M(Fe) = 162 \cdot 0{,}344 = 55{,}7$ g/mol

e) Mõlema metalli massiprotsent on 50,0 $\left(\frac{1{,}00}{2{,}00} \cdot 100 = 50{,}0\right)$

$$n(Cu) = \frac{1{,}00\text{ g}}{63{,}5\text{ g/mol}} = 0{,}0157\text{ mol}; \qquad n(Fe) = \frac{1{,}00\text{ g}}{55{,}8\text{ g/mol}} = 0{,}0179\text{ mol}$$

$$\%(Cu) = \frac{0{,}0157}{0{,}0336} \cdot 100 = 46{,}7\ \% \qquad \%(Fe) = \frac{0{,}0179}{0{,}0336} = 53{,}3\ \%$$