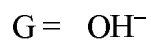
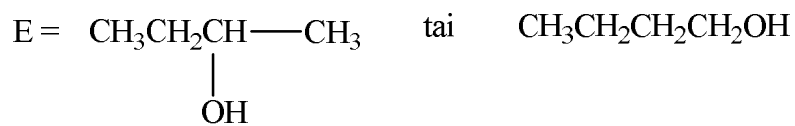
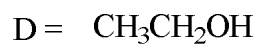
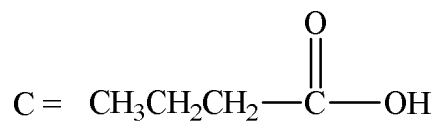
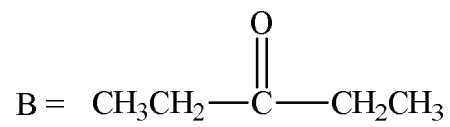
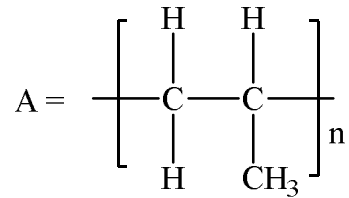


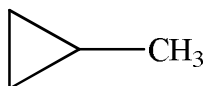
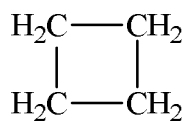
Diplomi-insinöörien ja arkkitehtien yhteisvalinta – dia-valinta 2011

Insinöörivalinnan kemian koe 2011 malliratkaisut

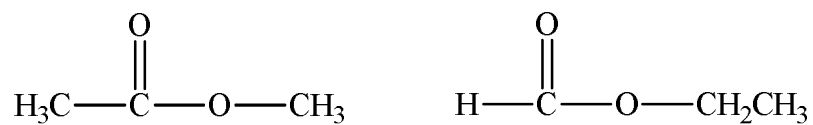
1.



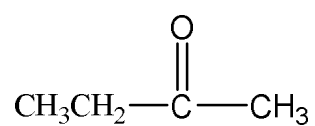
2. a) 2- buteeni: $\text{CH}_3\text{CH} = \text{CHCH}_3$ (C_4H_8)



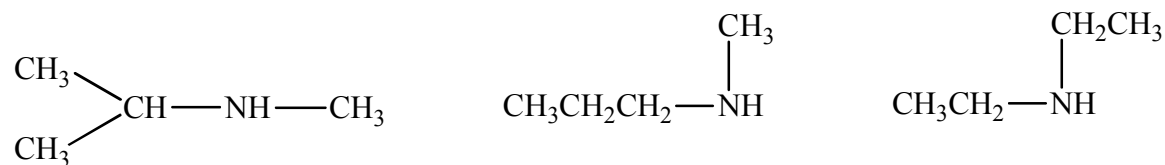
b) propaanihappo: $\text{CH}_3\text{CH}_2\text{COOH}$ ($\text{C}_3\text{H}_6\text{O}_2$)



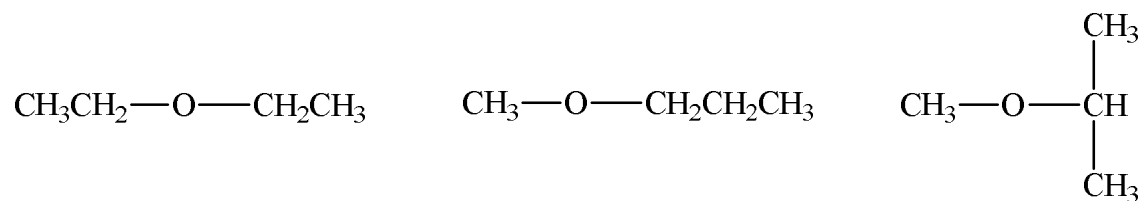
c) butanaali: $\text{CH}_3\text{CH}_2\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$ ($\text{C}_4\text{H}_8\text{O}$):

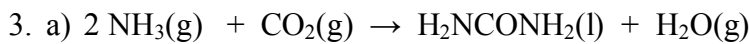


d) butyyliamiini: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2-\text{NH}_2$ ($\text{C}_4\text{H}_{11}\text{N}$)



e) 2-metyyli-2-propanoli: $\text{H}_3\text{C}-\overset{\text{OH}}{\underset{\text{CH}_3}{\text{C}}}-\text{CH}_3$ ($\text{C}_4\text{H}_{10}\text{O}$):





$$n(\text{NH}_3) = \frac{pV}{RT} = \frac{90 \cdot 10^5 \text{ Pa} \cdot 500 \cdot 10^{-3} \text{ m}^3}{8,314 \text{ J}/(\text{mol} \cdot \text{K}) \cdot 496,15 \text{ K}} = 1090,9 \text{ mol}$$

