2003/2004 õa keemiaolümpiaadi piirkonnavooru
ülesannete lahendused
11. klass

1. a) $\mathbf{V_M(Au)} = 197\ \text{g/mol} \cdot \frac{1\ \text{cm}^3}{19{,}3\ \text{g}} = \mathbf{10{,}2\ cm^3/mol}$

b) $O_2 \Leftrightarrow 4e^-$ N(F) = 4

c) Väheneb, sest dissotsiatsioonimäära muutus on ioonide kontsentratsiooni muutusest väiksem.

d) i) HCl, SO_2, NH_4Cl

ii) SiO_2, NaCl, CuO

iii) CaO, Na_2S, NaOH

e) Reaktsiooni kiirus väheneb $4^4 = 256$ korda.

f) Rõhu tõstmine, temperatuuri alandamine, lämmastiku või vesiniku kontsentratsiooni suurendamine, ammoniaagi kontsentratsiooni vähendamine.

2. a) i) $NH_4NO_2 = N_2 + 2H_2O$

-III VII 0 IV

ii) $(NH_4)_2S_2O_8 = N_2 + 2SO_2 + 4H_2O$

$2\cdot 0 \quad 2\cdot(-III)$

$N_2 + 6e^- = 2N$ | 1

$2\cdot IV \quad 2\cdot VII$ |

$2S - 6e^- = 2S$ | 1

iii) $3(NH_4)_2SO_4 = 1N_2 + 3SO_2 + 6H_2O + 4NH_3$

$0 \quad 2\cdot(-III)$

$N_2 + 6e^- = 2N$ | 1

$IV \quad VI$ |

$S - 2e^- = S$ | 3

b) Sobivaimaks on reaktsioon **i)**, kuna saadusained ei ole mürgised.

c) $NaNO_2 + NH_4Cl \xrightarrow{^0t} NaCl + N_2 + 2H_2O$

d) $V(N_2) = \frac{4}{3} \cdot 3{,}14 \cdot 3{,}2^3\ \text{cm}^3 = 137\ \text{cm}^3 = 0{,}000137\ \text{m}^3 = 1{,}37\cdot 10^{-4}\ \text{m}^3$

$n(N_2) = \frac{10^5\ \text{N/m}^2 \cdot 1{,}37 \cdot 10^{-4}\ \text{m}^3}{8{,}314\ \text{N}\cdot\text{m}/(\text{mol}\cdot\text{K}) \cdot 298\ \text{K}} = 0{,}00553\ \text{mol}$

$N_2 \Leftrightarrow 1NaNO_2 + 1NH_4Cl$

69,0 g/mol 53,5 g/mol

m(tablett) = 0,00553 mol · (69,0 g/mol + 53,5 g/mol) = 0,677 g ≈ **0,68 g**

3. a)

X – I_2, jood
Y – Br_2, broom
Z – Cl_2, kloor
Q – F_2, fluor
A - H_2, vesinik

B – HI, vesinikjodiid
C – HBr, vesinikbromiid
D – HCl, vesinikkloriid
E – HF, vesinikfluoriid
F – H_2SiF_6, heksafluororänihape

b) Võttes ruumalaühikuks 1 liiter, siis m(H_2O) = 1000 g ja n(H**X**) = 10 mooli

n(**B**) = 224 $dm^3 \cdot \frac{1\,mol}{22{,}4\,dm^3}$ = 10 mol

m(**B**) = 1000 g $\cdot \frac{56{,}1\%}{43{,}9\%}$ = 1278 g ≈ 1280 g

M(**B**) = 1280 g $\cdot \frac{1}{10\,mol}$ = 128 g/mol

2**B** ⇔ **X** M_r(**X**) = 2·128 - 2 · 1 = 2·127

X – I_2

c) i) $I_2 + H_2 = 2HI$

ii) $6HF + SiO_2 = H_2SiF_6 + 2H_2O$

iii) $8HI + 1H_2SO_4 = 4I_2 + 1H_2S + 4H_2O$

iv) $2HBr + H_2SO_4 = Br_2 + SO_2 + 2H_2O$

v) Anoodreaktsioon $2F^- = F_2 + 2e^-$

vi) $16HCl + 2KMnO_4 = 2KCl + 2MnCl_2 + 5Cl_2 + 8H_2O$

$\overset{2\cdot 0}{Cl_2} + 2e^- = \overset{2\cdot(-I)}{2Cl}$ | 5

$\overset{II}{Mn} - 5e^- = \overset{VII}{Mn}$ | 2

või

$14HCl + K_2Cr_2O_7 = 2KCl + 2CrCl_3 + 3Cl_2 + 7H_2O$

$\overset{2\cdot 0}{Cl_2} + 2e^- = \overset{2\cdot(-I)}{2Cl}$ | 3

$\overset{III}{Cr} - 3e^- = \overset{VI}{Cr}$ | 2

4. a) 1 dm^3 · 1,0 kg/dm^3 = 1000 g

i) c(CH_3COOH) = 1000 g · 0,006 · $\frac{1\,mol}{60\,g} \cdot \frac{1}{dm^3}$ = **0,10 mol/dm^3**

