CONCEPT: ELECTROLYSIS

Electrolysis deals with passing an electrical current through a substance in order to produce chemical changes.

- The use of outside energy is indicative of a non-spontaneous reaction.

The passing of an electrical current through water helps to generate its standard components:

$$2\,H_2O\,(l) \rightarrow O_2\,(g) + 2\,H_2\,(g)$$

Electrical Current

The units for electrical current are in _____ (A):

moles of electrons

The moles of electrons within a reaction are determined by:

Ohm's Law

The Ohmic potential, E, is the voltage necessary to overcome resistance, R, when the current, I, is flowing:

Overpotential is the voltage required to overcome the activation energy for a reaction at a given electrode.

Concentration polarization occurs when there is a difference in the concentrations of reactants and products on the surface of electrodes when compared to the solution.

Electrolysis is made more difficult by *ohmic potential, overpotential* and *concentration polarization*.

$$E_{Cell} = E_{Cathode} - E_{Anode} - E_{Ohmic} - \text{Overpotentials}$$

PRACTICE: ELECTROLYSIS CALCULATIONS 1

EXAMPLE 1: Aluminum can be electroplated at the cathode of an electrolysis cell by the half-reaction:

$$Al^{3+}(aq) + 3\,e^- \rightarrow Al(s)$$

How much time would it take for 825 mg of aluminum to be plated at a current of 4.1 A?

EXAMPLE 2: In the electrolysis of molecular iodine to iodide ions for 0.15 M NaI solution containing 4.2×10^{-4} M I_2 at a pH = 6.00 with P_{O_2} = 1.25 bar, calculate the voltage needed to drive the reaction.

$$O_2(g) + 4\,H^+(aq) + 4\,e^- \rightarrow 2\,H_2O(l) \qquad E^\circ_+ = -0.41\ V$$

$$I_2(aq) + 2\,e^- \rightarrow 2\,I^-(aq) \qquad E^\circ_- = 0.54\ V$$

PRACTICE: During electrolysis the concentration of I_2 increases to 8.3×10^{-3} M, while all other concentrations remain unchanged. If the electrical resistance is 1.8 ohms, the current is 71 mA, the anode overpotential is 0.013 V and the cathode overpotential is 0.115 V, what is the voltage needed?

CONCEPT: ELECTRICAL CURRENT

EXAMPLE 1: Gold can be plated out of a solution containing Au^{3+} based on the following half reaction:

$$Au^{3+}\ (aq) + 3\ e^{-} \longrightarrow Au\ (s)$$

a) What mass of gold is plated by a 41 minute flow of 6.8 A current?

EXAMPLE 2: A solution of Mn^{+5} is used to plate out Mn in an electrochemical cell. If a total of 1.13 g of Mn is plated out in a total time of 1600 seconds, what was the electrical current used? (**MW of Mn is 54.94 g/mol**)

PRACTICE: ELECTRIC CURRENT (CALCULATIONS 1)

EXAMPLE: If steady current of 15 amperes is provided by a stable voltage of 12 Volts for 600 seconds, answer each of the following questions.

a) Calculate the **total charge** that passes through the circuit in this time.

b) Calculate the **total number of moles of electrons** that pass through the circuit in this time.

c) Calculate the **total amount of energy** that passes through the circuit in this time.

d) Calculate the **power** that the battery provides during this process.