

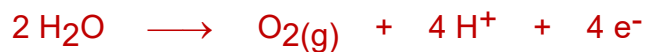
## Chem 10123, Quiz 8

April 8, 2020

## Answer Key

1. (2 points) Write balanced ionic equations for the half reactions that occur at the anode and cathode for the electrolysis of an aqueous solution of  $\text{Cu}(\text{NO}_3)_2$ .

Anode:



Cathode:



2. Consider the following galvanic cell in which the volume of each half-cell is 0.500 L.



- (a) (3 points) Write balanced chemical equations for the two half-reactions and for the overall cell reaction.

Anode:



Cathode:



Cell:



- (b) (5 points) Determine the *cell potential* ( $E_{\text{cell}}$ ) for the cell as described above.

$$E^\circ_{\text{cell}} = E^\circ_{\text{red}} + E^\circ_{\text{oxid}} = 1.50 \text{ v} + (0.58 \text{ v}) = 2.08 \text{ v}$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - (0.0592/n) \log Q$$

$$Q = 1 / [\text{OH}^-]^6 [\text{Au}^{3+}]^2 = 1 / (3.00)^6 (1.00)^2 = 0.001372$$

$$E_{\text{cell}} = 2.08 \text{ v} - (0.0592/6) \log(0.001372) = 2.08 - (-0.028) = 2.11 \text{ v}$$

\*Credit was also given for the possible reduction of  $\text{NO}_3^-$  instead of  $\text{Cu}^{2+}$ :



Although this reduction has a higher potential than  $\text{Cu}^{2+}$ , it requires an acidic solution (to supply the  $\text{H}^+$  reactant).  $\text{Cu}(\text{NO}_3)_2(\text{aq})$  is neutral, so the  $\text{Cu}^{2+}$  reduction actually occurs at the cathode.

2. continued.....

(c) (5 points) **SHOW ALL WORK.** If current is drawn from the above cell at a constant rate of 0.50 amp, determine the pH of the solution in the Pb half-cell after 72 hours.

$$(0.50 \text{ amp}) (72 \text{ hr}) (3600 \text{ sec / hr}) = 129,600 \text{ amp}\cdot\text{sec}$$

$$(129,600 \text{ amp}\cdot\text{sec}) (1 \text{ coul / amp}\cdot\text{sec}) (1 \text{ mole } e^- / 96,485 \text{ coul}) = 1.343 \text{ mole } e^-$$

$$(1.343 \text{ mole } e^-) (2 \text{ mole } OH^- / 2 \text{ mole } e^-) = 1.343 \text{ mole } OH^- \text{ consumed}$$

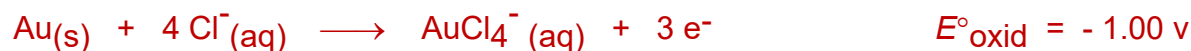
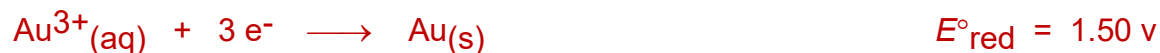
$$\text{initial mole } OH^- = (0.500 \text{ L}) (3.00 \text{ mole/L}) = 1.50 \text{ mole}$$

$$OH^- \text{ remaining} = 1.50 \text{ mole} - 1.343 \text{ mole} = 0.157 \text{ moles } OH^-$$

$$[OH^-] = 0.157 \text{ mole} / 0.50 \text{ L} = 0.314 \text{ M}$$

$$pOH = -\log(0.314) = 0.503 \quad pH = 13.50$$

3. (5 points) **SHOW ALL WORK.** Use appropriate electrochemical data to determine the *formation constant* ( $K_f$ ) for  $AuCl_4^-$  (aq). *Include balanced chemical equations for all relevant reactions.*



$$E^\circ_{\text{cell}} = 1.50 - 1.00 = 0.50 \text{ v}$$

$$\log K_f = n E^\circ_{\text{cell}} / 0.0592 = 3 (0.50) / 0.0592 = 25.33$$

$$K_f = 2.2 \times 10^{25}$$