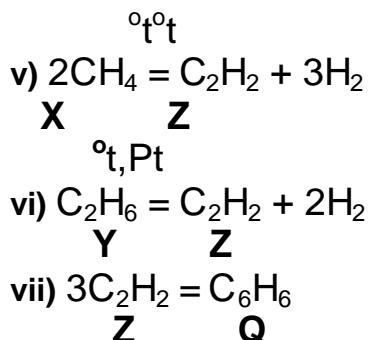
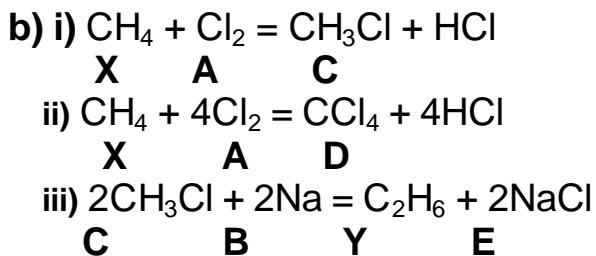


**2001/2002 õa keemiaolümpiaadi lõppvooru ülesannete lahendused**  
**11. klass**

- |   |   |
|---|---|
| 1. a) X – CH <sub>4</sub> , metaan          | B – Na, naatrium                                    |
| Y – C <sub>2</sub> H <sub>6</sub> , etaan   | C – CH <sub>3</sub> Cl, klorometaan e metüülkloriid |
| Z – C <sub>2</sub> H <sub>2</sub> , etüün   | D – CCl <sub>4</sub> , tetraklorometaan             |
| Q – C <sub>6</sub> H <sub>6</sub> , benseen | E – NaCl, naatriumkriid                             |
| A – Cl <sub>2</sub> , kloor                 |   |



c) i)  $M_r(\text{CCl}_4) = 154$   
 $M_r(\text{CH}_4) = 16$   
 $D(\text{CCl}_4)_{\text{CH}_4} = \frac{154}{16} = 9,6$

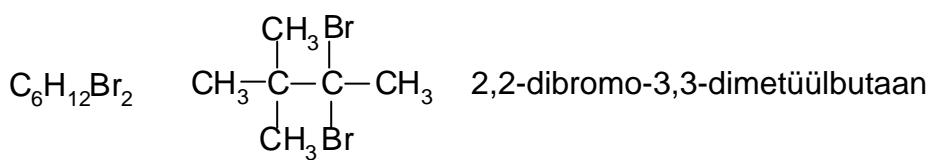
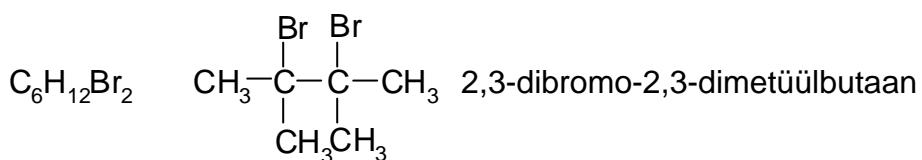
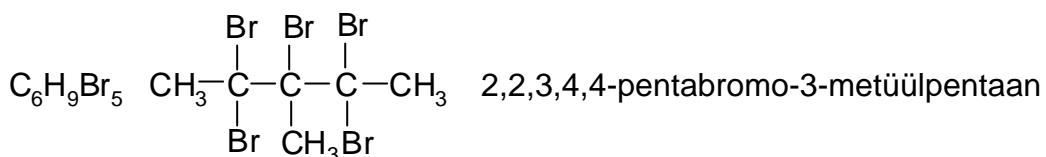
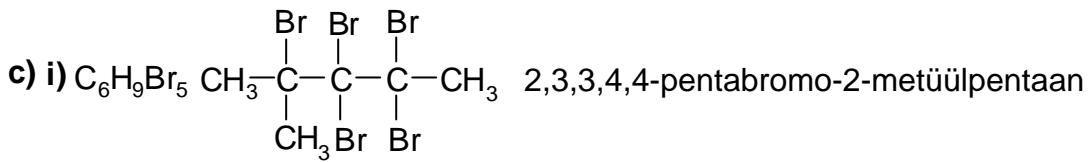
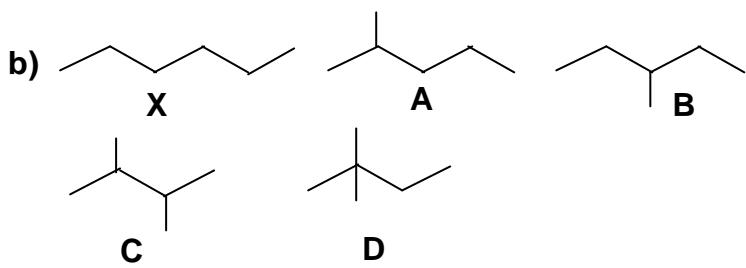
ii)  $M_r(\text{C}_2\text{H}_2) = 26$   
 $M_r(\text{C}_2\text{H}_6) = 30$   
 $D(\text{C}_2\text{H}_6)_{\text{C}_2\text{H}_6} = \frac{26}{30} = 0,867$

