

$$= \frac{0.049 \text{ C/s} \times 30.0 \text{ min} \times 60 \text{ s/min}}{9.65 \times 10^4 \text{ C/mol}}$$

$$n_{e^-} = 9.1 \times 10^{-4} \text{ mol}$$

$$n_{\text{Cu}} = 9.1 \times 10^{-4} \text{ mol } e^- \times \frac{1 \text{ mol Cu}}{2 \text{ mol } e^-}$$

$$n_{\text{Cu}} = 4.6 \times 10^{-4} \text{ mol}$$

$$m_{\text{Cu}} = 4.6 \times 10^{-4} \text{ mol} \times \frac{63.55 \text{ g}}{1 \text{ mol}}$$

$$m_{\text{Cu}} = 2.9 \times 10^{-4} \text{ g}$$

The other masses of copper deposited were very similar because the charge was controlled. For objects 2, 3, and 4, the mass of copper deposited was $3.0 \times 10^{-2} \text{ g}$.

Evaluation

- (h) In general, the design appears adequate to answer the question because it appears that electric current is a significant variable that affects the plating process. The materials were adequate, although the power supply was a little difficult to control to a predetermined value of the current. However, this would not seem to be a major problem. I am uncertain about the purpose and effect of acidifying the copper(II) sulfate with sulfuric acid. The procedure seemed to work well and gave sufficient evidence to answer the question.
- (i) The design seems to be promising because the final results were relatively clear. However, even the best plating could be scratched off with a little effort. Either a better surface preparation or a protective layer (e.g., a varnish) may be needed to produce a better plated object. The object was plated mostly on the side facing the anode, which is not very good if you want all sides of the object to be plated. Some of the other controlled variables need to be investigated to see if some other combination of variables, along with a low current, can improve the plating.
- (j) Some minor adjustments include a better control of the power supply, and perhaps mixing the electrolyte during the process. Some major adjustments include rotating the object to plate it on all sides and creating a surface to which the copper might adhere better (perhaps a rougher or pitted surface).
- (k) Two things were learned. One is that plating is not as easy as it sounds in a textbook. Secondly, there are many possible variables that make the discovery of the right combination of them a very long trial-and-error process of experimentation.

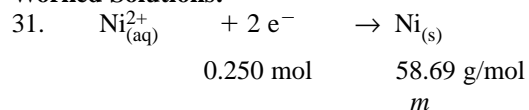
UNIT 5 SELF-QUIZ

(Page 764)

- True
- False: Reduction is the gain of electrons and occurs at the *cathode* ~~anode~~ of any cell.
- False: Oxidation is the ~~decrease~~ *increase* in oxidation number and reduction is the ~~decrease~~ *increase* in oxidation number.
- True
- False: Inert electrodes are required for *some* ~~all~~ electrolytic cells.
- True
- True
- False: The cell potential is determined by *subtracting* ~~adding~~ the reduction potentials for the two half-cell reactions.
- True
- False: A standard hydrogen-cobalt cell has a cell potential of ~~-0.28~~ *+0.28* V.
- False: In a standard copper-lead cell, lead is the *anode* ~~cathode~~ and copper is the *cathode* ~~anode~~.
- True
- False: The charge transferred by a 1.5-A current in a time of 2.0 min is *1.8×10^2* ~~3.0~~ C.
- True
- True
- True
- False: ~~Both tin and zinc plating work equally well in inhibiting the corrosion of iron.~~ *Zinc inhibits iron corrosion much better than tin, because its reduction potential is lower than that of iron.*
- False: Large *electrolytic* ~~galvanic~~ cells are used to refine metals and to produce nonmetals like chlorine.

19. (b)
20. (d)
21. (c)
22. (c)
23. (d)
24. (a)
25. (b)
26. (d)
27. (a)
28. (d)
29. (b)
30. (b)
31. (c)
32. (a)
33. (c)
34. (d)
35. (a)
36. (b)

Worked Solutions:

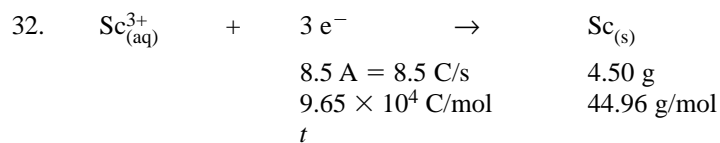


$$n_{\text{Ni}} = 0.250 \cancel{\text{mol e}^{-}} \times \frac{1 \text{ mol Ni}}{2 \cancel{\text{mol e}^{-}}}$$

$$n_{\text{Ni}} = 0.125 \text{ mol}$$

$$m_{\text{Ni}} = 0.125 \cancel{\text{mol}} \times 58.69 \frac{\text{g}}{\cancel{\text{mol}}}$$

$$m_{\text{Ni}} = 7.34 \text{ g} \quad (\text{c})$$



$$n_{\text{Sc}} = 4.50 \cancel{\text{g}} \times \frac{1 \text{ mol}}{44.96 \cancel{\text{g}}}$$

$$n_{\text{Sc}} = 0.100 \text{ mol}$$

$$n_{\text{e}^{-}} = 0.100 \cancel{\text{mol Sc}} \times \frac{3 \text{ mol e}^{-}}{1 \cancel{\text{mol Sc}}}$$

$$= 0.300 \text{ mol}$$

$$n_{\text{e}^{-}} = \frac{q}{F}$$

$$n_{\text{e}^{-}} = \frac{It}{F}$$

$$t = \frac{n_{\text{e}^{-}} F}{I}$$

$$= \frac{0.300 \cancel{\text{mol}} \times 9.65 \times 10^4 \frac{\cancel{\text{C}}}{\cancel{\text{mol}}}}{8.5 \frac{\cancel{\text{C}}}{\text{s}}}$$

$$t = 3.4 \times 10^3 \text{ s}$$

$$t = 3.4 \times 10^3 \cancel{\text{s}} \times \frac{1 \text{ min}}{60 \cancel{\text{s}}} = 57 \text{ min} \quad (\text{a})$$