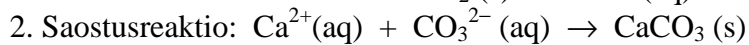


TKK, TTY, LTY, OY, TY, VY, ÅA / Insinööriosastot
Kemian valintakoetehtävien 2005 malliratkaisut

1. $m(\text{näyte}) = 2,11 \text{ g}$, $m(\text{CaCl}_2) = x \text{ g}$



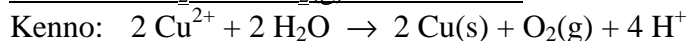
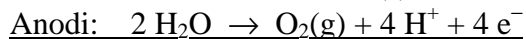
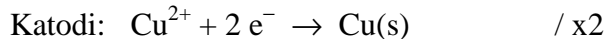
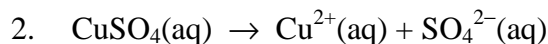
Reaktioyhtälöistä nähdään: $n(\text{CaO}) = n(\text{CaCO}_3) = n(\text{Ca}^{2+}) = n(\text{CaCl}_2)$
 $m(\text{CaO}) = 0,480 \text{ g}$, $M(\text{CaO}) = 56,08 \text{ g/mol}$

$$\Rightarrow n(\text{CaO}) = \frac{m(\text{CaO})}{M(\text{CaO})} = \frac{0,489 \text{ g}}{56,08 \text{ g/mol}} = 0,008559 \text{ mol} = n(\text{CaCl}_2)$$

$$M(\text{CaCl}_2) = 110,98 \text{ g/mol}$$

$$m(\text{CaCl}_2) = n \cdot M = 0,008559 \text{ mol} \cdot 110,98 \text{ g/mol} = 0,9499 \text{ g}$$

$$\text{CaCl}_2\text{:n osuus näytteessä (m-\%)} = \frac{0,9499}{2,11} \cdot 100\% = \underline{\underline{45,0\%}}$$



b) $m_{\text{Cu}} = 1,00 \text{ g}$, $M_{\text{Cu}} = 63,54 \text{ g/mol}$ $\Rightarrow n_{\text{Cu}} = m/M = \frac{1,00 \text{ g}}{63,54 \text{ g/mol}} = 0,01574 \text{ mol}$

$$Q = Z n F$$

$$Z = 2 \quad \rightarrow \quad Q = 2 \cdot 0,01574 \text{ mol} \cdot 96490 \text{ A s/mol} = \underline{\underline{3038 \text{ A s}}}$$

c) $n(\text{O}_2) = n_{\text{Cu}} / 2 = 0,01574 \text{ mol} / 2 = 0,00787 \text{ mol}$

Tai: $n(\text{O}_2) = Q / ZF$; $Z = 4 \rightarrow n(\text{O}_2) = \frac{3038 \text{ A s}}{4 \cdot 96490 \text{ A s mol}^{-1}} = 0,00787 \text{ mol}$

$$pV = nRT \rightarrow V(\text{O}_2) = \frac{n(\text{O}_2)RT}{p} = \frac{0,00787 \text{ mol} \cdot 8,314 \text{ Jmol}^{-1}\text{K}^{-1} \cdot 293 \text{ K}}{101000 \text{ Pa}} = 1,90 \cdot 10^{-4} \text{ m}^3$$
$$= \underline{\underline{190 \text{ cm}^3}}$$

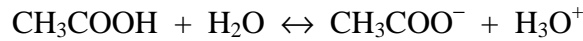
3. a) $m(\text{CH}_3\text{COOH}) = 0,600 \text{ g}$, $M(\text{CH}_3\text{COOH}) = 60,052 \text{ g/mol}$ $\rightarrow n(\text{CH}_3\text{COOH}) = \frac{m}{M} = 0,00999 \text{ mol}$

$$V = 1 \text{ dm}^3 \rightarrow c(\text{CH}_3\text{COOH}) = 0,00999 \text{ mol/dm}^3$$

$$m(\text{CH}_3\text{COONa}) = 0,738 \text{ g}, M(\text{CH}_3\text{COONa}) = 82,034 \text{ g/mol} \rightarrow n(\text{CH}_3\text{COONa}) =$$

$$\frac{m}{M} = 0,00900 \text{ mol}$$

$$V = 1 \text{ dm}^3 \rightarrow c(\text{CH}_3\text{COONa}) = 0,00900 \text{ mol/dm}^3$$