iii) **M(C<sub>6</sub>H<sub>6</sub>) = 78 g/mol**

2. a) i)  $\frac{n(\text{H})}{n(\text{C})} = \frac{2 \cdot 8,95 \text{ g}}{18,0 \text{ g/mol}} \cdot \frac{22,4 \text{ dm}^3 / \text{mol}}{9,55 \text{ dm}^3} = 2,333 \approx 2,33$

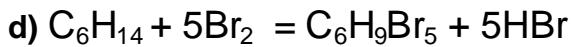
ii)  $2,333n = 2n + 2$   
 $n = \frac{2}{0,333} = 6,006 \approx 6$

**C<sub>6</sub>H<sub>14</sub>**



ii)  $\frac{M(C_6H_9Br_5)}{M(C_6H_{14})} = \frac{81 + 5 \cdot 80}{86} = 5,59$

$\frac{M(C_6H_{12}Br_2)}{M(C_6H_{14})} = \frac{84 + 2 \cdot 80}{86} = 2,84$



3. a) i) N(O) =  $\frac{47,1}{16} = 2,94$       N(Al) =  $\frac{52,9}{27,0} = 1,96$

Kui N(Al) = 1, siis      N(O) =  $\frac{2,94}{1,96} = 1,5$



ii) N(O) =  $\frac{50,4}{16} = 3,15$       N(Al) =  $\frac{42,5}{27} = 1,57$

N(Be) =  $\frac{7,1}{9,01} = 0,788$

Kui N(Be) = 1, siis N(Al) =  $\frac{1,57}{0,788} \approx 2$  ja      N(O) =  $\frac{3,15}{0,788} = 4$



$$\begin{array}{ll}
 \text{iii) } N(O) = \frac{53,6}{16} = 3,35 & N(Si) = \frac{31,4}{28} = 1,12 \\
 N(Al) = \frac{10}{27} = 0,37 & N(Be) = \frac{5,0}{9,01} = 0,555 \\
 \text{Kui } N(Al) = 1, \text{ siis} & N(O) = \frac{3,35}{0,37} \approx 9, \\
 N(Si) = \frac{1,12}{0,37} \approx 3 & N(Be) = \frac{0,555}{0,37} \approx 1,5 \\
 Al_9Si_3Be_{1,5} \Leftrightarrow Al_2O_{18}Si_6Be_3
 \end{array}$$

### $Al_2O_3 \times 3BeO \times 6SiO_2$

$$\begin{array}{lll}
 \text{iv) } N(O) = \frac{49,4}{16} = 3,09 & N(Si) = \frac{17,3}{28} = 0,618 & N(Al) = \frac{33,3}{27} = 1,23 \\
 \text{Kui } N(Si) = 1, \text{ siis } N(Al) = \frac{1,23}{0,618} \approx 2 & \text{ja} & N(O) = \frac{3,09}{0,618} = 5 \\
 SiAl_2O_5
 \end{array}$$

### $Al_2O_3 \times SiO_2$

b) i) X - V, vanaadium Z - Mn, mangaan  
 Y - Cr, kroom Q - Fe, raud

ii) Otsitavateks metallideks ei saa olla ei Ti ega Co. Nende vahel jäääb neli metalli, mis sobivad ülesande tingimustega, sest raual esinevad kahe- ja kolmevalentsed ioonid. Tuntud on pruunid mangaaniühendid ja rohelised kroomiühendid.

elektrolüüs

4. a) i)  $2NaCl + 2H_2O = 2NaOH + H_2 + Cl_2$   
 ii)  $2Cl^- = Cl_2 + 2e^-$  – **anoodprotsess**  
 iii)  $2H_2O + 2e^- = H_2 + 2OH^-$  – **katoodprotsess**  
 iv)  $H_2 + Cl_2 = 2HCl$   
 b) i) 1000 g I·t·0,9  
 $1NaOH = 1e^-$   
 40,0 g/mol 96500 A·s/mol

$$I \cdot t = \frac{1}{1} \cdot 1000 \frac{\text{g}}{\text{kg}} \cdot \frac{1 \text{ mol}}{40,0 \text{ g}} \cdot 96500 \frac{\text{A} \cdot \text{s}}{\text{mol}} \cdot \frac{1}{0,9} \cdot \frac{1 \text{ kA}}{1000 \text{ A}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 0,745 \frac{\text{kA} \cdot \text{h}}{\text{kg}}$$

