

## Electrochemistry Principles and Calculation Exercises

Answers to lab exercise

Use the above equations to calculate the following:

- 1) Calculate the number of moles of Ag (from an  $\text{Ag}^+$  solution) which plate out if  $1.00 \times 10^6$  C is used in the plating process.

$$n = Q/F$$

$$n = 1.00 \times 10^6 \text{ C} / 96487 \text{ C mol}^{-1}$$

ANS 10.4 mol Ag

- 2) How many grams of copper are plated out of a  $\text{Cu}^{2+}$  solution if one passes a current of 1.00 A for 2.00 hrs. to a cathode.

$$Q = 1.00 \text{ A} \times 2.00 \text{ hr.} \times 3600 \text{ s/hr} = 7200 \text{ C}$$

$$n_{\text{Cu}} = \frac{7200 \text{ C}}{2 \times 96487 \text{ C/mol}} = 0.0373 \text{ mol}$$

$$m_{\text{Cu}} = 63.55 \text{ g/mol} \times 0.0373 \text{ mol}$$

ANS 2.37 g Cu

- 3) If the density of Cu is 8.87 g/mL, what is the volume of the Cu plated out in the problem above?

$$V = m/\rho$$

$$V = 2.37\text{g}/8.87 \text{ g cm}^{-3}$$

$$V = 0.267 \text{ cm}^3$$

ANS 0.267 cm<sup>3</sup> Cu

- 4) How thick a plating of Ni can one form on a 100 cm<sup>2</sup> plate if one plates Ni from a  $\text{Ni}^{2+}$  bath for 8.00 hrs with a current of 2.00 A. The density of Ni metal is 7.62 g/cm<sup>3</sup>.

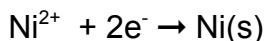
$$Q = It$$

$$Q = (2.00 \text{ A})(8.00 \text{ hr})(3600 \text{ s hr}^{-1})$$

$$Q = 5.76 \times 10^4 \text{ C}$$

$$n_{\text{e}^-} = 5.76 \times 10^4 \text{ C} / 96487 \text{ C mol}^{-1}$$

$$n_{\text{e}^-} = 0.597 \text{ mol}$$



$$n_{\text{Ni}}/1 = n_{\text{e}^-}/2$$

$$n_{\text{Ni}} = 0.298 \text{ mol}$$

$$m_{\text{Ni}} = (0.298 \text{ mol})(58.69 \text{ g mol}^{-1})$$

$$m_{\text{Ni}} = 17.5 \text{ g}$$

$$V = 17.5 \text{ g} / 7.62 \text{ g cm}^{-3}$$

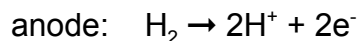
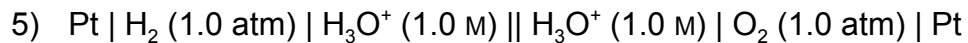
$$V = 2.30 \text{ cm}^3$$

$$d = V / A \quad d = 2.30 \text{ cm}^3 / 100 \text{ cm}^2$$

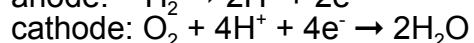
ANS  $2.30 \times 10^{-2}$  cm

Exercises:

Calculate the standard potential for the following electrochemical cells:

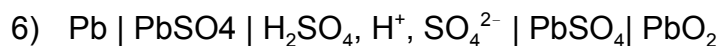


$$E^{\circ}_{\text{ox}} = 0.00 \dots$$

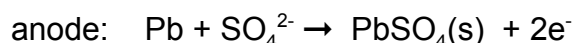


$$E^{\circ}_{\text{red}} = +1.229 \text{ V}$$

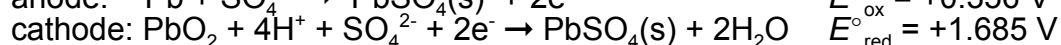
$$E^{\circ} = \underline{\quad +1.229 \quad} \text{ V}$$



Note that H<sup>+</sup> ≡ H<sub>3</sub>O<sup>+</sup>

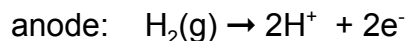
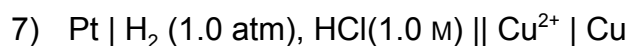


$$E^{\circ}_{\text{ox}} = +0.356 \text{ V}$$

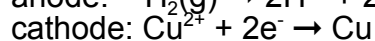


$$E^{\circ}_{\text{red}} = +1.685 \text{ V}$$

$$E^{\circ} = \underline{\quad +2.041 \quad} \text{ V}$$

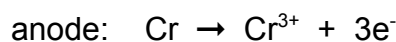
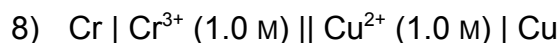


$$E^{\circ}_{\text{ox}} = 0.00 \dots$$

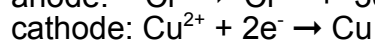


$$E^{\circ}_{\text{red}} = +0.3419 \text{ V}$$

$$E^{\circ} = \underline{\quad +0.3419 \quad} \text{ V}$$



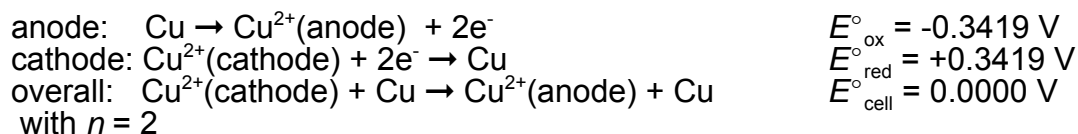
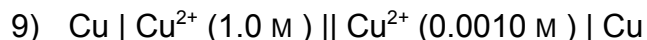
$$E^{\circ}_{\text{ox}} = +0.74 \text{ V}$$



$$E^{\circ}_{\text{red}} = +0.3419 \text{ V}$$

$$E^{\circ} = \underline{\quad +1.08 \quad} \text{ V}$$

Calculate the potentials for the following cells:

