

AP CHEMISTRY

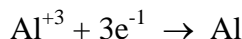
TOPIC 11: ELECTROCHEMISTRY, PART C,

Day 128:

- Electroplating
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1. How long will it take to plate out each of the following with a current of 100.0 amps?

a) 1.0 kg Al from aqueous Al^{+3}

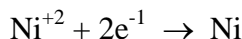


$$\frac{1.0 \text{ kg Al}}{1.0 \text{ kg}} \times \frac{1000 \text{ g Al}}{1 \text{ kg}} \times \frac{1 \text{ mol Al}}{26.98 \text{ g}} \times \frac{3 \text{ mol e}^{-1}}{1 \text{ mol Al}} \times \frac{96,500 \text{ coulombs}}{1 \text{ mol e}^{-1}} = 1.073 \times 10^7 \text{ coulombs}$$

$$I = \frac{q}{t} \quad ; \quad t = \frac{q}{I} = \frac{1.073 \times 10^7 \text{ amps} \cdot \text{sec}}{100.0 \text{ amps}} = 1.073 \times 10^5 \text{ sec}$$

$$\frac{1.073 \times 10^5 \text{ sec}}{3600 \text{ sec}} \times \frac{1 \text{ hour}}{3600 \text{ sec}} = 29.8 \text{ hour}$$

b) 1.0 g Ni from aqueous Ni^{+2}

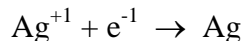


$$\frac{1.0 \text{ g Ni}}{58.69 \text{ g}} \times \frac{1 \text{ mol Ni}}{58.69 \text{ g}} \times \frac{2 \text{ mol e}^{-1}}{1 \text{ mol Ni}} \times \frac{96,500 \text{ coulombs}}{1 \text{ mol e}^{-1}} = 3288 \text{ coulombs}$$

$$I = \frac{q}{t} \quad ; \quad t = \frac{q}{I} = \frac{3288 \text{ amps} \cdot \text{sec}}{100.0 \text{ amps}} = 32.88 \text{ sec}$$

$$\frac{32.88 \text{ sec}}{60 \text{ sec}} \times \frac{1 \text{ min}}{60 \text{ sec}} = 0.548 \text{ min}$$

c) 5.0 mol Ag from aqueous Ag^{+}

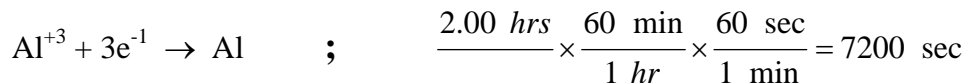


$$\frac{5 \text{ mol Ag}}{1 \text{ mol Ag}} \times \frac{1 \text{ mol e}^{-1}}{1 \text{ mol Ag}} \times \frac{96,500 \text{ coulombs}}{1 \text{ mol e}^{-1}} = 4.83 \times 10^5 \text{ coulombs}$$

$$I = \frac{q}{t} \quad ; \quad t = \frac{q}{I} = \frac{4.83 \times 10^5 \text{ amps} \cdot \text{sec}}{100.0 \text{ amps}} = 4825 \text{ sec}$$

$$\frac{4825 \text{ sec}}{60 \text{ sec}} \times \frac{1 \text{ min}}{60 \text{ sec}} = 80.4 \text{ min}$$

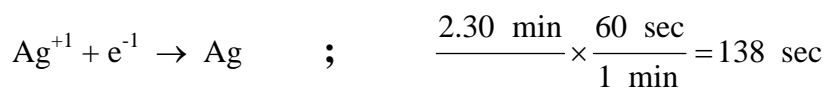
2. Aluminum is produced commercially by the electrolysis of Al_2O_3 in the presence of molten salt. If a plant has a continuous capacity of 1.00 million amp, what mass of aluminum can be produced in two hours?



$$q = It = (1.00 \times 10^6 \text{ amp})(7200 \text{ sec}) = 7.20 \times 10^9 \text{ coulombs}$$

$$\frac{7.20 \times 10^9 \text{ coulombs}}{96,500 \text{ coulombs}} \times \frac{1 \text{ mol } \text{e}^{-1}}{3 \text{ mol } \text{e}^{-1}} \times \frac{1 \text{ mol Al}}{1 \text{ mol Al}} \times \frac{26.98 \text{ g}}{1 \text{ mol Al}} = 6.71 \times 10^5 \text{ g}$$

3. It took 2.30 minutes using a current of 2.00 amps to plate all of the silver from 0.250 L of a solution containing Ag^{+1} . What was the original concentration of Ag^{+1} in the solution?



$$q = It = (2.0 \text{ amp})(138 \text{ sec}) = 276 \text{ coulombs}$$

$$\frac{276 \text{ coulombs}}{96,500 \text{ coulombs}} \times \frac{1 \text{ mol } \text{e}^{-1}}{1 \text{ mol } \text{e}^{-1}} \times \frac{1 \text{ mol Ag}^{+1}}{1 \text{ mol Ag}^{+1}} = 2.86 \times 10^{-3} \text{ mol}$$

$$M = \frac{2.86 \times 10^{-3} \text{ mol}}{0.250 \text{ L}} = 0.0114 \text{ M}$$

4. It is possible to extract many metals via the electrolysis of aqueous solutions of their ions. Such an experiment is carried out by passing 3.00 amps, for 2.00 hours, through a solution of metal ions that carry a +2 charge. 7.11 grams of the metal was produced. Identify the metal (choices are barium, copper, nickel, strontium, or zinc.)

$$\frac{2.00 \text{ hrs}}{1 \text{ hr}} \times \frac{60 \text{ min}}{1 \text{ min}} \times \frac{60 \text{ sec}}{1 \text{ min}} = 7200 \text{ sec}$$

$$q = It = (3.00 \text{ amp})(7200 \text{ sec}) = 2.16 \times 10^4 \text{ coulombs}$$

$$\frac{2.16 \times 10^4 \text{ coulombs}}{96,500 \text{ coulombs}} \times \frac{1 \text{ mol } \text{e}^{-1}}{2 \text{ mol } \text{e}^{-1}} \times \frac{1 \text{ mol Al}}{1 \text{ mol Al}} = 0.11192 \text{ mol}$$

$$\text{molar mass} = \frac{\text{g}}{\text{mol}} = \frac{7.11 \text{ g}}{0.11192 \text{ mol}} = 63.53 \frac{\text{g}}{\text{mol}}$$

Copper's molar mass is closest to the molar mass calculated.