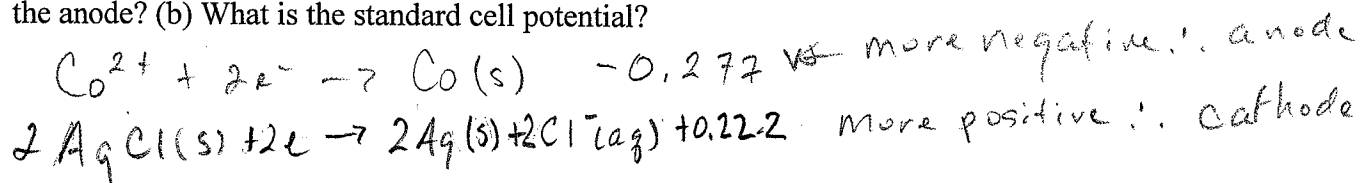


## CH 223 Worksheet 8

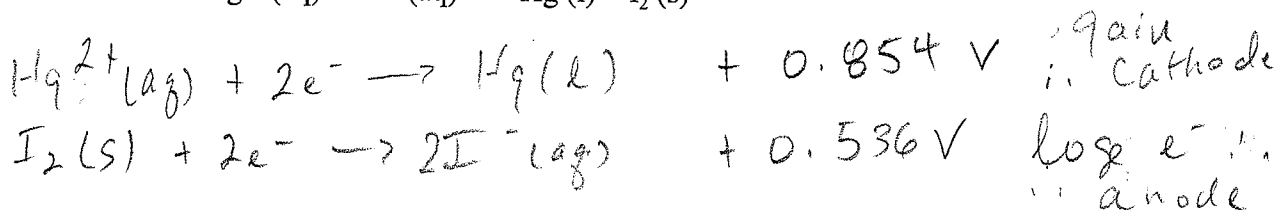
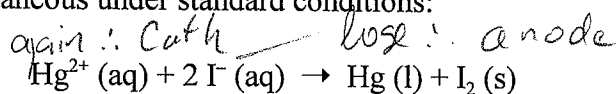
1. A voltaic cell is based on a  $\text{Co}^{2+} / \text{Co}$  half-cell and an  $\text{AgCl} / \text{Ag}$  half-cell. (a) What reaction occurs at the anode? (b) What is the standard cell potential?



$$E^\circ_{\text{cell}} = E^\circ_{\text{red}}(\text{cathode}) - E^\circ_{\text{red}}(\text{anode})$$

$$= 0.222 \text{ V} - (-0.277 \text{ V}) = \boxed{0.499 \text{ V}}$$

2. Using the standard reduction potentials listed in Appendix E (see attached), determine if the following reaction is spontaneous under standard conditions:

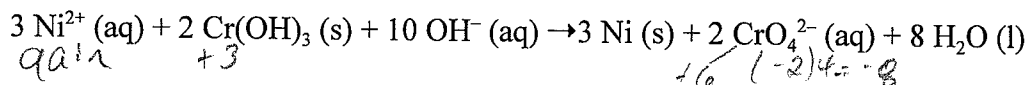


$$E^\circ_{\text{cell}} = E^\circ_{\text{red}}(\text{cathode}) - E^\circ_{\text{red}}(\text{anode})$$

$$= 0.854 \text{ V} - 0.536 \text{ V} = \boxed{0.318 \text{ V}} \quad \text{yes spontaneous}$$

$E^\circ$  positive

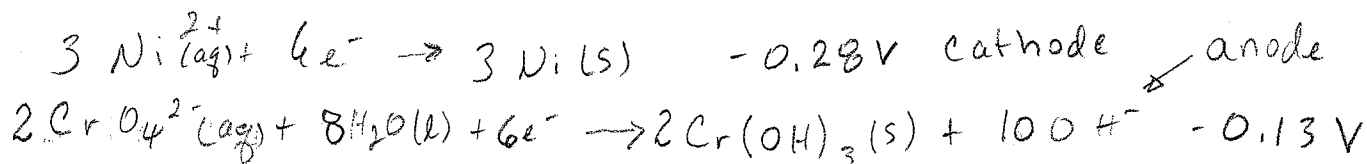
3. For the reaction



- (a) What is the value of  $n$ ? (b) Use the data in Appendix E to calculate  $\Delta G^\circ$ . (c) Calculate  $K$  at  $T = \frac{298 \text{ K}}{426 \text{ K}}$

(a)  $6e^-$

$$\Delta G^\circ = -nFE^\circ = -RT \ln K$$



$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = -0.28 \text{ V} - (-0.13 \text{ V}) = -0.15 \text{ V}$$

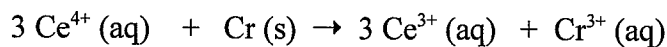
$$\Delta G^\circ = -6 \left( 96485 \frac{\text{C}}{\text{mol}} \right) \left( -0.15 \frac{\text{J}}{\text{C}} \right)$$

$$= 86,837 \text{ J}$$

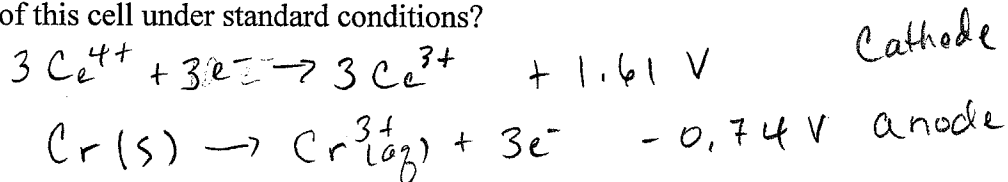
$V = \frac{J}{C}$

$$K = e^{\frac{-\Delta G^\circ}{RT}} = e^{\frac{-(86837 \frac{\text{J}}{\text{mol}})}{(8.314 \frac{\text{J}}{\text{mol K}})(426 \text{ K})}} = \boxed{2.25 \times 10^{-11}}$$

4. A voltaic cell utilizes the following reaction and operates at 310 K.



(a) What is the emf of this cell under standard conditions?



$$E_{\text{cell}}^{\circ} = E_{\text{red}}^{\circ}(\text{cathode}) - E_{\text{red}}^{\circ}(\text{anode}) = (1.61 \text{ V}) - (-0.74 \text{ V})$$

$$= 2.35 \text{ V}$$

(b) What is the emf of this cell when  $[\text{Ce}^{4+}] = 3.0 \text{ M}$ ,  $[\text{Ce}^{3+}] = 0.10 \text{ M}$  and  $[\text{Cr}^{3+}] = 0.010 \text{ M}$ ?

310 K and  $v = \frac{J}{C}$

$$E = E^{\circ} - \frac{RT}{nF} \ln Q = 2.35 \text{ V} - \frac{8.314 \frac{\text{J}}{\text{mol} \cdot \text{K}} \cdot 310 \text{ K}}{(3e^-) 96,485 \frac{\text{C}}{\text{mol}}} \ln \frac{(0.10)^3 (0.01)}{(3.0)^3}$$

$$Q = \frac{[\text{Ce}^{3+}]^3 [\text{Cr}^{3+}]}{[\text{Ce}^{4+}]^3} = 2.35 \text{ V} - (-0.132 \text{ V})$$

$$= 2.48 \text{ V}$$

5. An aqueous cadmium (Cd) solution is electrolyzed using a current of 7.60 A. How many grams of cadmium will be plated out after 2.00 days?

$$\text{Mass} = \frac{i t M M}{n F} \quad A = \frac{C}{s} \quad \text{Cd}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Cd}(\text{s})$$

$$= \frac{(7.60 \frac{\text{C}}{\text{s}}) (2.00 \text{ days}) (\frac{24 \text{ hrs}}{1 \text{ day}}) (\frac{60 \text{ min}}{1 \text{ hr}}) (\frac{60 \text{ s}}{1 \text{ min}}) (\frac{112.4 \text{ g}}{1 \text{ mol}})}{2 \cdot 96485 \frac{\text{C}}{\text{mol}}}$$

$$= 765 \text{ g Cd}$$