Alku (mol/dm ³)	0,00999	0,00900	0
Tasapaino (mol/dm ³)	0,00999 - x	0,00900 + x	x

$$K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]} = \frac{(0,00900 + x) \cdot x}{0,00999 - x} = 1,8 \cdot 10^{-5} \text{ mol/dm}^3$$

Oletetaan, että $x \ll 0,00900 \rightarrow$

$$\frac{0,00900 \cdot x}{0,00999} = 1,8 \cdot 10^{-5} \text{ mol/dm}^3 \rightarrow$$

$$x = [\text{H}_3\text{O}^+] = [\text{H}^+] = \underline{2,00 \cdot 10^{-5} \text{ mol/dm}^3} \text{ oletus ok!}$$

Tai:

$$K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]} \rightarrow [\text{H}_3\text{O}^+] = \frac{K_a [\text{CH}_3\text{COOH}]}{[\text{CH}_3\text{COO}^-]}$$

Puskuriliuoksessa:

$$[\text{H}_3\text{O}^+] \cong K_a \frac{[\text{happo}]}{[\text{emäs}]}$$

$$[\text{H}_3\text{O}^+] = 1,8 \cdot 10^{-5} \text{ mol/dm}^3 \frac{0,00999 \text{ mol/dm}^3}{0,00900 \text{ mol/dm}^3} = \underline{2,00 \cdot 10^{-5} \text{ mol/dm}^3}$$

$$\text{b) } [\text{OH}^-] = \frac{K_w}{[\text{H}_3\text{O}^+]^+} = \frac{1,00 \cdot 10^{-14} \text{ mol}^2/\text{dm}^6}{2,00 \cdot 10^{-5} \text{ mol/dm}^3} = \underline{5,00 \cdot 10^{-10} \text{ mol/dm}^3}$$

$$\text{c) } \underline{\text{pH}} = -\lg [\text{H}_3\text{O}^+] = -\lg 2,00 \cdot 10^{-5} = \underline{4,70}$$

4. a) Mooliprosenteista saadaan suoraan mooliosuudet x.
Ilman keskimääräinen moolimassa M_i :

$$\underline{M_i} = x(\text{O}_2)M(\text{O}_2) + x(\text{N}_2)M(\text{N}_2) + x(\text{Ar})M(\text{Ar}) =$$

$$(0,21 \cdot 32,00 + 0,78 \cdot 28,02 + 0,01 \cdot 39,95) \text{ g/mol} = \underline{28,98 \text{ g/mol}}$$

- b) ilman massa $m_i = 28,0140 \text{ g} - 27,9214 \text{ g} = 0,0926 \text{ g}$
 hiilivedyn massa $m_g = 28,0175 \text{ g} - 27,9214 \text{ g} = 0,0961 \text{ g}$

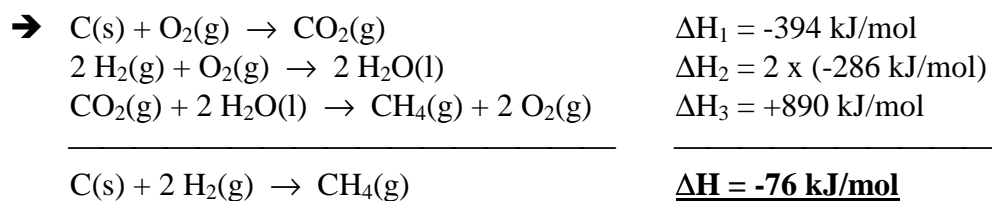
Samat olosuhteet, sama tilavuus $\rightarrow n_i = n_g$

$$n = \frac{m}{M} \rightarrow \frac{m_i}{M_i} = \frac{m_g}{M_g} \rightarrow M_g = \frac{m_g M_i}{m_i}$$

$$M_g = \frac{0,0961 \text{ g} \cdot 28,98 \text{ g/mol}}{0,0926 \text{ g}} = 30,07 \text{ g/mol}$$

