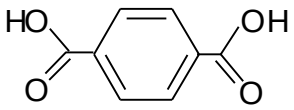
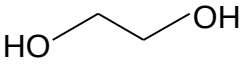
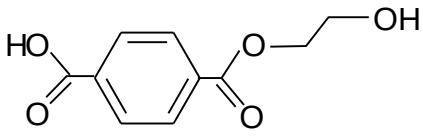
1999/2000 õa keemiaolümpiaadi III vooru ülesannete lahendused
11. klass

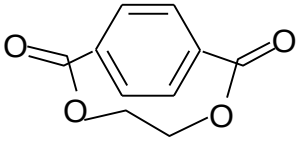
1. a) 

1,4–benseendikarboksüülhape, para–benseendikarboksüülhape

b) 

1,2–etaandiool

c) 

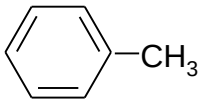
d) 

e) $p_1 \cdot V_1 = p_2 \cdot V_2$

$6\ \text{atm} \cdot 530\ \text{ml} = 1\ \text{atm} \cdot V$

$$V = 530\ \text{ml} \cdot \frac{6\ \text{atm}}{1\ \text{at}} \cdot \frac{1\ \text{dm}^3}{1000\ \text{ml}} = 3{,}18\ \text{dm}^3$$

$$\textbf{n(õhk)} = 3{,}18\ \text{dm}^3 \cdot \frac{1\ \text{mol}}{22{,}4\ \text{dm}^3} = \textbf{0,142 mol}$$

2. a) i) 

ii) $C(CH_3)_3OOH$

iii) $C(CH_3)_3OH$

b) i) $C(CH_3)_3OOH + 2KI + 2HCl = C(CH_3)_3OH + I_2 + 2KCl + H_2O$

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

c) $25{,}0\ \text{cm}^3$ $\qquad$ $10{,}20\ \text{cm}^3 \cdot 0{,}2039\ \text{mol/dm}^3$

$C(CH_3)_3OOH$ U $2Na_2S_2O_3$

90,1 g/mol

m[$C(CH_3)_3OOH$] = $\frac{1}{2} \cdot 10{,}20\ cm^3 \cdot 0{,}2039\ mol/dm^3 \cdot \frac{1}{25{,}0\ cm^3} \cdot 1\ dm^3 \cdot 90{,}1\ g/mol$ = **3,74 g**

3. a) M(X) = 2,0 g/mol·22 = 44 g/mol

b) **1)** $3H_2 + N_2 \xrightarrow[Pt]{p,\ t^o} 2NH_3$ (ühend **A** on ammoniaak)
2) $4NH_3 + 5O_2 = 4NO + 6H_2O$ (ühend **B** on lämmastikoksiid)
3) $2NO + O_2 = 2NO_2$ (ühend **C** on lämmastikdioksiid)
4) $4NO_2 + O_2 + 2H_2O = 4HNO_3$ (ühend **D** on lämmastikhape)
5) $HNO_3 + NH_3 = NH_4NO_3$ (ühend **E** on ammooniumnitraat)
6) $NH_4NO_3 \xrightarrow{t^o} N_2O\uparrow + 2H_2O$

c) $10HNO_3$ lahj. + 4Mg = $4Mg(NO_3)_2$ + **N_2O**$\uparrow$ + $5H_2O$
ühend **X** - dilämmastikoksiid

d) **i)** $2NH_3 + 2Na = 2NaNH_2 + H_2$
ii) $NaNH_2 + N_2O = NaN_3 + H_2O$
iii) $2NaN_3 + Pb^{2+} = Pb(N_3)_2\varnothing + 2Na^+$

e) H–N–N ρ N ⇌ H–N=N=N

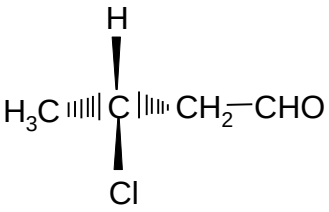
4. a) **i) M(A)** = 1,1607 g/dm^3·22,4 dm^3/mol = **26,0 g/mol**
ii) n(C) = 26,0 g·0,923·$\frac{1\ mol}{12\ g}$ = 2 mol
n(H) = 26,0 g·0,077·$\frac{1\ mol}{1\ g}$ = 2 mol
C_2H_2

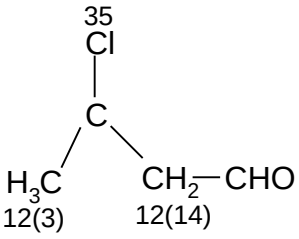
iii) HC r CH

b) **i)** $HC \equiv CH + H_2O \xrightarrow[OH^-]{katal} CH_3CHO$ (ühend **B**)
ii) $2CH_3CHO = CH_3CH(OH)CH_2CHO$ (ühend **X**)
iii) $CH_3CH(OH)CH_2CHO \xrightarrow{t^o} CH_3CH=CHCHO$ (krotoonaldehüüd)
ühend **E**

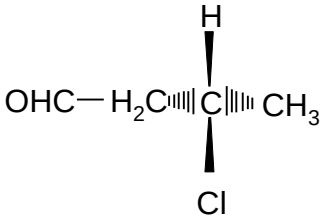
+σ -σ
iv) $CH_3CH=CHCHO + HCl = CH_3CHClCH_2CHO$ (3–klorobutanaal–1)

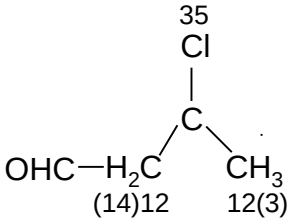
c)





R,3-klorobutanaal-1





S,3-klorobutanaal-1

5. a) **i)** $Zn = Zn^{2+} + 2e^-$

ii) $Cu^{2+} + 2e^- = Cu$

b) $Zn \mid ZnSO_4 \mid\mid CuSO_4 \mid Cu$

c) $E = E^o(Cu^{2+}/Cu) - E^o(Zn^{2+}/Zn) + \frac{0{,}0591}{2}\left[\lg c(Cu^{2+}) - \lg c(Zn^{2+})\right] =$

$= 0{,}340V - (-0{,}763\ V) + 0{,}0296\ [-1 - (-1)]\ V =$ **1,103 V**

d) Galvaanielement töötab kuni kogu Cu^{2+} on redutseerunud

Cu^{2+} Y $2e^-$

Q = $\frac{2}{1} \cdot 1{,}00\ dm^3 \cdot 0{,}100\ mol/dm^3 \cdot 96500\ A \cdot s/mol \cdot \frac{1\ h}{3600\ s}$ = **5,36 A×h**

6. a) **i)** $n(Cu) = 10{,}20 \cdot 10^{-3}\ dm^3 \cdot 0{,}0100\ mol/dm^3 \cdot 10 = 1{,}02 \cdot 10^{-3}\ mol$

$m(Cu) = 1{,}02 \cdot 10^{-3}\ mol \cdot 63{,}5\ g/mol = 0{,}0648\ g$

%(Cu) = $\frac{0{,}0648}{0{,}2317} \cdot 100$ = **28,0**

ii) $n(Y+Cu) = 13{,}70 \cdot 10^{-3}\ dm^3 \cdot 0{,}0100\ mol/dm^3 \cdot 10 = 1{,}36 \cdot 10^{-3}\ mol$

$n(Y) = 1{,}36 \cdot 10^{-3}\ mol - 1{,}02 \cdot 10^{-3}\ mol = 3{,}4 \cdot 10^{-4}\ mol$

$m(Y) = 3{,}4 \cdot 10^{-4}\ mol \cdot 88{,}9\ g/mol = 0{,}0302\ g \approx 0{,}030\ g$

%(Y) = $\frac{0{,}0302}{0{,}2317} \cdot 100$ = **13**

iii) $n(Ba) = (20{,}00 \cdot 10^{-3}\ dm^3 \cdot 0{,}0100\ mol/dm^3 -$

$- 8{,}80 \cdot 10^3 dm^3 \cdot 0{,}0150\ mol/dm^3) \cdot 10 = 6{,}8 \cdot 10^{-4}\ mol$

$m(Ba) = 6{,}8 \cdot 10^{-4}\ mol \cdot 137\ g/mol = 0{,}0932\ g \approx 0{,}093\ g$

%(Ba) = $\frac{0{,}0932}{0{,}2317} \cdot 100$ = **40**

iv) m(O) = 0,2317 g - 0,0648 g - 0,0302 g - 0,0932 g=0,0434 g ≈ 0,043 g

%(O) = $\frac{0,0434}{0,2317} \cdot 100$ = **19**

b)

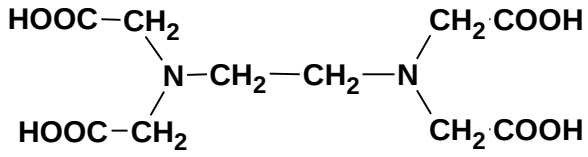
Cu	Y	Ba	O
$1,02 \cdot 10^{-3}$ mol	$3,4 \cdot 10^{-4}$ mol	$6,8 \cdot 10^{-4}$ mol	$\frac{0,0434\ g}{16 g/mol} = 2,71 \cdot 10^{-3}$ mol

$\frac{1\ mol}{3,4 \cdot 10^{-4}\ mol}$ = 2941

n(Cu) = $2941 \cdot 1,02 \cdot 10^{-3}$ mol = 3 mol
n(Ba) = $2941 \cdot 6,8 \cdot 10^{-4}$ mol = 2 mol
n(O) = $2941 \cdot 2,71 \cdot 10^{-3}$ mol = 8 mol

$Cu_3Y_1Ba_2O_8$

c) i)



ii)