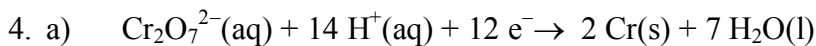
$$n(\text{CO}_2) = \frac{45 \cdot 10^5 \text{ Pa} \cdot 600 \cdot 10^{-3} \text{ m}^3}{8,314 \text{ J}/(\text{mol} \cdot \text{K}) \cdot 496,15 \text{ K}} = 654,5 \text{ mol}$$

Reaktioyhtälöstä: $n(\text{NH}_3) = 2 \cdot n(\text{CO}_2) \rightarrow \text{NH}_3$ on rajoittava tekijä

$$n(\text{urea}) = \frac{1}{2} n(\text{NH}_3)$$

$$m(\text{urea}) = \frac{1}{2} n(\text{NH}_3) \cdot M(\text{urea}) = \frac{1}{2} \cdot 1090,9 \text{ mol} \cdot 60,062 \text{ g/mol} = 32,8 \text{ kg} \approx \underline{\underline{33 \text{ kg}}}$$

b) $m(\text{typpi}) = \frac{2 \cdot M(\text{N})}{M(\text{urea})} \cdot m(\text{urea}) = \frac{2 \cdot 14,01}{60,062} \cdot 32,8 \text{ kg} = 15,3 \text{ kg} \approx \underline{\underline{15 \text{ kg}}}$



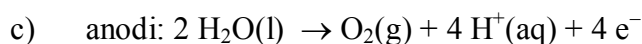
b) $V(\text{Cr}) = A \cdot h = 0,25 \text{ m}^2 \cdot 0,010 \cdot 10^{-3} \text{ m} = 2,5 \cdot 10^{-6} \text{ m}^3$

$$m(\text{Cr}) = \rho \cdot V = 7,19 \cdot 10^6 \text{ g/m}^3 \cdot 2,5 \cdot 10^{-6} \text{ m}^3 = 17,975 \text{ g}$$

$$n(\text{Cr}) = \frac{m}{M} = \frac{17,975 \text{ g}}{52,00 \text{ g/mol}} = 0,346 \text{ mol}$$

$$Q = I t = z n F \quad z = 6$$

$$t = \frac{z n F}{I} = \frac{6 \cdot 0,346 \text{ mol} \cdot 96485 \text{ A s/mol}}{25 \text{ A}} = 8012 \text{ s} \approx \underline{\underline{2,2 \text{ h}}}$$



$$I t = z n F \quad z = 4$$

$$n(\text{O}_2) = \frac{I t}{z F} = \frac{25 \text{ A} \cdot 8012 \text{ s}}{4 \cdot 96485 \text{ A s/mol}} = 0,519 \text{ mol}$$

$$V(\text{O}_2) = \frac{n R T}{p} = \frac{0,519 \text{ mol} \cdot 8,314 \text{ J}/(\text{mol} \cdot \text{K}) \cdot 298,15 \text{ K}}{101325 \text{ Pa}} = 12,7 \cdot 10^{-3} \text{ m}^3 \approx \underline{\underline{13 \text{ dm}^3}}$$

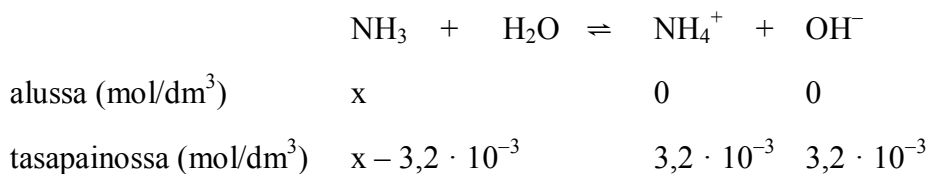
5. a) Oletus: $V = 1,00 \text{ dm}^3 \rightarrow m(\text{liuos}) = \rho V = 0,910 \text{ kg}$

sisältää 25,0 m-% NH_3 :a $\rightarrow m(\text{NH}_3) = 0,25 \cdot 0,910 \text{ kg} = 0,2275 \text{ kg}$

