

2000/2001 õa keemiaolümpiaadi lõppvooru ülesannete lahendused
9. klass

1. a) i) $V(\text{tilk vett}) = \frac{3,00 \text{ cm}^3}{110 \text{ tilka}} = 0,0273 \text{ cm}^3/\text{tilk} = 2,73 \cdot 10^{-2} \text{ cm}^3/\text{tilk}$

ii) $m(\text{H}_2\text{O}) = \frac{2,73 \cdot 10^{-2} \text{ cm}^3}{\text{tilk}} \cdot \frac{1,00 \text{ g}}{1 \text{ cm}^3} = 2,73 \cdot 10^{-2} \text{ g/tilk}$

iii) $n(\text{H}_2\text{O}) = \frac{2,73 \cdot 10^{-2} \text{ cm}^3}{\text{tilk}} \cdot \frac{1 \text{ mol}}{18,0 \text{ g}} = 1,52 \cdot 10^{-3} \text{ mol/tilk}$

iv) $N(\text{H}_2\text{O}) = \frac{1,52 \cdot 10^{-3} \text{ mol}}{\text{tilk}} \cdot \frac{6,02 \cdot 10^{23} \text{ molekuli}}{\text{mol}} = 9,15 \cdot 10^{20} \text{ molekuli/tilk}$

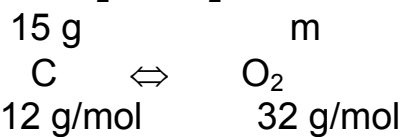
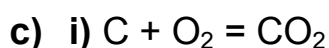
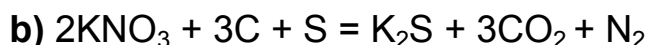
b) Molaarne kontsentratsioon defineeritakse moolide arvuna ühes kuupdetsimeetris $c = \frac{\text{mol}}{\text{dm}^3}$. Dimensiooni $\frac{\text{mol}}{\text{dm}^3}$ lühendiks on M.

$$c(\text{H}_2\text{O}) = \frac{1,52 \cdot 10^{-3} \text{ mol}}{\text{tilk}} \cdot \frac{1 \text{ tilk}}{2,73 \cdot 10^{-2} \text{ cm}^3} \cdot \frac{10^3 \text{ cm}^3}{\text{dm}^3} = 55,7 \text{ mol/dm}^3 = \mathbf{55,7 \text{ M}}$$

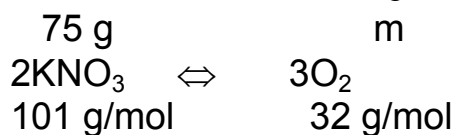
$$c) l(\text{H}_2\text{O}) = \frac{9,15 \cdot 10^{20} \text{ molekuli}}{\text{tilk}} \cdot \frac{1,50 \text{ \AA}}{\text{molekul}} \cdot \frac{1 \text{ m}}{10^{10} \text{ \AA}} \cdot \frac{1 \text{ km}}{10^3 \text{ m}} = 1,37 \cdot 10^8 \text{ km} = \mathbf{137 \text{ milj.km}}$$

2. a) i) $m(\text{C}) = 45 \text{ g} \cdot 0,15 \cdot 0,80 = 5,4 \text{ g}$

ii) $\%(\text{C}) = \frac{5,4}{45} \cdot 100 = 12$

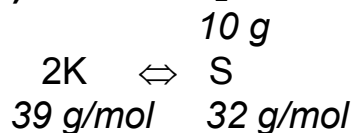


$$m(\text{O}_2, \text{vaja}) = \frac{1}{1} \cdot 15 \text{ g} \cdot \frac{1 \text{ mol}}{12 \text{ g}} \cdot 32 \text{ g/mol} = \underline{40 \text{ g}}$$

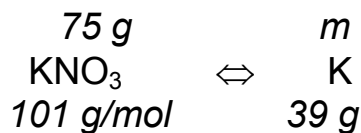


$$m(\text{O}_2, \text{saadakse}) = \frac{3}{2} \cdot 75 \text{ g} \cdot \frac{1 \text{ mol}}{101 \text{ g}} \cdot 32 \text{ g/mol} = 35,6 \approx 36 \text{ g}$$

Hapnikku ei jätku, osa süsinikust jäi põlemata.



$$m(K, \text{vaja}) = \frac{2}{1} \cdot 10 \text{ g} \cdot \frac{1 \text{ mol}}{32 \text{ g}} \cdot \frac{39 \text{ g}}{\text{mol}} = 24,3 \text{ g} \approx 24 \text{ g}$$



$$m(K, \text{saadakse}) = \frac{1}{1} \cdot 75 \text{ g} \cdot \frac{1 \text{ mol}}{101 \text{ g}} \cdot 39 \text{ g/mol} = 29 \text{ g}$$

Kogu väävel reageerib ära.

3. a) i) Q – H, vesinik (element)

ii) A – H₂O, vesi

B – H₂O₂, vesinikperoksiid

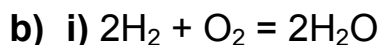
C – KOH, kaaliumhüdroksiid

D – NaOH, naatriumhüdroksiid

X – H₂, vesinik (lihtaine)

