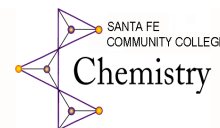




## Quantitative Redox Homework Answers



- $$\begin{array}{lcl} \text{Ag}(\text{H}_2\text{O})_2^+ + \text{e}^- & \longrightarrow & \text{Ag} + 2 \text{H}_2\text{O} \\ \text{Fe}(\text{H}_2\text{O})_6^{++} & \longrightarrow & \text{Fe}(\text{H}_2\text{O})_6^{+++} + \text{e}^- \end{array}$$

$$E^\circ_{\text{cath}} = 0.7996 \text{ V}$$

$$E^\circ_{\text{an}} = -0.783 \text{ V}$$


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$$\text{Ag}(\text{H}_2\text{O})_2^+ + \text{Fe}(\text{H}_2\text{O})_6^{++} \longrightarrow \text{Ag} + 2 \text{H}_2\text{O} + \text{Fe}(\text{H}_2\text{O})_6^{+++}$$

$$E^\circ_{\text{cell}} = 0.017 \text{ V}$$
- $$\begin{array}{lcl} \text{Fe} + 6 \text{H}_2\text{O} & \longrightarrow & \text{Fe}(\text{H}_2\text{O})_6^{++} + 2 \text{e}^- \\ 2 \times (\text{Fe}(\text{H}_2\text{O})_6^{+++} + \text{e}^-) & \longrightarrow & 2 \text{Fe}(\text{H}_2\text{O})_6^{++} \end{array}$$

$$E^\circ_{\text{an}} = 0.447 \text{ V}$$

$$E^\circ_{\text{cath}} = 0.783 \text{ V}$$


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$$\text{Fe} + 6 \text{H}_2\text{O} + 2 \text{Fe}(\text{H}_2\text{O})_6^{+++} \longrightarrow 3 \text{Fe}(\text{H}_2\text{O})_6^{++}$$

$$E^\circ_{\text{cell}} = 1.230 \text{ V}$$
- $$\begin{array}{lcl} \text{Pb} + \text{H}_2\text{O} + \text{HSO}_4^- & \longrightarrow & \text{PbSO}_4 + \text{H}_3\text{O}^+ + 2 \text{e}^- \\ \text{PbO}_2 + 3 \text{H}_3\text{O}^+ + \text{HSO}_4^- + 2 \text{e}^- & \longrightarrow & \text{PbSO}_4 + 5 \text{H}_2\text{O} \end{array}$$

$$E^\circ_{\text{an}} = 0.356 \text{ V}$$

$$E^\circ_{\text{cath}} = 1.691 \text{ V}$$


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$$\text{Pb} + \text{PbO}_2 + 2 \text{H}_3\text{O}^+ + 2 \text{HSO}_4^- \longrightarrow 2 \text{PbSO}_4 + 4 \text{H}_2\text{O}$$

$$E^\circ_{\text{cell}} = 2.047 \text{ V}$$
- $$\begin{array}{lcl} \text{NO}_3^- + 4 \text{H}_3\text{O}^+ + 3 \text{e}^- & \longrightarrow & \text{NO} + 6 \text{H}_2\text{O} \\ 3 \times (\text{Ag} + 2 \text{H}_2\text{O}) & \longrightarrow & 3 \text{Ag}(\text{H}_2\text{O})_2^+ + 3 \text{e}^- \end{array}$$

$$E^\circ_{\text{cath}} = 0.956 \text{ V}$$

$$E^\circ_{\text{an}} = -0.7996 \text{ V}$$


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$$\text{NO}_3^- + 4 \text{H}_3\text{O}^+ + 3 \text{Ag} \longrightarrow 3 \text{Ag}(\text{H}_2\text{O})_2^+ + \text{NO}$$

$$E^\circ_{\text{cell}} = 0.156 \text{ V}$$

Using the Nernst Equation: 
$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059160 \text{ V}}{n} \times \log Q$$

where Q (the reaction quotient) in the case is: 
$$Q = \frac{[\text{Ag}(\text{H}_2\text{O})_2^+]^3 \cdot P_{\text{NO}}}{[\text{H}_3\text{O}^+]^4 \cdot [\text{NO}_3^-]}$$

the new  $E_{\text{cell}}$  is: 
$$E_{\text{cell}} = 0.156 \text{ V} - \frac{0.059160 \text{ V}}{3} \times \log \left( \frac{[1.000]^3 \cdot 1.000}{[6.0]^4 \cdot [6.0]} \right) = 0.233 \text{ V}$$

