2000/2001 õa keemiaolümpiaadi lõppvooru ülesannete lahendused
11. klass

1. a) i) **X** + Pb^{2+} = X^{2+} + Pb↓

ii) ii) **X** + Cu^{2+} = X^{2+} + Cu↓

b) M(Pb) = 207,29 g/mol ja M(Cu) = 63,5 g/mol; M(X) – metalli molaarmass, m – metallplaadi mass, n – reaktsiooni astunud metalli ja ioonide hulk.

Lahuses 1 Δm_1=207,2 g/mol·n-M(X)·n; [207,2 g/mol·n-M(X)·n]/m=0,190

Lahuses 2 Δm_2=M(X)·n-63,5 g/mol·n; [M(X)·n-63,5 g/mol·n]/m=0,098

207,2 g/mol - M(X) = 0,190 m/n (I)

M(X) - 63,5 g/mol = 0,098m/n (II)

Liites (I) ja (II) saame

143,7 g/mol = 0,288 m/n, millest m/n = 498,9 g/mol

Asetame saadud tulemuse võrrandisse I saame

M(X) = 207,2 g/mol - 0,190·498,9 g/mol = 112 g/mol

X – Cd, kaadmium

c) 3600 s·1,000 A 2,097 g

$2e^-$ ⇔ **X**

96485 m

$$2{,}097\ \text{g} = \frac{1}{2}\cdot 3600\ \text{s}\cdot 1{,}000\ \text{A}\cdot\frac{1\ \text{mol}}{96485\ \text{A}\cdot\text{s}}\cdot M(X)$$

$$M(X) = 2{,}097\ \text{g}\cdot 2\cdot 96485\ \text{A}\cdot\text{s}\cdot\frac{1}{\text{mol}}\cdot\frac{1}{3600\ \text{A}\cdot\text{s}} = \mathbf{112{,}4\ g/mol}$$

d) Cd + H_2SO_4 (lahj.)= $CdSO_4$ + H_2 (elektrolüüdi saamiseks)

anoodil Cd = Cd^{2+} + $2e^-$

katoodil Cd^{2+} + $2e^-$ = Cd

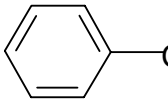
Elektroodideks on Cd plaadid.

2. a) i) Ühend **C** on kahte fenüülrühma sisaldav ester.

ii) $C_{15}H_{14}O_2$ + NaOH = $C_7H_5O_2Na$ + C_8H_9OH

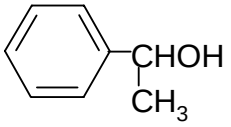
C **D** **A**

b) Ühend **B** peab olema fenüülrühma (C_6H_5–) ja karboksüülrühma (–COOH) sisaldav hape, sest ta saadi ühendi **A** oksüdeerimisel ja ühend **D** on ühendi **A** sool

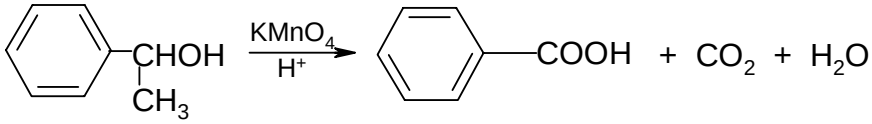


COOH ühend **B**

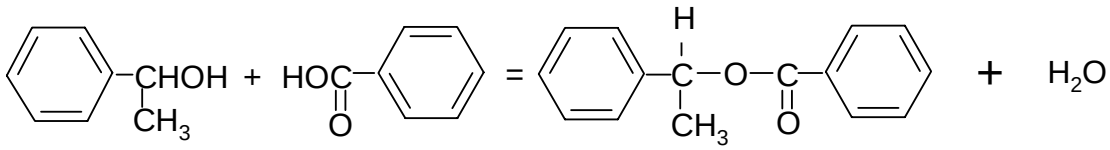
Ühend **A** on fenüülrühma (C_6H_5–) ja metüülrühma (CH_3–) sisaldav sekundaarne alkohol (>CHOH) C_8H_9OH. 1–metüül-1–fenüülmetanool on optiliselt aktiivne, sest üks süsinikest on seotud nii vesiniku, hapniku, metüül– kui ka fenüülrühmaga. Rühma [–$CH(CH_3)OH$] molaarmass on karbonüülrühma (–COOH) molaarmassiga võrdne.



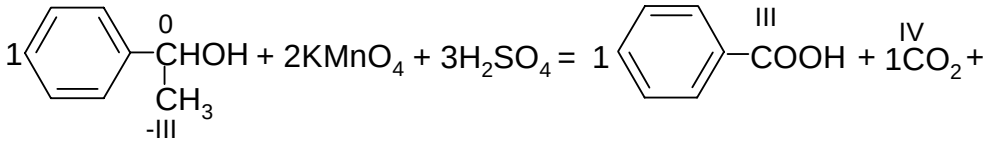
ühend **A**

c) i)


A **B**

ii)


A **B** **C**

d)


$+ 1K_2SO_4 + 2MnSO_4 + 5H_2O$

$0 \quad III$
$C - 3e^- = C$ ⎫
$-III \quad IV$ ⎬ -10 1
$C - 7e^- = C$ ⎭
$VII \quad II$
$Mn + 5e^- = Mn$ +5 2

3. a) $n(C) = n(CO_2) = 1{,}15\ dm^3 \cdot \frac{1\ mol}{22{,}4\ dm^3} = 0{,}05134\ mol$

$m(C) = 0{,}05134\ mol \cdot 12{,}0\ g/mol = 616\ mg$

$n(H) = 2n(H_2O) = 2 \cdot 1{,}15\ g \cdot \frac{1\ mol}{18{,}0\ g} = 0{,}1278\ mol$

