

## 2002/2003 õa keemiaolümpiaadi lõppvooru ülesannete lahendused

### 9. klass

1. a) IV periood VIII B alarühm ( VIII kõrvalalarühm)

b) i)  ${}_{27}^{59}\text{Co}$

ii)  ${}_{28}^{58}\text{Ni}$ ;  ${}_{28}^{60}\text{Ni}$ ;  ${}_{28}^{61}\text{Ni}$ ;  ${}_{28}^{62}\text{Ni}$ ;  ${}_{28}^{64}\text{Ni}$

c) i)  $A_r(\text{Co}) = 59 - 0,1 = 58,9$

ii)  $A_r(\text{Ni}) = 57,9 \cdot 0,681 + 59,9 \cdot 0,262 + 60,9 \cdot 0,0114 + 61,9 \cdot 0,0363 +$   
 $+ 63,9 \cdot 0,00926 = 39,43 + 15,69 + 0,69 + 2,25 + 0,59 = 58,65 \approx \mathbf{58,7}$

d) Koobalt peab olema eespool, sest tema järjenumbr (tuumalaeng) on väiksem.

e) **A** on koobalt ja **B** on nikkel, sest aatomite arv on võrdne ja suurema massi annavad suurema aatommassiga aatomid.

2. a)  $n(\text{HCO}_3^-) = 1 \text{ l} \cdot 100 \text{ mg/l} \cdot \frac{1 \text{ mol}}{61 \text{ g}} = 1,64 \text{ mmol} \approx \mathbf{1,6 \text{ mmol}}$

$n(\text{SO}_4^{2-}) = 1 \text{ l} \cdot 40 \text{ mg/l} \cdot \frac{1 \text{ mol}}{96 \text{ g}} = 0,417 \text{ mmol} \approx \mathbf{0,4 \text{ mmol}}$

$n(\text{Cl}^-) = 1 \text{ l} \cdot 1200 \text{ mg/l} \cdot \frac{1 \text{ mol}}{35,5 \text{ g}} = \mathbf{33,8 \text{ mmol}}$

$n(\text{Ca}^{2+}) = 1 \text{ l} \cdot 120 \text{ mg/l} \cdot \frac{1 \text{ mol}}{40 \text{ g}} = \mathbf{3,0 \text{ mmol}}$

$n(\text{Mg}^{2+}) = 1 \text{ l} \cdot 50 \text{ mg/l} \cdot \frac{1 \text{ mol}}{24 \text{ g}} = 2,08 \text{ mmol} \approx \mathbf{2,1 \text{ mmol}}$

$n(\text{ühelaenguliste anioonidena}) = 1,6 \text{ mmol} + 2 \cdot 0,4 \text{ mmol} + 33,8 \text{ mmol} =$   
 $= 36,2 \text{ mmol}$

$n(\text{Ca}^{2+} + \text{Mg}^{2+}) \cdot 2 = (3,0 \text{ mmol} + 2,1 \text{ mmol}) \cdot 2 = 10,2 \text{ mmol}$

$n(\text{ühelaengulised katioonid}) = 36,2 \text{ mmol} - 10,2 \text{ mmol} = 26,0 \text{ mmol}$

b)  $n(\text{Na}^+) = n(\text{K}^+) = 26,0 : 2 = 13,0 \text{ mmol}$

$m(\text{Na}^+) = 13 \text{ mol/l} \cdot 23 \text{ g/mol} = 299 \text{ mg/l} \approx \mathbf{300 \text{ mg/l}}$

$m(\text{K}^+) = 13 \text{ mol/l} \cdot 39 \text{ g/mol} = 507 \text{ mg/l} \approx \mathbf{510 \text{ mg/l}}$   
 $\mathbf{810 \text{ mg/l}}$

$\Sigma m = 100 \text{ mg/l} + 40 \text{ mg/l} + 1200 \text{ mg/l} + 120 \text{ mg/l} + 50 \text{ mg/l} + 810 \text{ mg/l} = \mathbf{2320 \text{ mg/l}}$

c)

100 mg

$2\text{HCO}_3^- = \text{CO}_3^{2-} + \text{H}_2\text{O} + \text{CO}_2$

61 g/mol

$\underbrace{\hspace{10em}}_{62 \text{ g/mol}}$

$\Delta m = \frac{1}{2} \cdot 100 \text{ mg/l} \cdot \frac{1 \text{ mol}}{61 \text{ g}} \cdot 62 \text{ g/mol} = 51 \text{ mg/l}$

$$\Sigma m = 2320 \text{ mg/l} - 51 \text{ mg/l} = 2269 \text{ mg/l} \approx \mathbf{2270 \text{ mg/l}}$$

3. a) i) **C** – A<sub>2</sub>O  
**G** – HB

$$\text{ii) } A_r(\mathbf{A}) = 16 \cdot \frac{1}{0,258} \cdot 0,742 \cdot \frac{1}{2} = \mathbf{23}$$

$$A_r(\mathbf{B}) = 1,008 \cdot \frac{1}{0,0276} \cdot 0,9724 = \mathbf{35,5}$$

$$\text{b) } N(\mathbf{A}) = 2 \cdot 16 \cdot \frac{1}{0,41} \cdot 0,59 \cdot \frac{1}{23} = \mathbf{2}$$

c) **A** – Na, naatrium

**B** – Cl, kloor

**C** – Na<sub>2</sub>O, naatriumoksiid

**D** – Na<sub>2</sub>O<sub>2</sub>, naatriumperoksiid

**E** – Na<sub>2</sub>CO<sub>3</sub>, naatriumkarbonaat

**F** – O<sub>2</sub>, hapnik

**G** – HCl, vesinikkloriid

d) i)  $2\text{Na} + \text{Cl}_2 = 2\text{NaCl}$

ii)  $4\text{Na} + \text{O}_2 = 2\text{Na}_2\text{O}$

iii)  $2\text{Na}_2\text{O}_2 + 2\text{CO}_2 = 2\text{Na}_2\text{CO}_3 + \text{O}_2$

iv)  $\text{Cl}_2 + \text{H}_2 = 2\text{HCl}$

4. a) i) Neeldunud gaasiks saab olla ainult CO<sub>2</sub>, sest lähtesegu sisaldas kahte keemilist elementi.