$$E = 0,745 \frac{\text{kA} \cdot \text{h}}{\text{kg}} \cdot 3,80 \text{ V} \cdot \frac{1 \text{ kW}}{\text{kA} \cdot \text{V}} = 2,829 \text{ kWh/kg}$$

$$\text{Hind}(NaOH) = 2,829 \frac{\text{kWh}}{\text{kg}} \cdot 80 \frac{\text{senti}}{\text{kWh}} = 226,4 \text{ senti/kg} \approx \mathbf{226 \text{ senti/kg}}$$

ii) 40,0 g NaOH  $\Leftrightarrow$  100 g 36,5% soolhape

$$\begin{aligned}
 \text{Hind}(36,5\% HCl) &= 226,4 \text{ senti} \cdot \frac{1}{\text{kg}(NaOH)} \cdot \frac{0,04 \text{ kg (NaOH)}}{0,1 \text{ kg (36,5\% soolhape)}} = \\
 &= 90,56 \text{ senti/kg} \approx \mathbf{90,6 \text{ senti/kg}}
 \end{aligned}$$

c) i)  $m(\text{NaOH}) = 100 \text{ krooni} \cdot \frac{1 \text{ kg}}{2,264 \text{ krooni}} = 44,2 \text{ kg}$

ii)  $m(36,5\% \text{ HCl}) = 100 \text{ krooni} \cdot \frac{1 \text{ kg}}{0,9056 \text{ krooni}} = 110 \text{ kg}$

5. a)  $c(\text{NaCl}) = c(\text{Cl}^-) = \frac{1,56 \cdot 10^{-10} \text{ mol}^2 / (\text{dm}^3)^2}{1,56 \cdot 10^{-9} \text{ mol/dm}^3} = 1,00 \times 10^{-1} \text{ mol/dm}^3$

b)  $[\text{OH}^-] = 1,79 \cdot 10^{-5} \text{ mol/dm}^3 \cdot \frac{1,25 \cdot 10^{-1}}{1,00 \cdot 10^{-1}} = 2,238 \cdot 10^{-5}$

$\text{pOH} = -\lg 2,238 \cdot 10^{-5} = 4,65$

$\text{pH} = 14 - 4,65 = 9,35$

c) lähtehulk 0,09375 mol 0,1875 mol 0,0750 mol



lõpp-hulk – 0,09375 mol 0,169 mol

Lähtehulk:  $n(\text{NH}_3 \cdot \text{H}_2\text{O}) = 0,750 \text{ dm}^3 \cdot 0,125 \text{ mol/dm}^3 = 0,09375 \text{ mol}$

$n(\text{HCl}) = 1,50 \text{ dm}^3 \cdot 0,125 \text{ mol/dm}^3 = 0,1875 \text{ mol}$

Lõpp-hulk:  $n(\text{HCl}) = 0,1875 \text{ mol} - 0,09375 \text{ mol} = 0,09375 \text{ mol}$

Lahust Z on  $1,50 \text{ dm}^3 + 1,50 \text{ dm}^3 = 3,00 \text{ dm}^3$  ja selles sisaldub 0,09375 mooli tugevat hapet, mis nõrga aluse soolaga ei moodusta enam puhversüsteemi

$$[\text{H}^+] = \frac{0,09375 \text{ mol}}{3,00 \text{ dm}^3} = 3,125 \cdot 10^{-2} \text{ mol/dm}^3$$

$\text{pH} = -\lg 3,125 \cdot 10^{-2} \text{ mol/dm}^3 = 1,51$



A – naatriumbromiid X – kloor naatriumkloriid Y – broom



B – naatriumjodiid X – kloor naatriumkloriid Z – jood



vääveldioksiid X – kloor C – sulfurüülkloriid



fosfor X – kloor D – fosforpentakloriid



metaan X – kloor E – tetraklorometaan F – vesinikkloriid  
hv



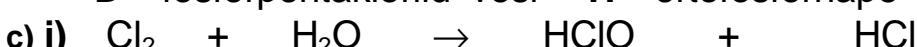
vesinik X – kloor F – vesinikkloriid



C – sulfurüülkloriid vesi G – väävelhape F – vesinikkloriid



D – fosforpentakloriid vesi H – ortofosforhape F – vesinikkloriid



X – kloor vesi hüpoploorishape F – vesinikkloriid



X – kloor kaalium- I – kaalium- kaalium- vesi  
hüdroksiid kloraat kloriid