$m(H) = 0{,}1278\ mol \cdot 1{,}008\ g/mol = 128{,}8\ mg \approx 129\ mg$

$m(O) = (949 - 616 - 129)\ mg = 204\ mg$

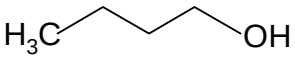
$n(O) = 0{,}204\ g \cdot \frac{1\ mol}{16{,}0\ g} = 0{,}01275\ mol$

Eeldame, et 1 ainet sisaldab 1 mool hapnikku

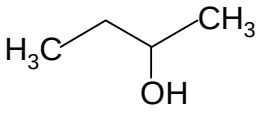
$n(C) = 0{,}05134\ mol \cdot \frac{1\ mol}{0{,}01275\ mol} = 4\ mol$

$n(H) = 0{,}1278\ mol \cdot \frac{1\ mol}{0{,}01275\ mol} = 10\ mol$

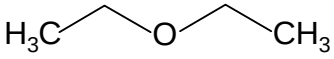
$C_4H_{10}O$

b) 

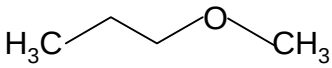
1-butanool



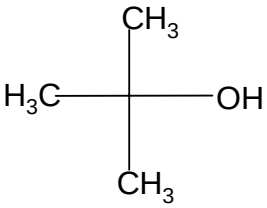
2-butanool



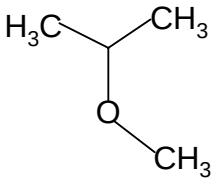
etoksüetaan



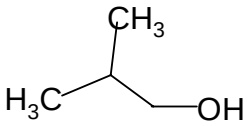
metoksüpropaan



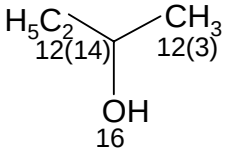
2-metüül-2-propanool



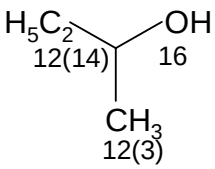
2-metoksüpropaan



2-metüülpropanool

c) 

R-2-butanool



S-2-butanool

4. a) **B –** CH_3CH_3, etaan
C – NaOH, naatriumhüdroksiid
D – CO_2, süsinikdioksiid
E – H_2, vesinik
F – Na_2CO_3, naatriumkarbonaat
G – $NaHCO_3$, naatriumvesinikkarbonaat
H – $CH_2=CH_2$, eteen
I – $BrCH_2CH_2Br$, 1,2–dibromoetaan
J – $CH{\equiv}CH$, etüün

b) i) CH_3CH_3 (**B**) = $CH_2=CH_2$ (**H**) + H_2

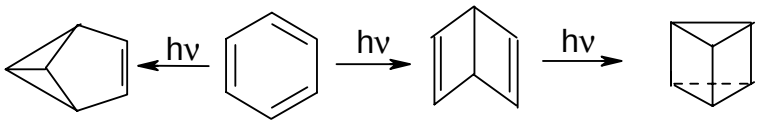
ii) $CH_2=CH_2$ (**H**) + Br_2 = $BrCH_2CH_2Br$ (**I**)

iii) $BrCH_2CH_2Br$ (**I**) + 2KOH $\xrightarrow[H_2O]{t^o}$ $CH{\equiv}CH$ (**J**) + 2KBr + $2H_2O$

iv) CO_2 (liias) (**D**) + NaOH (**C**) $\xrightarrow{H_2O}$ Na_2CO_3 (**F**) + H_2O

v) CO_2 (**D**) + NaOH (**C**) = $NaHCO_3$ (**G**)

c)



L benseen **K** Dewar'i benseen **M** Landenburgi benseen ehk prismaan

5. a) i) $H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$

$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$

ii) $K_1 = \frac{[H^+]\cdot[HCO_3^-]}{[H_2CO_3]}$ $K_2 = \frac{[H^+][CO_3^{2-}]}{[HCO_3^-]}$

b) i) $pH = pK - \lg\frac{[H_2CO_3]}{[HCO_3^-]} = 6{,}10 - \lg\frac{1}{20} =$ **7,40**

ii) $[H^+] = 10^{-pH} = 10^{-7,4} =$ **$3{,}98\cdot10^{-8}$ M**

c) Esialgse pH väärtuse saavutamiseks peab (langenud) pH väärtus tõusma, mis eeldab, et liige $-\lg\frac{[H_2CO_3]}{[HCO_3^-]}$ peab suurenema. Liige $\frac{[H_2CO_3]}{[HCO_3^-]}$ annab murdarvu, mille negatiivne logaritm suureneb, kui murdarv ise väheneb. Tasakaaluline süsihappe kontsentratsioon väheneb kiiremal hingamisel, sest gaasifaasist eemaldatakse CO_2. (Esialgne) pH väärtus taastub kiiremal hingamisel.

6. a) X – Sn, tina

Y – Pb, plii

b) i) $Sn + S = SnS$

$SnS + S \xrightarrow{^{o}t} SnS_2$

A

ii) $Pb(NO_3)_2 + 2KI = PbI_2 + 2KNO_3$

B

iii) $3Sn + 8HNO_3\ (lahj.) = 3Sn(NO_3)_2 + 2NO + 4H_2O$

(-) (+)

c) $Pb\,|\,H_2SO_4\,|\,PbO_2$

d) i) katoodreaktsioon: $Pb^{4+} + 2e^- = Pb^{2+}$

ii) anoodreaktsioon: $Pb = Pb^{2+} + 2e^-$

iii) $Pb + PbO_2 + 2H_2SO_4 = 2PbSO_4\downarrow + 2H_2O$

e) IV II IV

H_2SnO_3 $Pb_2PbO_4 \Leftrightarrow Pb_3O_4$

D **E**