$$\text{ii) } V(\text{CO}_2) = 1,375 \text{ g} \cdot \frac{1 \text{ mol}}{44,0 \text{ g}} \cdot 22400 \text{ cm}^3/\text{mol} = \mathbf{700 \text{ cm}^3}$$

b) Lähtesegus peavad olema CO, O<sub>2</sub> ja CO<sub>2</sub>, sest neeldunud CO<sub>2</sub> ruumala on suurem, kui O<sub>2</sub> reageerimisel süsinikmonooksiidiga moodustunud CO<sub>2</sub> ruumala. Lähtesegu ruumala saab väheneda ainult reageerinud O<sub>2</sub> arvelt.

c) i)  $2\text{CO} + \text{O}_2 = 2\text{CO}_2$

$$V(\text{O}_2, \text{reageeris}) = \mathbf{100 \text{ cm}^3}$$

$$V(\text{CO}, \text{reageeris}) = \frac{2}{1} \cdot 100 \text{ cm}^3 = \mathbf{200 \text{ cm}^3}$$

d) Lõpp- ja lähtesegs on mõlema variandi korral CO<sub>2</sub> ruumala ühesugune: vastavalt  $700 \text{ cm}^3$  ja  $700 \text{ cm}^3 - 200 \text{ cm}^3 = 500 \text{ cm}^3$

	<i>Lähtesegu</i>		<i>Lõppsegu</i>	
I variant	CO <sub>2</sub>	500 cm <sup>3</sup>	CO <sub>2</sub>	700 cm <sup>3</sup>
	CO	200 cm <sup>3</sup>	CO	–
	O <sub>2</sub>	300 cm <sup>3</sup>	O <sub>2</sub>	200 cm <sup>3</sup>
II variant	CO <sub>2</sub>	500 cm <sup>3</sup>	CO <sub>2</sub>	700 cm <sup>3</sup>
	CO	400 cm <sup>3</sup>	CO	200 cm <sup>3</sup>
	O <sub>2</sub>	100 cm <sup>3</sup>	O <sub>2</sub>	–

5. a)  $M(\mathbf{B}) = 28,0 \text{ g/mol} \cdot 9,07 \approx \mathbf{254 \text{ g/mol}}$

$M(\mathbf{C}) = 2,0 \text{ g/mol} \cdot 32 = \mathbf{64 \text{ g/mol}}$

b) i) X – I, jood

ii) A – KI, kaaliumjodiid

B – I<sub>2</sub>, jood

C – SO<sub>2</sub>, vääveldioksiid

D – KHSO<sub>4</sub>, kaaliumvesiniksulfaat

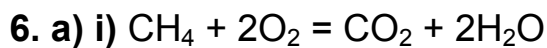
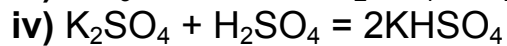
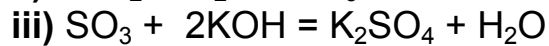
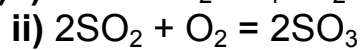
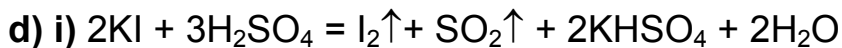
E – SO<sub>3</sub>, vääveltrioksiid

F – K<sub>2</sub>SO<sub>4</sub>, kaaliumsulfaat

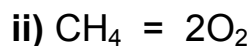
c) i)  $n(\mathbf{A}) = n(\text{KI}) = 3,32 \text{ g} \cdot \frac{1 \text{ mol}}{166 \text{ g}} = \mathbf{0,02 \text{ mol}}$

ii)  $n(\mathbf{C}) = n(\text{SO}_2) = 0,224 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{22,4 \text{ dm}^3} = \mathbf{0,01 \text{ mol}}$

iii)  $n(\mathbf{D}) = n(\text{KHSO}_4) = 2,72 \text{ g} \cdot \frac{1 \text{ mol}}{136 \text{ g}} = \mathbf{0,02 \text{ mol}}$



$$V \cdot 0,21$$



$$V(\text{õhk}) = \frac{2}{1} \cdot \frac{1}{0,21} = 9,5$$

$$V(\text{CH}_4) : V(\text{õhk}) = 1 : 9,5$$

iii) Ei teki tahkeid jääke (tuhk) ega tekita happevihma. Kivisüsi sisaldab väävlit, mis paiskab atmosfääri vääveldioksiidi.

b)  $V(\text{CH}_4) = 10^9 \text{ J} \cdot \frac{1 \text{ mol}}{8,9 \cdot 10^5 \text{ J}} \cdot 0,0224 \text{ m}^3 / \text{mol} = 25,17 \text{ m}^3 \approx \mathbf{25,2 \text{ m}^3}$

c)  $V(\text{CH}_4) = 2,3 \cdot 10^7 \text{ J} \cdot \frac{1 \text{ mol}}{8,9 \cdot 10^5 \text{ J}} \cdot 0,0224 \text{ m}^3 / \text{mol} = 0,579 \text{ m}^3 \approx \mathbf{0,58 \text{ m}^3}$