2002/2003 õa keemiaolümpiaadi lõppvooru ülesannete lahendused

10. klass

1. a) i) A – CO_2, süsinikdioksiid
B – H_2, vesinik
C – Na, naatrium
ii) D – H_2SO_4, väävelhape
E – NH_3, ammoniaak

b) CO_2 täidetud õhupall on ohutu, H_2 on plahvatusohtlik ja NH_3 on hingamist ärritav.

c) M_r(õhk) = 29 < M_r (CO_2)= 44, langeb põrandale
M_r(õhk) = 29 > M_r(H_2) = 2, tõuseb lakke
M_r(õhk) = 29 > M_r(NH_3) = 17, tõuseb lakke

d) F – NaOH, naatriumhüdroksiid
G – $NaHCO_3$, naatriumvesinikkarbonaat
H – NH_4HCO_3, ammooniumvesinikkarbonaat
I – $(NH_4)_2SO_4$ ammooniumsulfaat
J – Na_2SO_4, naatriumsulfaat

e) i) $2Na + 2H_2O = 2NaOH + H_2\uparrow$
ii) $2NaOH + H_2SO_4 = Na_2SO_4 + 2H_2O$
iii) $NaOH + CO_2 = NaHCO_3$
iv) $2NaHCO_3 + H_2SO_4 = Na_2SO_4 + 2CO_2 + 2H_2O$
v) $CO_2 + NH_3 + H_2O = NH_4HCO_3$
vi) $2NH_4HCO_3 + H_2SO_4 = (NH_4)_2SO_4 + 2CO_2 + 2H_2O$

2. a) i) $Cu + 4HNO_3(konts) = Cu(NO_3)_2 + 2NO_2 + 2H_2O$

II	(-)	0	
Cu	$+ 2e^-$	$= Cu$	1
IV	(-)	V	
N	$- 1e^-$	$= N$	2

ii) $Sn + 4HNO_3(konts) = H_2SnO_3 \cdot H_2O + 4NO_2$

0	(-)	IV	
Sn	$- 4e^-$	$= Sn$	1
V	(-)	IV	
N	$+ 1e^-$	$= N$	4

b) $Sn(OH)_4$, tina(IV)hüdroksiid
c) m($H_2SnO_3 \cdot H_2O$) = 32,61 g - 5,08 g = 27,53 g
M_r ($H_2SnO_3 \cdot H_2O$) ⇔ A_r(Sn)
186,6 118,6

%(Sn) = 27,53 g · 118,6 · $\frac{1}{186,6} \cdot \frac{1}{139,88\ \text{g}} \cdot 100$ = **12,51**

d) $M_r(CuO) \Leftrightarrow A_r(Cu)$
79,5 63,5

m[Cu, vask(II)oksiidis] = $0,636\ \text{g} \cdot 63,5 \cdot \frac{1}{79,5}$ = 0,508 g

m(Cu, saadud sulamis) = (5,08 g - 0,508 g) · 0,0556 = 0,254 g

%(Au) = (5,08 g - 0,508 g - 0,254 g) · $\frac{1}{5,08\ \text{g}} \cdot 100$ = **85,0**

3. a) Mineraalsest osast lendub põletamisel sama kogus CO_2, nagu eraldub seda soolhappega reageerimisel.

$m(CO_2) = 6,74\ \text{dm}^3 \cdot \frac{1\ \text{mol}}{22,4\ \text{dm}^3} \cdot 44\ \text{g/mol}$ = 13,2 g

i) %(kerogeen) = (100 g - 13,2 g - 53,0 g) · $\frac{1}{100\ \text{g}} \cdot 100$ = **33,8**

ii) %(mineraalne osa) = (100 g - 33,8 g) · $\frac{1}{100\ \text{g}} \cdot 100$ = **66,2**

ehk mineraalne osa = 100% - 33,8% = 66,2%

b) %saagis(õli põlevkivist) = 0,338 · 0,66 · 100 = **22,3**

c) m(tahke jääk põlevkivi utmisel) = 100 g - 1,9 g - 5,6 g - 22,3 g = 70,2 g

i) %(poolkoks) = (70,2 g - 66,2 g) · $\frac{1}{100\ \text{g}} \cdot 100$ = **4,0**

ii) %(poolkoks, kerogeenist) = 4 g · $\frac{1}{33,8\ \text{g}} \cdot 100$ = 11,8 ≈**12**

4. a) i) $2Al + 2NaOH + 6H_2O = 2Na[Al(OH)_4] + 3H_2\uparrow$

ii) $Cu + Cl_2 = CuCl_2$
$2Fe + 3Cl_2 = 2FeCl_3$
$2Al + 3Cl_2 = 2AlCl_3$

iii) $2Al + 6HCl = 2AlCl_3 + 3H_2\uparrow$
$Fe + 2HCl = FeCl_2 + H_2\uparrow$

b) i) $2Al \Leftrightarrow 2NaOH$

m(Al) = $\frac{2}{2} \cdot 40,0\ \text{g} \cdot \frac{1\ \text{mol}}{40,0\ \text{g}} \cdot 26,98\ \text{g/mol}$ = 26,98 g ≈**27,0 g**

ii) n(HCl, lähte) = $1035\ \text{cm}^3 \cdot 1,10\ \text{g/cm}^3 \cdot 0,100 \cdot \frac{1\ \text{mol}}{36,5\ \text{g}}$ = 3,12 mol