ii) n($NH_3 \cdot H_2O$) ⇔ n(NH_3)

c($NH_3 \cdot H_2O$) = 1000 g · 0,0017 · $\frac{1\,mol}{17\,g} \cdot \frac{1}{dm^3}$ = **0,10 mol/dm^3**

b) i) $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

$K_{dis}(CH_3COOH) = \frac{[CH_3COO^-]\cdot[H^+]}{[CH_3COOH]}$ ühik mol/dm^3

ii) $NH_3 \cdot H_2O \rightleftharpoons NH_4^+ + OH^-$

$K_{dis}(NH_3 \cdot H_2O) = \frac{[NH_4^+][OH^-]}{[NH_3 \cdot H_2O]}$

c) i) $[H^+] = \alpha \cdot c(CH_3COOH)$

$\alpha = \sqrt{\frac{K_{dis}}{c}}$

$[H^+]$= $\sqrt{\frac{K_{dis}\cdot c^2}{c}} = \sqrt{1{,}8\cdot 10^{-5}\ mol/dm^3 \cdot 0{,}1\ mol/dm^3}$ = **$1{,}3\cdot 10^{-3}$** mol/dm^3

ii) $[OH^-] = \sqrt{1{,}8\cdot 10^{-5}\ mol/dm^3 \cdot 0{,}1\,mol/dm^3}$ = $1{,}3\cdot 10^{-3}$ mol/dm^3

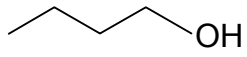
[H^+] = $\frac{K_w}{[OH^-]} = \frac{10^{-14}\ mol^2/dm^6}{1{,}3 \cdot 10^{-3}\ mol/dm^3}$ **= 7,7·10^{-12} mol/dm^3**

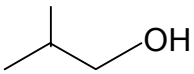
d) $K_w(80\ ^0C) = 4{,}6 \cdot 10^{-15}\ mol/dm^3 \cdot 971{,}83\ g/dm^3 \cdot \frac{1\,mol}{18{,}0\,g} = 2{,}5 \cdot 10^{-13}\ mol^2/dm^6$

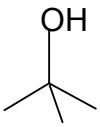
[H^+,H_2O,80 ^{0}C] = $\sqrt{2{,}5 \cdot 10^{-13}}$ **= 5,0·10^{-7} mol/dm^3**

5.

a) i) $C_4H_{10}O$ jaoks 3 ahelisomeeri;

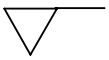
1.  1-butanool

2.  2-metüül-1-propanool

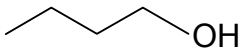
3.  2-metüül-2-propanool

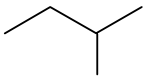
ii) C_4H_8 jaoks 2 ahelisomeeri;

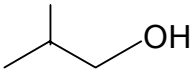
1.  tsüklobutaan

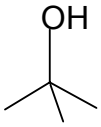
2.  metüültsüklopropaan

b) $C_4H_{10}O$ jaoks 2 paari (kokku 4) asendiisomeeri:

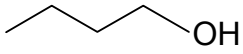
1.  1-butanool

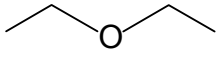
2.  2-butanool

3.  2-metüül-1-propanool

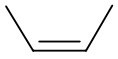
4.  2-metüül-2-propanool

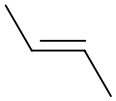
c) $C_4H_{10}O$ jaoks 2 isomeeri, mis kuuluvad erinevatesse aineklassidesse;

1.  1-butanool

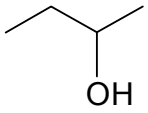
2.  dietüüleeter

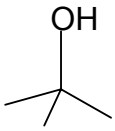
d) C_4H_8 jaoks cis-trans isomeerid;

1.  cis-but-2-een

2.  trans-but-2-een

e) $C_4H_{10}O$ jaoks **i)** sec-ühend ja **ii)** tert-ühend.

i)  sec-butüülalkohol

ii)  tert-butüülalkohol

6. a) i) $CH_3COOH(v) + 2O_2 = 2CO_2 + 2H_2O(v)$

ii) ΔH^0 = 2 mol·(-394 kJ/mol)+2 mol·(-286 kJ/mol)–1 mol·(-487 kJ/mol) = = -873 kJ

ΔH_c^0 **(CH_3COOH) = -873 kJ/mol**

b) i) $2C + 3H_2 + 0{,}5O_2 = C_2H_5OH(v)$

ii) ΔH^0= 2 mol·(-394 kJ/mol)+3 mol·(-286 kJ/mol)–1 mol·(-1368 kJ/mol) = = -278 kJ

ΔH_f^0 **[$C_2H_5OH(v)$] = -278 kJ/mol**

Märkus: Vesiniku ja süsiniku põlemisentalpiad on vastavalt vee ja süsinikdioksiidi tekkeentalpiateks.

c) i) $C_2H_5OH(v) + 0{,}5O_2 = CH_3CHO + H_2O$

ii) ΔH^0 = 1 mol·(-167 kJ/mol)+1 mol·(-286 kJ/mol)-1 mol·(-278 KJ/mol) = **= -175 kJ**