AP CHEMISTRY

TOPIC 11: ELECTROCHEMISTRY, PART C,

Day 128:

- Electroplating

---

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}

$$Al^{+3} + 3e^{-1} \rightarrow Al$$

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

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

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

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

$$Ni^{+2} + 2e^{-1} \rightarrow Ni$$

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

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

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

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

$$Ag^{+1} + e^{-1} \rightarrow Ag$$

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

$$I = \frac{q}{t} \quad ; \quad t = \frac{q}{I} = \frac{4.38 \times 10^{5}\ amps \cdot \sec}{100.0\ amps} = 4825\ \sec$$

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

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?

$$Al^{+3} + 3e^{-1} \rightarrow Al \quad ; \quad \frac{2.00\ hrs}{} \times \frac{60\ \text{min}}{1\ hr} \times \frac{60\ \text{sec}}{1\ \text{min}} = 7200\ \text{sec}$$

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

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

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?

$$Ag^{+1} + e^{-1} \rightarrow Ag \quad ; \quad \frac{2.30\ \text{min}}{} \times \frac{60\ \text{sec}}{1\ \text{min}} = 138\ \text{sec}$$

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

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

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

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.)

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

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

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

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

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