Y – O₂, hapnik

Z – I₂, jood



X Y A



A

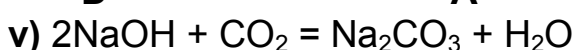


A



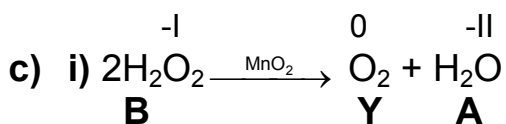
D

A



D

A



B

Y

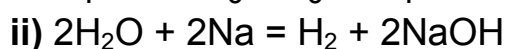
A

I

0

0

I



A

X

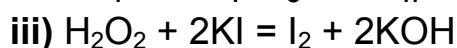
D

-I

-I

0

-II



B

Z

C

4. a) **A** – CO₂, süsinikdioksiid

B – H₂O, vesi

C – N₂, lämmastik

D – MgO, magneesiumoksiid

Et oksiid on kaheaatomiline, siis oksiidi moodustava elemendi aatommass on 40,3 - 16 = 24,3. Selline aatommass on magneesiumil.

$$\text{b) } n(\text{C}) = n(\text{CO}_2) = 2420 \text{ g} \cdot \frac{1 \text{ mol}}{44,0 \text{ g}} = 55 \text{ mol}$$

$$n(\text{H}) = 2n(\text{H}_2\text{O}) = 2 \cdot 648 \text{ g} \cdot \frac{1 \text{ mol}}{18,0 \text{ g}} = 72 \text{ mol}$$

$$n(\text{N}) = 2n(\text{N}_2) = 2 \cdot 44,8 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{22,4 \text{ dm}^3} = 4 \text{ mol}$$

$$n(\text{Mg}) = n(\text{MgO}) = 40,3 \text{ g} \cdot \frac{1 \text{ mol}}{40,3 \text{ g}} = 1 \text{ mol}$$

$$\text{c) } M(\text{klorofüll, arvutuslik}) = (55 \text{ mol} \cdot 12,0 \text{ g/mol} + 72 \text{ mol} \cdot 1,0 \text{ g/mol} + 4 \text{ mol} \cdot 14,0 \text{ g/mol} + 1 \text{ mol} \cdot 24,3 \text{ g/mol}) \cdot \frac{1}{\text{mol}} = 812,3 \text{ g/mol} \approx 812 \text{ g/mol}$$

$$M(\text{klorofüll, tegelik}) - M(\text{klorofüll, arvutuslik}) = (892 - 812) \text{ g/mol} = 80 \text{ g/mol}$$

$$n(\text{O, arvutuslik}) = (2 \cdot 55 + 0,5 \cdot 72 + 1 \cdot 1) \text{ mol} = 147 \text{ mol}$$

$n(\text{O, tegelik}) = 2 \cdot 71 \text{ mol} = 142 \text{ mol}$, järelikult klorofüllis on 5 mooli hapnikku.

Klorofüllis molekuli brutovalem on **C₅₅H₇₂N₄O₅Mg**

5. a) Ühendis **E** on 6 fluoriidi iooni ja 3 naatriumi iooni. Seal võib veel olla kas üks kolmelaenguline katioon või kolm ühelaengulist katiooni.

$$M(\text{X}^{3+}) = (3 \text{ mol} \cdot 23,0 \text{ g/mol} + 6 \text{ mol} \cdot 19,0 \text{ g/mol}) \cdot \frac{1}{\text{mol}} \cdot \frac{1}{0,871} \cdot 0,129 = 27,1 \text{ g/mol}$$

$$M(\text{X}^+) = 27,1 \text{ g/mol} \cdot \frac{1}{3} = 9,0 \text{ g/mol}$$

X³⁺ – Al³⁺ sobib

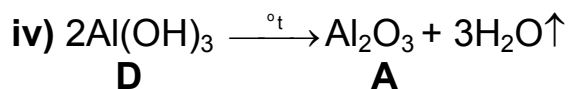
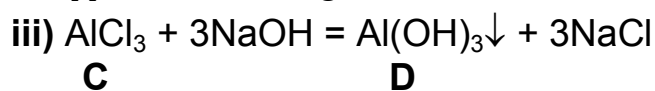
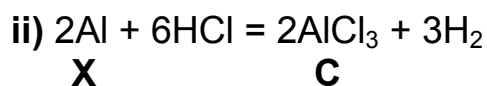
X⁺ – Be⁺ ei sobi nii omaduste kui valentsi tõttu

b) Elementi Al toodetakse sulatatud Al₂O₃ redutseerimisega elektrolüüsi teel.

c) i) korund

ii) abrasiivmaterjalina

d) i) $4\text{Al} + 3\text{O}_2 = 2\text{Al}_2\text{O}_3$
X B



- e) **A** – Al_2O_3 , alumiiniumoksiid
C – AlCl_3 , alumiiniumkloriid
D – Al(OH)_3 , alumiiniumhüdroksiid
E – Na_3AlF_6 , krüoliit, naatriumheksafluoroaluminaat

6. a) Kui aine protsendiline sisaldus segus ületab aine protsendilise sisalduse küllastunud lahuses, siis osa ainest jääb lahustumata ja moodustunud lahuses vastab aine protsendiline sisaldus küllastunud lahuses olevale aine protsendilisele sisaldusele.

$$\%(\text{KNO}_3, 10^\circ\text{C}, \text{küllastunud lahus}) = \frac{20,9}{100 + 20,9} \cdot 100 = 17,3$$

$$\%(\text{KNO}_3, \text{segus}) = \frac{200,0 \cdot 0,150 + 50,0}{200,0 + 50,0} \cdot 100 = 32,0$$

$$\%(\text{KNO}_3, \text{moodustunud lahus}) = 17,3$$

$$\text{b) } m(\text{H}_2\text{O}, \text{alglahus}) = 200,0 \text{ g} \cdot 0,850 = 170 \text{ g}$$

$$m(\text{KNO}_3 \text{ lahus}, 10^\circ\text{C}) = 170 \text{ g (vesi)} \cdot \frac{120,9 \text{ g (lahus)}}{100 \text{ g (vesi)}} = 205,53 \text{ g} \approx \mathbf{206 \text{ g}}$$