$$n(\text{NH}_3) = \frac{m}{M} = \frac{0,2275 \text{ kg}}{17,034 \text{ kg/kmol}} = 0,013356 \text{ kmol} = 13,356 \text{ mol}$$

$$c(\text{NH}_3) = \frac{n}{V} = \frac{13,356 \text{ mol}}{1,00 \text{ dm}^3} \approx \underline{\underline{13,4 \text{ mol/dm}^3}}$$

b) $\text{pH} = 11,5 \rightarrow \text{pOH} = 2,5 \rightarrow [\text{OH}^-] = 3,2 \cdot 10^{-3} \text{ mol/dm}^3$



$$K_b = \frac{(3,2 \cdot 10^{-3})^2}{x - 3,2 \cdot 10^{-3}} = 1,8 \cdot 10^{-5}$$

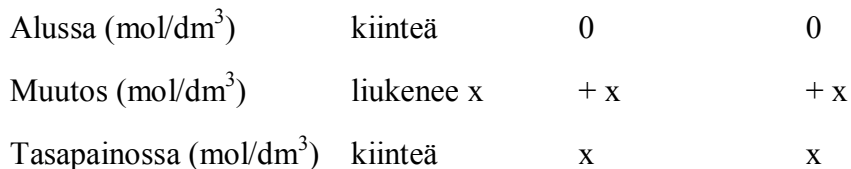
$$\Rightarrow x = 0,5721 \text{ mol/dm}^3$$

Liuosta valmistetaan 200 ml $\rightarrow n(\text{NH}_3) = 0,5721 \text{ mol/dm}^3 \cdot 0,20 \text{ dm}^3 = 0,1144 \text{ mol}$

5,70 mol/dm^3 NH_3 - liuosta tarvitaan: $\frac{0,1144 \text{ mol}}{5,70 \text{ mol/dm}^3} = 2,007 \cdot 10^{-2} \text{ dm}^3 \approx \underline{\underline{20 \text{ ml}}}$

$$\text{Tai: } c_1 V_1 = c_2 V_2 \rightarrow V_1 = \frac{c_2 V_2}{c_1} = \frac{0,5721 \text{ mol/dm}^3 \cdot 0,20 \text{ dm}^3}{5,70 \text{ mol/dm}^3} \approx \underline{\underline{20 \text{ ml}}}$$

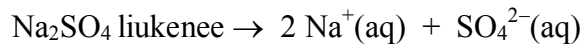
6. a) $\text{BaSO}_4(\text{s}) \rightleftharpoons \text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$



$$K_s = [\text{Ba}^{2+}][\text{SO}_4^{2-}] = x^2 = 1,10 \cdot 10^{-10} \text{ mol}^2/\text{dm}^6$$

$$x = [\text{Ba}^{2+}] = \underline{\underline{1,05 \cdot 10^{-5} \text{ mol/dm}^3}}$$

b) Lisätään 10,0 mg Na₂SO₄:a



$$\Leftrightarrow n(\text{Na}_2\text{SO}_4) = \frac{m}{M} = \frac{10,0 \cdot 10^{-3} \text{ g}}{142,05 \text{ g/mol}} = 7,04 \cdot 10^{-5} \text{ mol/dm}^3$$

Alussa (mol/dm ³)	BaSO ₄ (s) ⇌	Ba ²⁺ (aq)	+	SO ₄ ²⁻ (aq)
		1,05 · 10 ⁻⁵		1,05 · 10 ⁻⁵
Lisäys (mol/dm ³)		0		7,04 · 10 ⁻⁵
Uusi alku (mol/dm ³)		1,05 · 10 ⁻⁵		8,09 · 10 ⁻⁵
Tasapainossa (mol/dm ³)	kiinteä	1,05 · 10 ⁻⁵ - x		8,09 · 10 ⁻⁵ - x

$$K_s = (1,05 \cdot 10^{-5} - x)(8,09 \cdot 10^{-5} - x) = 1,10 \cdot 10^{-10}$$

$$x^2 - 9,14 \cdot 10^{-5} x + 7,39 \cdot 10^{-10} = 0$$

$$\Leftrightarrow x = 0,896 \cdot 10^{-5} \text{ mol/dm}^3$$

$$[\text{Ba}^{2+}] = 1,05 \cdot 10^{-5} - x = \underline{\underline{0,154 \cdot 10^{-5} \text{ mol/dm}^3}}$$