$6HCl \Leftrightarrow 2Al$

$N(HCl)_{Al} = \frac{6}{2} \cdot 1,00\ \text{mol} = 3,00\ \text{mol}$

$n(HCl)_{Fe}$ = 3,12 mol - 3,00 mol = 0,12 mol

$2HCl \Leftrightarrow Fe$

m(Fe) = $\frac{1}{2} \cdot 0,12\ \text{mol} \cdot 55,85\ \text{g/mol}$ = 3,35 g ≈ **3,4 g**

iii) $n(Cl_2, \text{lähte}) = 37,4\ \text{dm}^3 \cdot \frac{1\ \text{mol}}{22,4\ \text{dm}^3}$ = 1,6696 mol ≈ 1,67 mol

$2Al \Leftrightarrow 3Cl_2$

$n(Cl_2)_{Al} = \frac{3}{2} \cdot 1{,}00\ mol = 1{,}50\ mol$

$2Fe \Leftrightarrow 3Cl_2$

$n(Cl_2)_{Fe} = \frac{3}{2} \cdot 0{,}060\ mol = 0{,}090\ mol$

$n(Cl_2)_{Cu} = 1{,}67\ mol - 1{,}50\ mol - 0{,}090\ mol = 0{,}08\ mol$

$Cu \Leftrightarrow Cl_2$

m(Cu) = 0,08 mol · 63,55 g/mol = 5,08 g ≈ **5,1 g**

5. a) i) A – H_2O_2, vesinikperoksiid

B – Cl_2, kloor

C – $KMnO_4$, kaaliumpermanganaat

ii) %(O_2, H_2O_2) = $\frac{32}{34} \cdot 100$ = **94,1**

%(O_2, $KMnO_4$) = $\frac{64}{158} \cdot 100$ = **40,5**

b) i) $H_2O_2 + Cl_2 = 2HCl + O_2$

$2\cdot(-I)$ (-) $2\cdot0$

$O_2 - 2e^- = 2O$

$2\cdot0$ (-) $2\cdot(-I)$

$Cl_2 + 2e^- = 2Cl^-$

ii) $5H_2O_2 + 2KMnO_4 + 3H_2SO_4 = 1K_2SO_4 + 2MnSO_4 + 5O_2 + 8H_2O$

$2\cdot(-I)$ (-) $2\cdot0$ | 5

$O_2 - 2e^- = 2O$ |

VII (-) II |

$Mn + 5e^- = Mn$ | 2

c) i) $H_2S + 4H_2O + 4Cl_2 = 8HCl + 1H_2SO_4$

-II (-) VI |

$S - 8e^- = S$ | 1

$2\cdot0$ (-) $2\cdot(-II)$ |

$Cl_2 + 2e^- = 2Cl$ | 4

ii) $3S^{2-} + 8KMnO_4 + 4H_2O = 3SO_4^{2-} + 8MnO_2 + 8KOH$

-II (-) VI |

$S^{2-} - 8e^- = S$ | 3

VII (-) IV |

$Mn + 3e = Mn$ | 8

iii) $H_2S + H_2O_2 = S + 2H_2O$

iv) $5H_2S + 2KMnO_4 + 3H_2SO_4 = 5S + K_2SO_4 + 2MnSO_4 + 8H_2O$

-II (-) 0 |

$S - 2e^- = S$ | 5

VII II |

$Mn + 5e^- = Mn$ | 2

d) $1H_2S \Leftrightarrow 10H^+ \Leftrightarrow 10NaOH$; ja võrrandi c) i) järgi

$H_2S \Leftrightarrow 4\ Cl_2$

n(NaOH) = $\frac{10}{1} \cdot \frac{1}{4} \cdot 1mol = \mathbf{2{,}5mol}$

e) $Cl_2 + H_2O = HCl + HClO$

$HCl+NaOH \rightarrow NaCl+H_2O$,

$HClO+NaOH \rightarrow NaClO+H_2O$

6. a) $C_{12}H_{22}O_{11}(t) + 12O_2(g) = 12CO_2(g) + 11H_2O(v)$ ΔH(sahh, põlem)

b) ΔH(sahh,põlem) = $\Sigma\Delta H$(tekke,saad) - $\Sigma\Delta H$(tekke,lähte) =

= 12 mol·(-393,5 kJ/mol) +11 mol·(-285,8 kJ/mol) - mol·(-2222,0 kJ/mol)-

- 12 mol·0 kJ/mol) = - **5643,8 kJ/mol**

c) $\Delta H\ [H_2O(v) \rightarrow H_2O(g)]$ = -241,8 kJ/mol -(-285,8 kJ/mol) = 44,0 kJ/mol

Plussmärk on seetõttu, et süsteem saab energiat

M(sahharoos) = 342 g/mol

Ühe grammi suhkru oksüdeerumisel saame +5643,8 kJ/mol $\cdot \frac{1\ mol}{342\ g}$ =

= 16,502 kJ/g ≈ 16,5 kJ/g

Ühe liitri vee aurustamiseks kulub

+44,0 kJ/mol · 1000 cm^3· 1,00 g/cm^3 · $\frac{1\ mol}{18{,}0\ g}$ = 2444 kJ ≈ 2440 kJ

m(sahharoos) = 2444 kJ · $\frac{1\ g}{16{,}5\ kJ}$ = **148 g**