

CHEMISTRY 133

Quiz 3 – Solutions

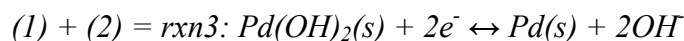
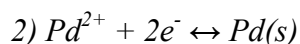
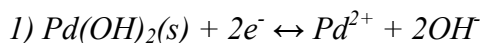
Calculate E° for the half-reaction $\text{Pd}(\text{OH})_2(\text{s}) + 2\text{e}^- \leftrightarrow \text{Pd}(\text{s}) + 2\text{OH}^-$ given that K_{sp} for $\text{Pd}(\text{OH})_2$ is 3×10^{-28} and $E^\circ = 0.915 \text{ V}$ for the reaction $\text{Pd}^{2+} + 2\text{e}^- \leftrightarrow \text{Pd}(\text{s})$. $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$

Equations that might be useful:

$$E = E^\circ - \frac{RT}{nF} \ln Q = E^\circ - \frac{2.303RT}{nF} \log Q = E^\circ - \frac{0.05916}{n} \log Q \quad (T = 298 \text{ K})$$

$$\Delta G^\circ = -nFE^\circ \quad \text{and} \quad \Delta G^\circ = -RT \ln K \quad F = 96,500 \text{ C/mol e}$$

If we look at the reaction associated with K_{sp} and the reduction of Pd^{2+} to $\text{Pd}(\text{s})$, we can see that these combined gives the half reaction for which we want to calculate E° :



Thus, $\Delta G^\circ_{\text{rxn1}} + \Delta G^\circ_{\text{rxn2}} = \Delta G^\circ_{\text{rxn3}}$ and $\Delta G^\circ_{\text{rxn1}} = -RT \ln K$ and $\Delta G^\circ_{\text{rxn2}} = -nFE^\circ_{\text{rxn2}}$

$$\Delta G^\circ_{\text{rxn3}} = -(8.314 \text{ J mol}^{-1} \text{ K}^{-1})(298 \text{ K}) \ln K + -(2 \text{ mol e})(96,500 \text{ C/mol e})(0.915 \text{ V})$$

(note: standard conditions means $T = 25\text{C} = 298\text{K}$)

$$\Delta G^\circ_{\text{rxn3}} = -(8.314 \text{ J mol}^{-1} \text{ K}^{-1})(298 \text{ K})(-63.37) - 176,600 \text{ J mol}^{-1}$$

$$\Delta G^\circ_{\text{rxn3}} = -19,590 \text{ J mol}^{-1} = -nFE^\circ \quad \text{or} \quad E^\circ = -(-19,590 \text{ J mol}^{-1}) / [(96,500 \text{ C/mol e})(2 \text{ mol e})]$$

$$E^\circ = 0.102 \text{ V}$$