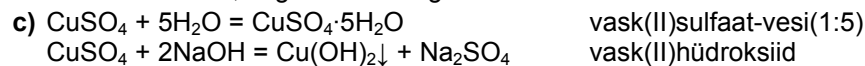


2007/2008 õ.a. keemiaolümpiaadi lõppvooru ülesannete lahendused

11. klass

1. a) $m(\text{CuSO}_4) = 12 \text{ g} + \frac{1}{3} \cdot 12 \text{ g} \cdot \frac{1 \text{ mol}}{159,5 \text{ g}} \cdot \frac{5}{1} \cdot \frac{18 \text{ g}}{1 \text{ mol}} = 14,26 \text{ g}$

b) $\%(\text{CuSO}_4) = \frac{12 \text{ g}}{14,26 \text{ g} + 90 \text{ cm}^3 \cdot 1 \text{ g/cm}^3} \cdot 100 = 11,51$



$n(\text{CuSO}_4) = 12 \text{ g} \cdot \frac{1 \text{ mol}}{159,5 \text{ g}} = 0,07524 \text{ mol}$

$n(\text{CuSO}_4, \text{NaOH} \text{ järgi}) = \frac{1}{2} \cdot 300 \text{ cm}^3 \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} \cdot \frac{0,04 \text{ mol}}{1 \text{ dm}^3} = 0,00600 \text{ mol}$

CuSO_4 on liias.

$m(\text{CuO}) = \frac{1}{1} \cdot \frac{1}{1} \cdot 0,006 \text{ mol} \cdot \frac{79,5 \text{ g}}{1 \text{ mol}} = 0,477 \text{ g}$

2. a) $M(\text{C}_x\text{H}_y) = \frac{x \cdot 12,01}{0,8727} = 13,76x$

$y = 13,76x - 12,01x = 1,75x$

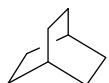
$x : y = x : 1,75x = 1 : 1,75 = 4 : 7$

Lihtsaim brutovalem on C_4H_7 .

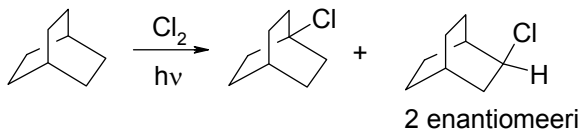
$\rho_{\text{H}_2} = 75 < \frac{M(\text{C}_x\text{H}_y)}{2}$

Võttes arvesse, et $\rho_{\text{H}} = 75 < \frac{M(\text{C}_x\text{H}_y)}{2}$ ja struktuuris sisaldub vähemalt

kaks kuuelülilist tsükli on süsivesiniku valemiks C_8H_{14} .



b) Tekib kaks erinevat monokloorderivaati, millest üks võib esineda kahe enantiomeerina.

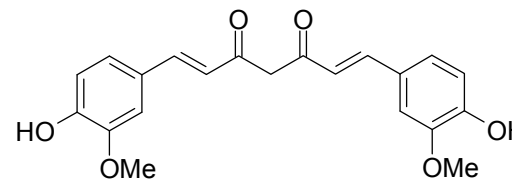


3. Tabel

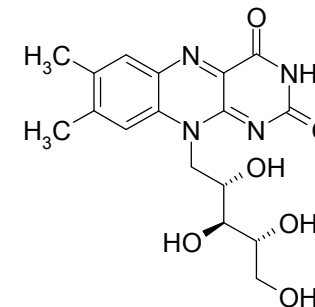
	1	2	3	4	5
Värvus	Tume punane	Kollane	Sinine	Punane	Kollakas-oranž
Nimetus	Lükopeen	Riboflaviin	Indigokarmiin	Karmoisiin	Kurkumiin
Struktuur, rühm	-CH ₃ (10 tk)	-OH (4 tk)	N-H·····O=C	E-isomeer	C=O
Aineklass	Karotinoid	Vitamiin	Sool	Asouhend	Polüfenool
Toiduaine	Arbuus	Mandlid	Limonaad	Martsipan	Kurkum

Martsipanis sisaldub karmoisiin

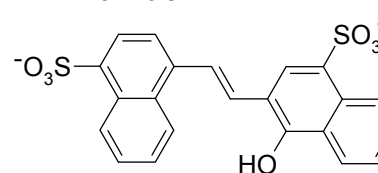
E100 kurkumiin



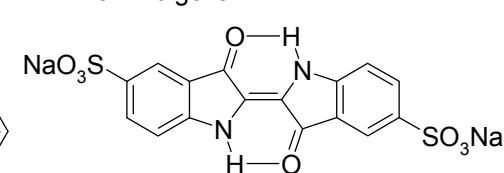
E101 Riboflaviin



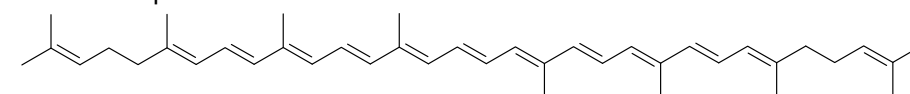
E122 Karmoisiin



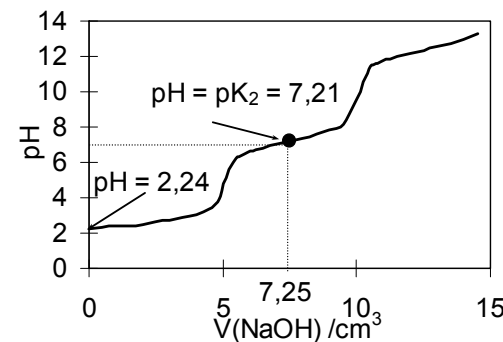
E132 Indigokarmiin



E160d Lükopeen



4. a) Fosforhappe tiitrimiskõver. Kuna fosforhape on kolmeprootoniline hape, siis on tiitrimiskõveral kolm astet.



b) NaOH lahus $\text{pH} = 14 - \text{pOH} = 14 + \log [\text{OH}^-] = 14 + \log 0,1 = 13$

H_3PO_4 lahus



Massibilanss: $C_{\text{hape}} = [\text{H}_3\text{PO}_4] + [\text{H}_2\text{PO}_4^-]$

Laengubilanss: $[\text{H}^+] = [\text{H}_2\text{PO}_4^-]$

Avaldame eelmistest seostest: $[\text{H}_3\text{PO}_4] = C_{\text{hape}} - [\text{H}_2\text{PO}_4^-] = C_{\text{hape}} - [\text{H}^+]$

$$K_1 = \frac{[\text{H}^+]^2}{C_{\text{hape}} - [\text{H}^+]} \Rightarrow [\text{H}^+] = -\frac{K_1}{2} + \sqrt{\frac{K_1^2}{4} + K_1 C_{\text{hape}}}$$

$$[\text{H}^+] = -0,0076/2 + \sqrt{0,0076^2/4 + 0,0076 \cdot 0,01} = 0,0243$$

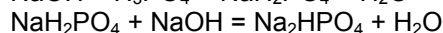
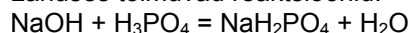
$$\text{pH} = -\log 0,0571 = 2,24$$

c) Tekkinud puhverlahuses võib vaadelda nõrga happena NaH_2PO_4 ja vastav sool Na_2HPO_4 .

$$\text{d) } \text{pH} = \text{p}K_2 + \log \frac{[\text{vastav sool}]}{[\text{nõrk hape}]}$$

$$[\text{NaH}_2\text{PO}_4] = [\text{Na}_2\text{HPO}_4] \Rightarrow \text{pH} = \text{p}K_2 = -\log(7,6 \cdot 10^{-3}) = 7,21$$

Lahuses toimuvad reaktsioonid:



$$V(\text{NaOH}) = \left(\frac{1}{1} + \frac{1}{2}\right) \cdot 50 \text{ cm}^3 \cdot 0,01 \text{ M} \cdot \frac{1}{0,1 \text{ M}} = 7,5 \text{ cm}^3$$

$$\text{e) } n(\text{NaH}_2\text{PO}_4)_{\text{alg}} = n(\text{Na}_2\text{HPO}_4)_{\text{alg}} = \frac{1}{2} \cdot 50 \text{ cm}^3 \cdot \frac{1 \text{ dm}^3}{1000 \text{ cm}^3} \cdot 0,01 \frac{\text{mol}}{\text{dm}^3} = 2,5 \cdot 10^{-4} \text{ mol} = 0,25 \text{ mmol}$$

$$n(\text{NaOH})_{\text{lisatud}} = 0,005 \text{ g} \cdot \frac{1 \text{ mol}}{40 \text{ g}} = 1,25 \cdot 10^{-4} \text{ mol} = 0,125 \text{ mmol}$$

$$\text{pH} = 7,21 + \log \frac{(0,25 + 0,125) \text{ mmol}}{(0,25 - 0,125) \text{ mmol}} = 7,69$$

$$\Delta \text{pH} = 7,69 - 7,21 = 0,48$$

5. a) $\text{Ag}_n\text{X} \quad \%(\text{Ag}) = \frac{n \cdot A_r(\text{Ag})}{n \cdot A_r(\text{Ag}) + A_r(\text{X})} = 0,7526 \Rightarrow A_r(\text{X}) = 35,46$

Lahendiks sobib $n = 1$, siis **X** – Cl. Valge sade on **AgCl**.

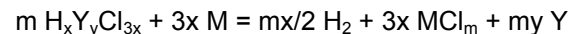
Happe **A** koostises on H, Cl ja tundmatu element **Y**.

$$N(\text{Cl}) = N(\text{AgCl}) = 25,81 \text{ g} \cdot \frac{1 \text{ mol}}{143,3 \text{ g}} = 0,18 \text{ mol}$$

$$N(\text{H}) = 2N(\text{H}_2) = 2 \cdot 0,672 \text{ dm}^3 \cdot \frac{1 \text{ mol}}{22,4 \text{ dm}^3} = 0,06 \text{ mol}$$

Kuna $N(\text{H}) : N(\text{Cl}) = 1 : 3$, siis **A** – $\text{H}_x\text{Y}_y\text{Cl}_{3x}$

Üldine reaktsioonivõrrand:



$$M(\text{A}) = 75 \text{ g} \cdot 0,164 \cdot \frac{x}{0,06 \text{ mol}} = 205x \text{ g/mol}$$

$$\text{Kui } x = 1, \text{ siis } A_r(\text{Y}) = \frac{205 - 1,008 - 3 \cdot 35,45}{y} = \frac{97,642}{y}$$

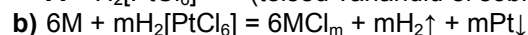
$y = 1$ korral on **Y** – Tc, $y = 2$ korral on **Y** – Ti, ...