- $$\begin{array}{lcl} 3 \times (2 \text{H}_2\text{O} + 2 \text{e}^-) & \longrightarrow & \text{H}_2 + 2 \text{OH}^- \\ 2 \times (\text{Al} + 2 \text{H}_2\text{O} + 4 \text{OH}^-) & \longrightarrow & 2 \text{Al}(\text{H}_2\text{O})_2(\text{OH})_4^- + 3 \text{e}^- \end{array}$$

$$E^\circ_{\text{cath}} = -0.8277 \text{ V}$$

$$E^\circ_{\text{an}} = 2.310 \text{ V}$$


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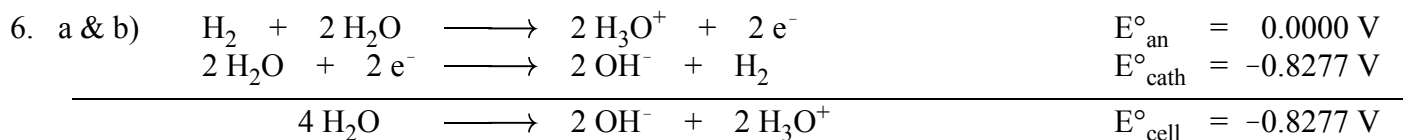

$$2 \text{Al} + 10 \text{H}_2\text{O} + 2 \text{OH}^- \longrightarrow 2 \text{Al}(\text{H}_2\text{O})_2(\text{OH})_4^- + 3 \text{H}_2$$

$$E^\circ_{\text{cell}} = 1.482 \text{ V}$$

Using the Nernst Equation: 
$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059160 \text{ V}}{n} \times \log Q$$

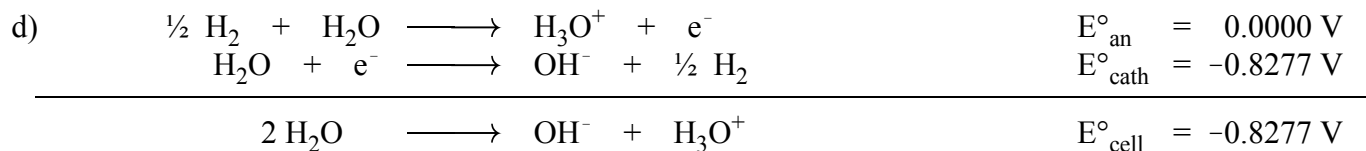
where Q (the reaction quotient) in the case is: 
$$Q = \frac{[\text{Al}(\text{H}_2\text{O})_2(\text{OH})_4^-]^2 \cdot (P_{\text{H}_2})^3}{[\text{OH}^-]^2}$$

the new  $E_{\text{cell}}$  is: 
$$E_{\text{cell}} = 1.482 \text{ V} - \frac{0.059160 \text{ V}}{6} \times \log \left( \frac{[1.000]^2 \cdot 1.000^3}{[6.0]^2} \right) = 1.497 \text{ V}$$



$$c) \Delta G^\circ = -nFE^\circ = (-2 \text{ mol})(96485.3 \text{ C/mol})(-0.8277 \text{ V}) = 1.597 \times 10^5 \text{ J}$$

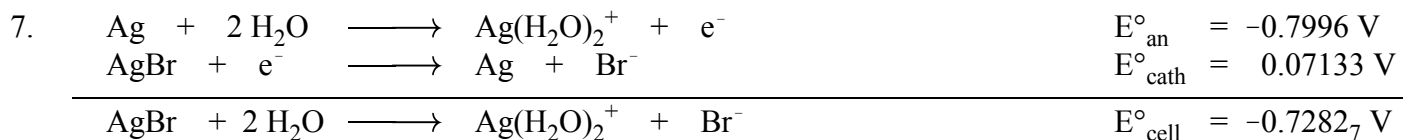
$$E^\circ = \frac{0.059160 \text{ V}}{n} \times \log K_{\text{eq}} \text{ or } K_{\text{eq}} = 10^{\frac{n \cdot E^\circ}{0.059160 \text{ V}}} = 10^{\frac{2(-0.8277 \text{ V})}{0.059160 \text{ V}}} = 1.0 \times 10^{-28}$$



$$e) \Delta G^\circ = -nFE^\circ = (-1 \text{ mol})(96485.3 \text{ C/mol})(-0.8277 \text{ V}) = 7.986 \times 10^4 \text{ J}$$

and

$$E^\circ = \frac{0.059160 \text{ V}}{n} \times \log K_{\text{eq}} \text{ or } K_w = 10^{\frac{n \cdot E^\circ}{0.059160 \text{ V}}} = 10^{\frac{1(-0.8277 \text{ V})}{0.059160 \text{ V}}} = 1.0 \times 10^{-14}$$



$$E^\circ = \frac{0.059160 \text{ V}}{n} \times \log K_{\text{eq}} \text{ or } K_{\text{SP}} = 10^{\frac{n \cdot E^\circ}{0.059160 \text{ V}}} = 10^{\frac{1(-0.7282_7 \text{ V})}{0.059160 \text{ V}}} = 4.9 \times 10^{-13}$$