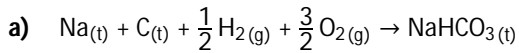
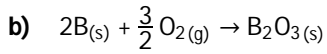


## VV2009.1

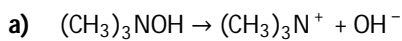


$$\Delta_f H^0 = (-425,61 - 393,51 - 127,5) \text{ kJ/mol} = -946,6 \text{ kJ/mol}$$



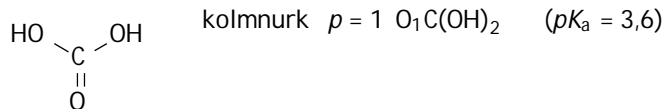
$$\Delta_f H^0 = (-2035 - 3 \cdot 44,0 - 3 \cdot (-285,8) + 38,5) \text{ kJ/mol} = -1271 \text{ kJ/mol}$$

## VV2009.2

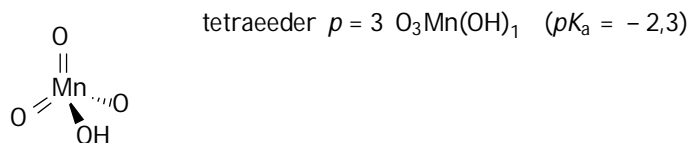
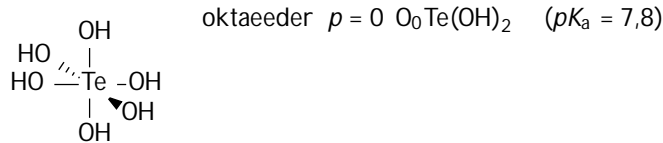
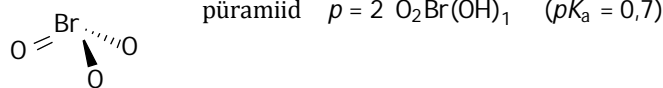


$$K_b = \frac{[(\text{CH}_3)_3\text{N}^+][\text{OH}^-]}{[(\text{CH}_3)_3\text{NOH}]}$$

Tugevam alus on NaOH, sest  $pK_{b,I} > pK_{b,II}$  ja NaOH on dissotsieerunud suuremal määral.



b)



Happete tugevus kasvab reas:  $\text{O}_0\text{Te}(\text{OH})_6 > \text{O}_1\text{C}(\text{OH})_2 > \text{O}_2\text{Br}(\text{OH})_1 > \text{O}_3\text{Mn}(\text{OH})_1$

c) 1.  $\text{HNO}_2$

$$K_a = \frac{[\text{H}^+][\text{NO}_2^-]}{[\text{HNO}_2]} = \frac{\alpha c \cdot \alpha c}{(1 - \alpha)c} = \frac{\alpha^2 c}{1 - \alpha}$$

$$K_a = \frac{0,073^2 \cdot 0,1}{1 - 0,073} = 5,7 \cdot 10^{-5}$$

$$pK_a(\text{HNO}_2) = -\log(5,7 \cdot 10^{-5}) = 3,24$$

2.  $\text{HNO}_3$

$$pK_a(\text{HNO}_3) = -\log(43,6) = -1,64$$

3.  $\text{HClO}_4$

$$pK_a(\text{HClO}_4) \approx -10$$

4.  $\text{CH}_3\text{COOH}$

$$[\text{H}^+] = 10^{-3,39} = 4,07 \cdot 10^{-4} \text{ M}$$

$$\alpha = \frac{[H^+]}{c} = \frac{4,07 \cdot 10^{-4} \text{ M}}{0,01 \text{ M}} = 0,0407$$

$$K_a = \frac{0,0407^2 \cdot 0,01}{1 - 0,0407} = 1,7 \cdot 10^{-5}$$

$$pK_a(\text{CH}_3\text{COOH}) = -\log(1,7 \cdot 10^{-5}) = 4,76$$

5.  $\text{H}_3\text{PO}_4$

$$K_{a1} = \frac{[H^+][\text{H}_2\text{PO}_4^-]}{[\text{H}_3\text{PO}_4]}$$

$$pK_{a1} = pH - \log \frac{c(\text{NaH}_2\text{PO}_4)}{c(\text{H}_3\text{PO}_4)} = pH - \log \frac{n(\text{NaH}_2\text{PO}_4)}{n(\text{H}_3\text{PO}_4)}$$

$$pK_{a1} = 2,46 - \log \frac{41 \text{ cm}^3 \cdot 0,38 \text{ M}}{23 \text{ cm}^3 \cdot 0,31 \text{ M}} = 2,12$$

6.  $\text{HBrO}$

$$c(\text{NaBrO}) = \frac{0,65 \text{ g}}{119 \frac{\text{g}}{\text{mol}}} \cdot \frac{100 \text{ g} + 0,65 \text{ g}}{1 \frac{\text{g}}{\text{cm}^3}} \cdot \frac{10^3 \text{ cm}^3}{1 \text{ dm}^3} = 0,0543 \text{ M}$$

$$K_b = K_{\text{hydr.}} = \frac{K_W}{K_a} = \frac{[\text{HBrO}][\text{OH}^-]}{[\text{BrO}^-]} \approx \frac{[\text{OH}^-]^2}{c(\text{NaBrO})}$$

$$K_a = \frac{[H^+]^2 c(\text{NaBrO})}{K_W} = \frac{10^{-10,71 \cdot 2} \cdot 0,0543}{10^{-14}} = 2,06 \cdot 10^{-9}$$

$$pK_a = -\log(2,06 \cdot 10^{-9}) = 8,7$$

Hapete tugevus:  $\text{HClO}_4 > \text{HNO}_3 > \text{H}_3\text{PO}_4 > \text{HNO}_2 > \text{CH}_3\text{COOH} > \text{HBrO}$

## VV2009.3

a) 1. Anood (-):  $\text{Ag}(t) + \text{I}^-(\text{aq}) - e^- = \text{AgI}(t)$

Katood (+):  $\text{Ag}^+(\text{aq}) + e^- = \text{Ag}(t)$

$\text{Ag}(t) + \text{I}^-(\text{aq}) + \text{Ag}^+(\text{aq}) = \text{AgI}(t) + \text{Ag}(t)$

2.  $\text{AgI}(t) \rightleftharpoons \text{I}^-(\text{aq}) + \text{Ag}^+(\text{aq})$

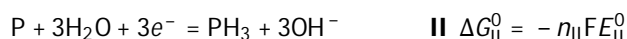
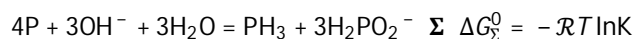
$$\Delta G^0 = -nFE^0 = -(\Delta G_A^0 + \Delta G_K^0) = -\mathcal{R}T \ln K_L$$

$$K_L = \exp(1 \cdot 96485 \text{ C/mol} \cdot 0,9509 \text{ V} / 8,314 \text{ J/mol} \cdot \text{K} \cdot 298 \text{ K}) = 8,3 \cdot 10^{-17}$$

$$s = [\text{Ag}^+] = \sqrt{K_L} = \sqrt{8,3 \cdot 10^{-17}} = 9,1 \cdot 10^{-9} \text{ M}$$

b) 1. Fosfor P, sest  $-0,06 < -0,51$  (pH = 0) ja  $-0,89 < -2,05$  (pH = 14).

2.



$$\Delta G_{\Sigma}^0 = \Delta G_{\text{I}}^0 - 3\Delta G_{\text{II}}^0 = -3F(E_{\text{II}}^0 - E_{\text{I}}^0)$$

$$\Delta G_{\Sigma}^0 = -3 \cdot 96485 \frac{\text{C}}{\text{mol}} \cdot (-0,89 \text{ V} - (-2,05 \text{ V})) = -336 \frac{\text{kJ}}{\text{mol}} \ll 0$$

$$K = \exp\left(\frac{-336000 \frac{\text{J}}{\text{mol}}}{8,314 \frac{\text{J}}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K}}\right) = 7 \cdot 10^{58}$$

3.

$$E_x^0 = \frac{n_I E_I^0 + n_{II} E_{II}^0}{n_I + n_{II}} = \frac{2 \cdot (-1,57 \text{ V}) + 1 \cdot (-2,05 \text{ V})}{2 + 1} = -1,73 \text{ V}$$

## VV2009.4

a) **A** on  $^{283}_{112}\text{Uub}$ , **B** ja **C** on  $^{287}_{114}\text{Uuq}$ , **D** on  $^{288}_{114}\text{Uuq}$ , **E** on  $^{289}_{114}\text{Uuq}$

1) Uub isotoopile vastab massiarv 281–283. Uuq isotoopidele vastavad massiarvud 285–288 (2. reaktsioon) ning 287–289 (3. reaktsioon). **A**, **B** ja **C** lagunemise ahelaid omavahel võrreldes saame järeldada, **A** on  $^{283}_{112}\text{Uub}$  ning **B** ja **C** on üks ja sama isotoop –  $^{287}_{114}\text{Uuq}$

2) Alfa-osakese energia ja eluea järgi **D** on  $^{288}_{114}\text{Uuq}$ , **E** on  $^{289}_{114}\text{Uuq}$  (alfa-osakese energia väheneb).

b) **F** on  $^{290}_{116}\text{Uuh}$ , **G** on  $^{291}_{116}\text{Uuh}$ , **H** on  $^{292}_{116}\text{Uuh}$

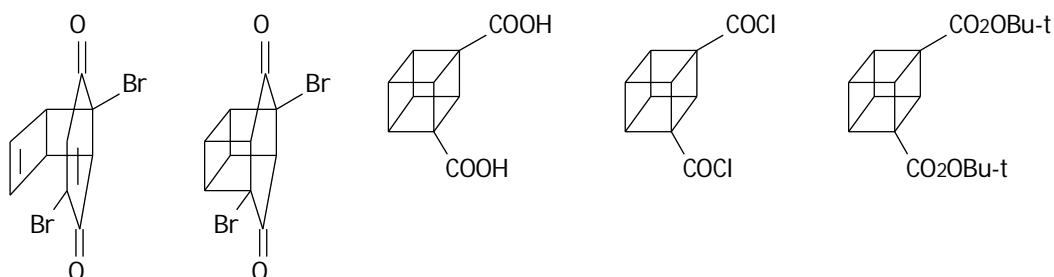
1) **G'** on  $^{287}_{114}\text{Uuq}$  ja **H'** on  $^{288}_{114}\text{Uuq}$ , saame järeldada võrreldes alfa-osakese energia ja eluea väärtuseid. Järelikult **G** on  $^{291}_{116}\text{Uuh}$ , **H** on  $^{292}_{116}\text{Uuh}$ .

2) **F** massiarv erineb **G** ja **H** massiarvudest ühe võrra. **F** ei saa olla  $^{293}_{116}\text{Uuh}$ , kuna selle isotoopi alfa-osakese energia peab olema suurem, kui  $^{292}_{116}\text{Uuh}$ -il (**H**). Seega **F** on  $^{290}_{116}\text{Uuh}$ .

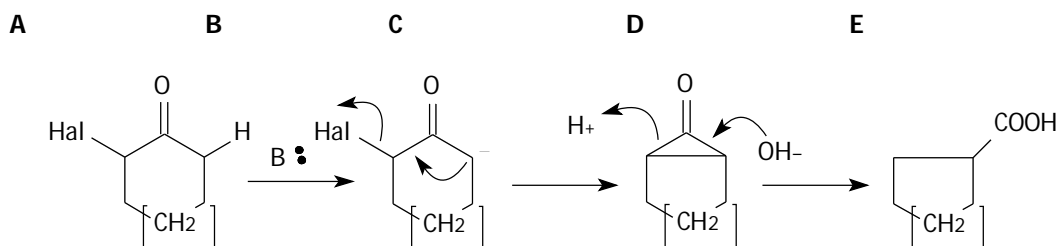
c) **I** –  $^{294}_{118}\text{Uuo}$

1) Võrreldes **I** ahela **F–H** ahelatega, järeldame, et **I'** = **F**. Seetõttu **I** on  $^{294}_{118}\text{Uuo}$ .

## VV2009.5



a)



b)

- c) 1. tsüklobutadien ei ole tavatingimustes stabiilne, seega selle sünteiline ekvivalent genereeritakse kompleksina. (Õigeks vastuseks võib lugeda „tsüklobutadieni stabiliseerimiseks”)
2.  $\text{Ce}^{\text{IV}}$  soolade abil genereeritakse in situ tsüklobutadien, mis kohe reageerib ära.