Mitte ükski variant ei sobi ülesande tingimusega.

$$\text{Kui } x = 2, \text{ siis } A_r(\text{Y}) = \frac{2 \cdot 97,642}{y} = \frac{195,284}{y}$$

$y = 1$ korral on **Y** – Pt, $y = 2$ korral on **Y** – Tc, $y = 3$: Zn, ...

A – $\text{H}_2[\text{PtCl}_6]$ (teised variandid ei sobi samuti ülesande tingimusega)

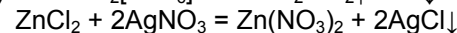
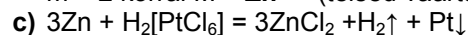


Kuna teostatud reaktsioonide tagajärjel plaadi mass ei muutunud, siis

$$m(\text{M}) = m(\text{Pt}) = \frac{1}{2} \cdot 0,06 \text{ mol} \cdot \frac{195,08 \text{ g}}{1 \text{ mol}} = 5,8524 \text{ g}$$

$$M(\text{M}) = 5,8524 \text{ g} \cdot \frac{1}{6/m \cdot 0,03 \text{ mol}} = 32,51m \text{ g/mol}$$

$m = 2$ korral **M** – Zn (teised väärtused ei sobi ülesande tingimusega)



6. a) i) $M_{\text{ideaal}} = 1398 \cdot \frac{28 \text{ g}}{1 \text{ mol}} + 466 \cdot \frac{118 \text{ g}}{1 \text{ mol}} + 699 \cdot \frac{42 \text{ g}}{1 \text{ mol}} = 123 \text{ 500 } \frac{\text{g}}{\text{mol}}$

ii) E : P : S $1398 : 699 : 466$ $6 : 3 : 2$
6E-3P-2S

iii) $M_{\text{tüü}} = 6 \cdot \frac{28 \text{ g}}{1 \text{ mol}} + 2 \cdot \frac{118 \text{ g}}{1 \text{ mol}} + 3 \cdot \frac{42 \text{ g}}{1 \text{ mol}} = 530 \frac{\text{g}}{\text{mol}}$

$$\text{Lülide arv} = \frac{123 \text{ 500 g/mol}}{530 \text{ g/mol}} = 233$$

b) $\frac{\Pi}{RT} = \frac{55,68 \text{ N}}{\text{m}^2} \cdot \frac{1 \text{ mol} \cdot 1 \text{ K}}{8,314 \text{ N} \cdot \text{m}} \cdot \frac{1}{(273,15 + 25) \text{ K}} = 0,0225 \frac{\text{mol}}{\text{m}^3}$

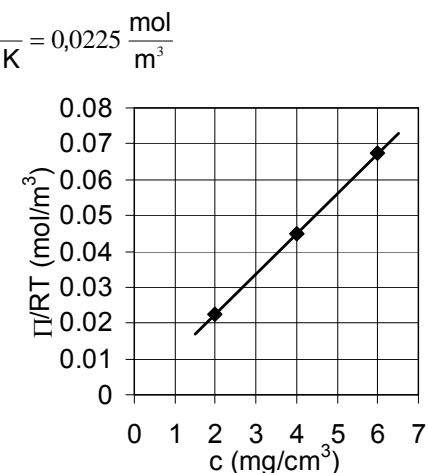
Π (Pa)	55,68	111,4	167,0
c (mg/cm ³)	2	4	6
Π/RT	0,0225	0,0449	0,0674

$$\text{Tõus} = (0,0449 - 0,0225) \frac{\text{mol}}{\text{m}^3}$$

$$\cdot \frac{1 \text{ cm}^3}{(4 - 2) \text{ mg}} \cdot \frac{1 \text{ m}^3}{10^6 \text{ cm}^3} \cdot \frac{10^3 \text{ mg}}{1 \text{ g}} =$$

$$= 1,12 \cdot 10^{-5} \text{ mol/g}$$

$$M_{\text{arv}} = \frac{1 \text{ g}}{1,12 \cdot 10^{-5} \text{ mol}} = 89300 \text{ g/mol}$$



Keskmine polümeri ahel on **lühem** võrreldes ideaalsega.

c) Süsiniku aatomite arv kordub lülis on $(6 + 2 + 3) \cdot 2 = 22$.

$$\text{Lülide arv} = \frac{89\,300 \text{ g/mol}}{530 \text{ g/mol}} = 168$$

$$\mathbf{N(C)} = 168 \cdot 22 = \mathbf{3710}$$