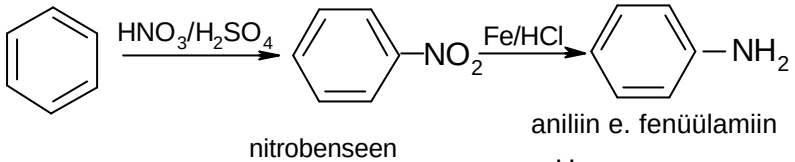
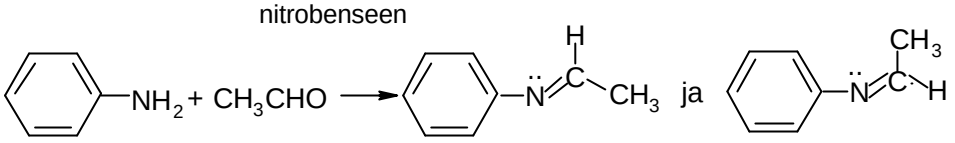
1999/2000 õa keemiaolümpiaadi piirkondliku vooru ülesannete lahendused
11. klass

1. a) Näiteks: Aniliini sünteesiks nitreeris keemiateaduskonna **dekaan benseeni lämmastik-** ja **väävelhappe** seguga ning redutseeris moodustunud nitrobenseeni **rauaga soolhappe** keskkonnas. 0,5

b) 

nitrobenseen — aniliin e. fenüülamiin (á 1*) 4

c) 

(1,5;1*;1*) 3,5 .

8 p

2. a) $4C_6H_2(NO_2)_3CH_3 = 26C + 10H_2O + 2CO + 6NO_2 + 3N_2$ 2*

b) 1000 g

4(TNT) Y (10+2+6+3) (gaase) 1

227 g/mol

n(gaas) = $\frac{21}{4} \cdot 1000\ \text{g} \cdot \frac{1\ \text{mol}}{227\ \text{g}} = \mathbf{23{,}1\ mol}$ 2

c) $p \cdot V = n \cdot R \cdot T$; 2*

V(gaas) = $23{,}13\ \text{mol} \cdot 8{,}314 \frac{\text{N} \cdot \text{m}}{\text{K} \cdot \text{mol}} \cdot 1773\ \text{K} \cdot \frac{1}{1{,}013 \cdot 10^5} \frac{\text{m}^2}{\text{N}} = \mathbf{3{,}37\ m^3}$ 2 .

9 p

3. a) i) 1–butanool; (0,5*) **ii)** 2–pentanool; (1*) **iii)** 3–metüül–3–heksanool; (1,5*) 3

b) i) $C_4H_9OH \xrightarrow{O} C_3H_7CHO \xrightarrow{O} C_3H_7COOH$ 2

butanaal butaanhape

ii) $C_3H_7CH(OH)CH_3 \xrightarrow{O} C_3H_7COCH_3$ 2

2–pentanoon

iii) $C_3H_7C(CH_3)(OH)C_2H_5 \xrightarrow{O}$ ei oksüdeeru 1* .

8 p

4. a) i) %(CH_4) = $\frac{49{,}1}{100 - 32} \cdot 100 = \mathbf{72{,}2}$ 1

ii) %(O_2) = $\frac{7{,}5}{100 - 32} \cdot 100 = \mathbf{11}$ 2

b) $CH_4 + 2O_2 = CO_2 + 2H_2O$ 0,5

Olgu puhastatud prügilagaasi ruumala V

$V(\Sigma O_2) = \frac{2}{1} \cdot 0{,}722V = 1{,}44V$ 1

$V(O_2, \text{õhust}) = 1{,}44V - 0{,}11V = 1{,}33V$ 1

$V(\text{õhk}) = \frac{1{,}33V}{0{,}21} = 6{,}3V$ **V(prügilagaas) : V(õhk)** = **1 : 6,3** 1,5

c) $CH_4 + 2O_2 = CO_2 + 2H_2O$ 0,5

Reaktsioonientalpia tekkeentalpiate järgi võrdub saadusainete tekkeentalpiate (summa) ja lähteainete tekkeentalpiate (summa) vahega

ΔH = 1 mol·(-393 kJ/mol)+2 mol·(-286 kJ/mol)-[2·0+1 mol·(-75 kJ/mol)] = -890 kJ 2

$\Delta H = \frac{1000\ \text{dm}^3 \cdot 0{,}722}{22{,}4\ \text{dm}^3/\text{mol}} \cdot (-890\ \text{kJ/mol}) =$ **-28,7 MJ** 1,5 .

11 p

5. a) Moodustunud soolade sinine värvus viitab, et katiooniks on vask. Et aine **A** reageerimisel hapetega happed redutseeruvad, siis on ühendiks **A** vask(I)ühend. Kui mittemetalliks on element **X**, siis

2,72 g 0,851 dm^3

CuX → NO_2

M 22,4 dm^3/mol

$$2{,}72\ \text{g} = \frac{1}{1} \cdot 0{,}851\ \text{dm}^3 \cdot \frac{1\ \text{mol}}{22{,}4\ \text{dm}^3} \cdot M(CuX)$$

M(CuX) = 71,5 g/mol; M(X*) = 71,5 g/mol - 63,5 g/mol = 8 g/mol

* - sellise molaarmassiga mittemetalli ei ole.

$Cu_2X = 2NO_2$, mis arvutades annab $M(Cu_2X) = 2 \cdot M(CuX^*)$ 0,5

$M(Cu_2X) = 2 \cdot 71{,}5$ g/mol = 143 g/mol 1,5

M(X) = 143 g/mol - 127 g/mol = 16 g/mol 1

A → Cu_2O 1

b) i) $Cu_2O + 6HNO_3 = 2Cu(NO_3)_2 + 2NO_2 + 3H_2O$ 1*

ii) $Cu_2O + 3H_2SO_4 = 2CuSO_4 + H_2SO_3 + 2H_2O$ 1,5*

c) Cu_2O reageerimisel lämmastikhappega moodustub $Cu(NO_3)_2$ ja väävelhappega – $CuSO_4$.

i) $M[Cu(NO_3)_2] = 187{,}6$ g/mol 0,5

$$0{,}596 = \frac{6 \cdot 16 + n \cdot 16}{187{,}6 + n \cdot 18}; \qquad 5{,}27n = 15{,}8$$ 1

$n(H_2O)$ = 3 0,5

ii) $M(CuSO_4) = 159{,}6$ g/mol 0,5

$$0{,}577 = \frac{4 \cdot 16 + n \cdot 16}{159{,}6 + n \cdot 18}; \qquad 5{,}61n = 28{,}1$$ 1

$n(H_2O)$ = 5 0,5

d) A - Cu_2O, vask(I)oksiid; **B** – NO_2, lämmastikdioksiid; **C** – $Cu(NO_3)_2$, vask(II)nitraat; **D**–$Cu(NO_3)_2 \cdot 3H_2O$, vask(II)nitraat-3-vesi; **E**–$CuSO_4$, vasksulfaat; **F** – H_2SO_3, väävlishape; **G** – $CuSO_4 \cdot 5H_2O$, vasksulfaat-5-vesi. (á 0,5*) 3,5 .

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6. a) i) 2 NaOH → H_2SO_4

$$\textbf{m(NaOH)} = \frac{2}{1} \cdot 20{,}0\ \text{g} \cdot 0{,}200 \cdot \frac{1\ \text{mol}}{98{,}1\ \text{g}} \cdot 40{,}0\ \text{g/mol} =$$ **3,26 g** 1

ii) m(NaOH) = 16,04 g - 3,26 g = **12,78 g** 1

b) H_2SO_4 → 2NaOH SO_3 → 2NaOH

$n(H_2SO_4, SO_3) = \frac{2}{1} n(NaOH)$ 2*

$$\frac{m(SO_3)}{80{,}1\ \text{g/mol}} + \frac{15{,}0\ \text{g} - m(SO_3)}{98{,}1\ \text{g/mol}} = \frac{1}{2} \cdot \frac{12{,}78}{40{,}00\ \text{g/mol}}$$ 4

$0{,}01248m(SO_2) + 0{,}1529\ \text{g} - 0{,}01019m(SO_3) = 0{,}15975\ \text{g}$

$0{,}00229m(SO_3) = 0{,}00685\ \text{g}$ $m(SO_3) = 3{,}0\ \text{g}$

$$\textbf{\%(SO}_3\textbf{)} = \frac{3{,}0\ \text{g}}{15{,}0\ \text{g}} \cdot 100 =$$ **20** 2 .

8 p