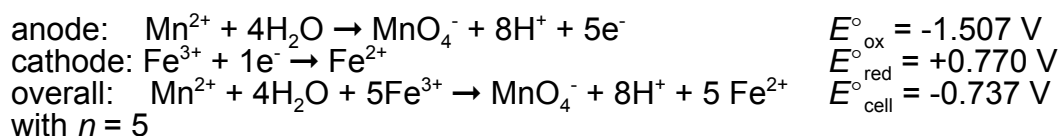
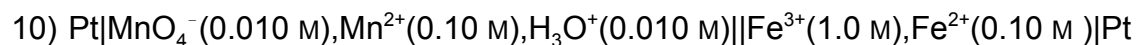


$$Q = [\text{Cu}^{2+}(\text{anode})] / [\text{Cu}^{2+}(\text{cathode})]$$

$$Q = (1.0) / (0.0010) = 1 \times 10^3$$

$$E = 0.0000 - (0.0592 / 2)\log(1 \times 10^3)$$

$$E = \underline{\underline{-0.089}} \text{ V}$$

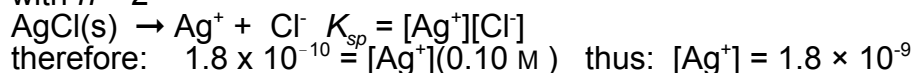
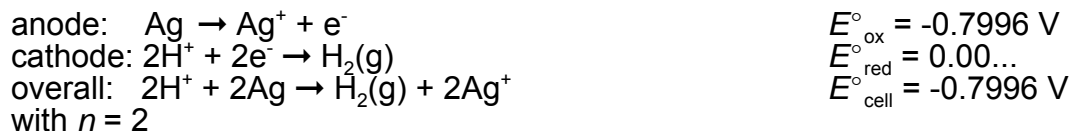
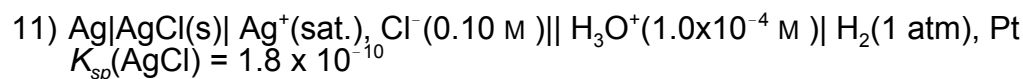


$$Q = [\text{MnO}_4^-][\text{H}^+]^8[\text{Fe}^{2+}]^5 / ([\text{Mn}^{2+}][\text{Fe}^{3+}]^5)$$

$$Q = (0.010)(0.010)^8 (0.10)^5 / \{(1.0)^5(0.10)\} = 1 \times 10^{-22}$$

$$E = -0.737 - (0.0592 / 5)\log(1 \times 10^{-22})$$

$$E = \underline{\underline{-0.477}} \text{ V}$$

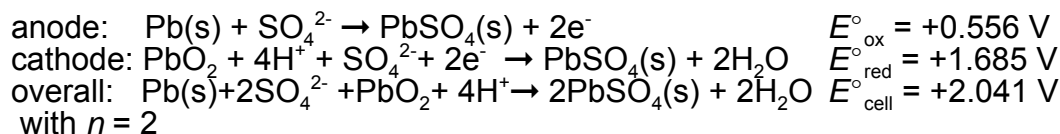


$$Q = [\text{Ag}^+]^2 P_{\text{H}_2} / [\text{H}^+]^2$$

$$Q = (1.8 \times 10^{-9})^2 (1.0) / (1.0 \times 10^{-4})^2 = 3.2 \times 10^{-10}$$

$$E = -0.7996 - (0.0592 / 2)\log(3.2 \times 10^{-10})$$

$$E^\circ = \underline{\underline{-0.5187}} \text{ V}$$



$$Q = 1 / ([\text{SO}_4^{2-}]^2[\text{H}^+]^4)$$

$$Q = 1 / [(1.2 \times 10^{-2})^2(9.0)^4] = 1.058$$

$$E = +2.041 - (0.0592 / 2)\log(1.058)$$

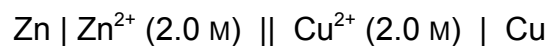
$$E^\circ = \underline{\underline{+2.040}} \text{ V}$$

**NAME** \_\_\_\_\_

## Electrochemistry Laboratory Demonstration of the Principles

**Project 1:**

In the laboratory you will find the necessary material to determine the cell potential for the cell:



The one problem you may have is creating a salt bridge. A paper towel soaked in salt solution ( $\text{NaNO}_3$ ) is sufficient for this purpose.

Write down a description of the experimental apparatus and materials you are to use.

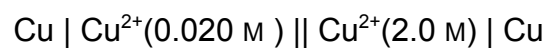
Write down the steps in the experiment.

Write below a section describing the experimental results. Part of this description should be a comparison to the literature value and the possible reasons for any difference.

Experimental Results:

Project 2:

Determine the cell potential of the concentration cell:



Write down a description of the experimental apparatus and materials you are to use.

Write down the steps in the experiment.

Write below a section describing the experimental results. Part of this description should be a comparison to the literature value and the possible reasons for any difference.

Experimental Results: