CHEMISTRY 133

Name_____ **Quiz 3 – 10 points**

Calculate E° for the half-reaction $Pd(OH)_2(s) + 2e^- \leftrightarrow Pd(s) + 2OH^-$ given that K_{sp} for $Pd(OH)_2$ is 3×10^{-28} and E° = 0.915 V for the reaction $Pd^{2+} + 2e^- \leftrightarrow Pd(s)$. Assume T = 298 K

Information you may want to use:

Nernst Equation:

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

R = Universal Gas Constant = 8.314 J mol^{-1} K^{-1}; F = the faraday = 96,500 C/mol e^-; n = moles e^-

$\Delta G° = -RT\ln K$

Rxn: $Pd(OH)_2(s) + 2e^- \leftrightarrow Pd(s) + 2OH^-$ = $[Pd(OH)_2(s) \leftrightarrow Pd^{2+} + 2OH^-] + [Pd^{2+} + 2e^- \leftrightarrow Pd(s)]$

For 1 mol of $Pd^{2+} + 2e^- \leftrightarrow Pd(s)$, $\Delta G° = -nFE° = -(2)(96{,}490\ C/mol\ e)(0.915\ V) = -176.6\ kJ/mol$

For 1 mol of $Pd(OH)_2(s) \leftrightarrow Pd^{2+} + 2OH^-$, $\Delta G° = -RT\ln K = -8.314(298)\ln(3 \times 10^{-28}) = 157.0\ kJ/mol$

For 1 mol of $Pd(OH)_2(s) + 2e^- \leftrightarrow Pd(s) + 2OH^-$, $\Delta G° = -176.6 + 157.0\ kJ/mol = -19.6\ kJ/mol$

$E° = -\Delta G°/nF = 19.6/(2 \cdot 96490\ C/mol\ e)$ = ***0.101 V***

Alternatively, can solve by using the Nernst equation for the half- reaction $Pd^{2+} + 2e^- \leftrightarrow Pd(s)$ under standard conditions for the half-reaction $Pd(OH)_2(s) + 2e^- \leftrightarrow Pd(s) + 2OH^-$. Standard conditions means $[OH^-] = 1$ M and Pd will be present at the equilibrium concentration in the presence of $Pd(OH)_2(s)$ and 1 M OH^-.

$E°(Pd(OH)_2(s)\ reduction) = E° - 0.05916/2\log\{1/[Pd^{2+}]\} = 0.915\ V + 0.05916/2\log[Pd^{2+}]$

$[Pd^{2+}] = K_{sp}/[OH^-]^2 = 3 \times 10^{-28}$ so $E°(Pd(OH)_2(s)\ reduction) = 0.915 - 0.814\ V =$ ***1.01 V***