- c) Hiilivety $C_xH_y \rightarrow$ C: 12,01 g/mol, H: 1,008 g/mol
 \rightarrow hiiliatomeja voi olla 2 kpl, ts. $x = 2$
 $\rightarrow 2 \cdot 12,01 \text{ g/mol} + y \cdot 1,008 \text{ g/mol} = 30,07 \text{ g/mol}$
 $\rightarrow y = 6,00$
 \rightarrow Hiilivety on **C₂H₆** eli etaani

5. a) Kysytty reaktio saadaan yhdistämällä annetut reaktiot. Ennen reaktioiden yhteenlaskua reaktio 2 kerrotaan kahdella ja reaktio 3 käännetään (= x -1).
 Samat toimenpiteet tehdään vastaavasti reaktioiden entalpia-arvoille (Hessin laki).

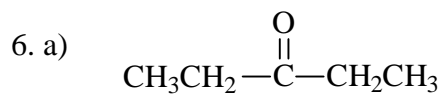


- b) $m(CH_4) = 100 \text{ g}$, $M(CH_4) = 16,042 \text{ g/mol}$

$$\rightarrow n(CH_4) = \frac{m}{M} = \frac{100 \text{ g}}{16,04 \text{ g/mol}} = 6,23 \text{ mol}$$

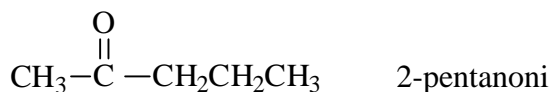
$$\Delta H = 6,23 \text{ mol} \cdot (-890 \text{ kJ/mol}) = -5544,7 \text{ kJ} = -5,54 \text{ MJ}$$

\rightarrow **Lämpöä vapautuu 5,54 MJ**

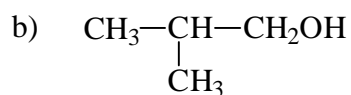
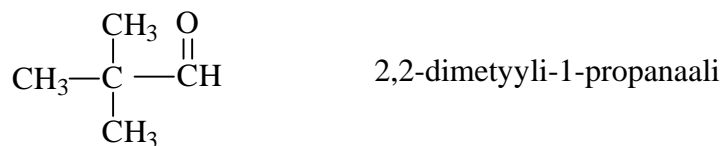
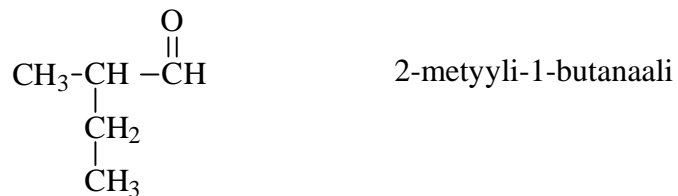
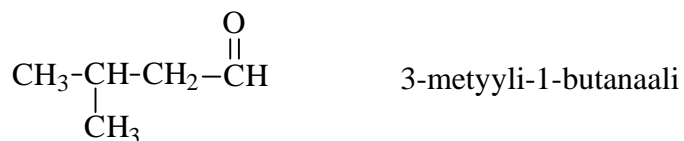
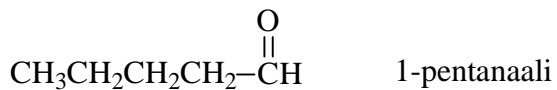


3-pentanoni

Kaksi ketoni-isomeeriä:



Neljä aldehydi-isomeeriä:



2-metyyli-1-propanoli

Kolme eetteri-isomeeriä:

