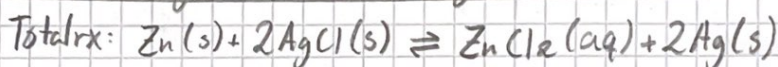
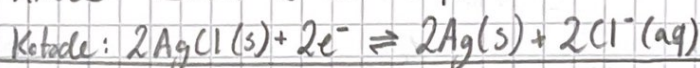
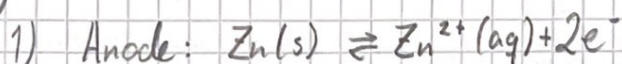


Termopøving 13

Kjapp teori

- 1) I en galvanisk celle produseres strøm ved en elektrokjemisk reaksjon, mens i en elektrolysecelle brukes strøm for å sette i gang en elektrokjemisk reaksjon
- 2) Det er potensialet i en elektrokjemisk celle hvor den ene halvdel er en standard hydrogencelle.
- 3) $\Delta G = -z \cdot F \cdot E$
- 4) Nernst likning kan brukes til å bestemme E i cellen når konsentrasjoner eller temperatur endres.

Oppgave 1



2) $\Delta_r G^\circ = -z \cdot F \cdot E^\circ = -2 \cdot 96500 \cdot 0,9853 \cdot (10^{-3} \frac{\text{kJ}}{\text{J}})$

$\Delta_r G^\circ = -190,2 \text{ kJ/mol}$

3) Nernst likning: $E = E^\circ - \frac{RT}{zF} \ln Q$, $E^\circ = 0,9853 \text{ V}$, $E = 1,1566 \text{ V}$
 $T = 298 \text{ K}$, $z = 2$

$$Q = \frac{a_{\text{Zn}^{2+}} \cdot a_{\text{Cl}^-}^2 \cdot \cancel{a_{\text{Ag(s)}}^2}}{\cancel{a_{\text{Zn(s)}}} \cdot \cancel{a_{\text{AgCl(s)}}^2}} = a_{\text{Zn}^{2+}} \cdot a_{\text{Cl}^-}^2$$
$$= \gamma_{\pm}^3 \cdot m_{\text{Zn}^{2+}} \cdot m_{\text{Cl}^-}^2, m_{\text{Zn}^{2+}} = \frac{1}{2} m_{\text{Cl}^-} = m$$

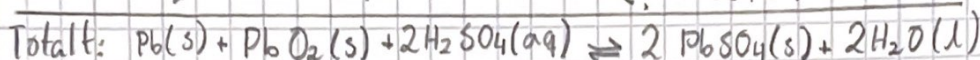
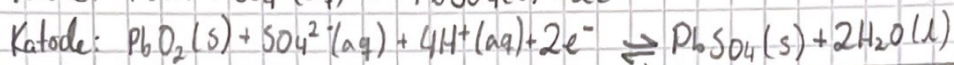
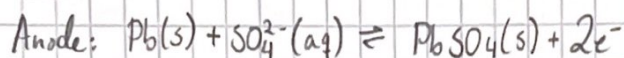
$$\Rightarrow E = E^\circ - \frac{RT}{zF} \ln(\gamma_{\pm}^3 \cdot m_{\text{Zn}^{2+}} \cdot m_{\text{Cl}^-}^2)$$

$$\gamma_{\pm} = \exp \left[\frac{zF}{3RT} (E^\circ - E) - \frac{1}{3} \ln(4m^3) \right]$$

$\gamma_{\pm} = 0,724$

Opgave 2

1)



$$\Delta_r G = -zFE = -2 \cdot 96485 (1,9174 + 56 \cdot 10^{-6} \cdot 25 + 108 \cdot 10^{-8} \cdot 25^2) \text{ J/mol}$$

$$= -370,5 \text{ kJ/mol}$$

$$\Delta_r S = - \left(\frac{\partial \Delta_r G}{\partial T} \right)_p = zF \left(\frac{\partial E}{\partial T} \right)_p = zF (56 \cdot 10^{-6} + 2 \cdot 108 \cdot 10^{-8} T)$$

$$= 2 \cdot 96485 \cdot (56 \cdot 10^{-6} + 2 \cdot 108 \cdot 10^{-8} \cdot 25) \text{ J/Kmol}$$

$$= 21,23 \text{ J/Kmol}$$

$$\Delta_r H = \Delta_r G + T \Delta_r S = -364,1 \text{ kJ/mol}$$

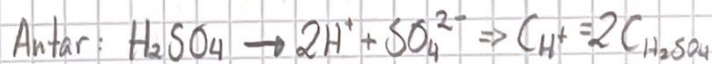
2)

$$E^\circ = -E^\circ_{\text{SO}_4^{2-}|\text{PbSO}_4|\text{Pb}} + E^\circ_{\text{SO}_4^{2-}|\text{PbSO}_4|\text{PbO}_2} = 0,355 + 1,685$$

$$E^\circ = 2,040 \text{ V}$$

$$E = 1,9174 + 56 \cdot 10^{-6} \cdot 25 + 108 \cdot 10^{-8} \cdot 25^2$$

$$E = 1,9195 \text{ V}$$



$$\text{Nernst: } E = E^\circ - \frac{RT}{zF} \ln Q \quad Q = \frac{a_{\text{H}_2\text{O}}^2}{a_{\text{H}_2\text{SO}_4}^2} = \frac{1^2}{\gamma_{\pm}^6 \cdot C_{\text{H}^+}^4 \cdot C_{\text{SO}_4^{2-}}^2} = 2C_{\text{SO}_4^{2-}}$$

$$\gamma_{\pm} = \sqrt[6]{\exp\left(\frac{zF}{RT} [E^\circ - E]\right)} \cdot \frac{1}{16 \cdot C_{\text{H}_2\text{SO}_4}}$$

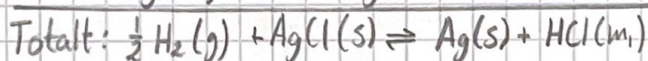
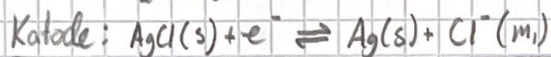
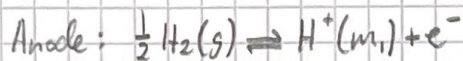
$$\gamma_{\pm} = 0,132$$

Oppgave 3

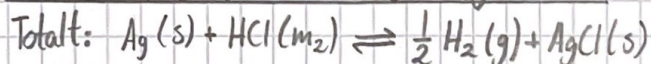
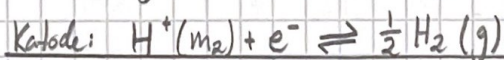
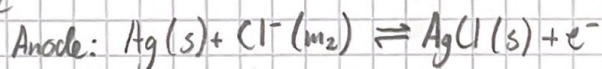
La $m_1 = 0,001 \text{ mol/kg}$, $m_2 = 0,01 \text{ mol/kg}$

• Celle I: (Dobbeltcelle)

- Venstre



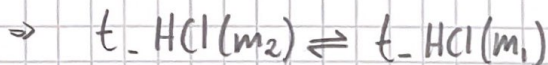
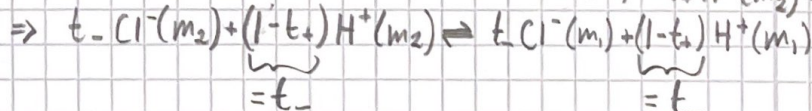
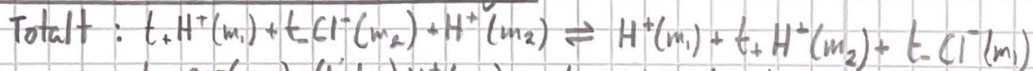
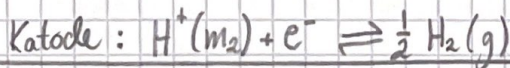
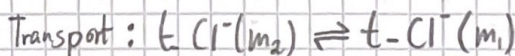
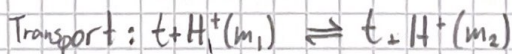
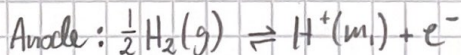
- Høyre



- Totalt



• Celle 2



$$1) E_1 = 0 - \frac{RT}{F} \ln \frac{a_{HCl}(m_1)}{a_{HCl}(m_2)} = - \frac{RT}{F} \ln \frac{\gamma_{\pm}^2(m_1) m_{H^+}(m_1) m_{Cl^-}(m_1)}{\gamma_{\pm}^2(m_2) m_{H^+}(m_2) m_{Cl^-}(m_2)}$$

Hvis $\gamma_{\pm}(m_1) = \gamma_{\pm}(m_2)$

$$E_1 = - \frac{RT}{F} \ln \left(\frac{m_1^2}{m_2^2} \right) = - \frac{8,3145 \cdot 298,2}{96485} \ln \left(\frac{0,001^2}{0,01^2} \right)$$

$$\underline{\underline{E_1 = 0,118V}}$$

$$2) E_1 = E^{\circ} - \frac{RT}{F} \ln \left(\frac{a_{HCl}(m_1)}{a_{HCl}(m_2)} \right) = - \frac{RT}{F} \ln Q_1$$

$$E_2 = E^{\circ} - \frac{RT}{F} \ln \left(\frac{a_{HCl}(m_1)}{a_{HCl}(m_2)} \right)^{t_-} = -t_- \frac{RT}{F} \ln Q_2, \text{ set } Q_1 = Q_2$$

$$\underline{\underline{\frac{E_2}{E_1} = t_- = \frac{0,02}{0,118} = 0,174, t_+ = 1 - t_- = 0,826}}}$$

3) Siden $\gamma_{\pm}(1) = \gamma_{\pm}(2)$

$$E_1(T) = -\frac{RT}{F} \ln Q = T \cdot k$$

$$\begin{aligned} \Rightarrow E_1 = kT_1 &\Rightarrow k = \frac{E_1}{T_1} \\ E_2 = kT_2 &\Rightarrow k = \frac{E_2}{T_2} \end{aligned} \quad \Rightarrow k = k \Rightarrow \frac{E_1}{T_1} = \frac{E_2}{T_2}$$

$$E_2 = \frac{T_2}{T_1} E_1$$

$$E_2(0^\circ\text{C}) = \frac{273,2}{298,2} \cdot 0,118 =$$

$$\underline{\underline{E_2(0^\circ\text{C}) = 0,108 \text{ V}}}$$

4) Bruker uttrykket fra 1)

• Ved $m_1 = 0,001$ og $m_2 = 0,01$

$$E_1 = -\frac{RT}{F} \ln \left(\frac{\gamma_{\pm}^2(m_1) m_1^2}{\gamma_{\pm}^2(m_2) m_2^2} \right) = -\frac{8,3145 \cdot 298,2}{96485} \ln \left(\frac{0,965^2 \cdot 0,001^2}{0,904^2 \cdot 0,01^2} \right)$$

$$\underline{\underline{E_1 = 0,115 \text{ V}}}$$

• 10 ganger høyere $\Rightarrow m_1 = 0,01$, $m_2 = 0,1 \Rightarrow \gamma_{\pm}(m_1) = 0,904$, $\gamma_{\pm}(m_2) = 0,796$

$$\underline{\underline{E_1 = 0,112 \text{ V}}}$$

$\Rightarrow E_1$ blir mindre hvis konsentrasjonene er 10 ganger høyere.