

CHAPTER 10 ELECTROLYTIC CELLS

Reflect on Your Learning

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1. *[Likely initial answer]* If the cell potential is a negative value, this might mean that the reaction goes in reverse or maybe does not happen at all.
[More complete answer] A negative cell potential indicates that the predicted cell reaction is nonspontaneous and requires an external power supply to force the reaction to occur.
2. *[Likely initial answer]* Elements are produced by decomposing naturally occurring substances using heat or electricity or using a single displacement reaction.
[More complete answer] Most elements are produced or refined in industrial processes using aqueous, nonaqueous, or molten salt electrolysis.
3. *[Likely initial answer]* There is probably some relationship but it is not clear what that might be.
[More complete answer] The coefficients in the half-reaction equation provide the mole ratio of electrons to the product at the electrode.
4. *[Likely initial answer]* All of these are interrelated with science and technology producing useful products and processes for society.
[More complete answer] The technology of electrolytic cells preceded any scientific understanding of the processes. Eventually, atomic and redox theories developed to explain known electrolytic cells. Further scientific investigation of electrolytic cells led to new technologies that were very useful to society, which in turn encouraged more research. Today, the continuing cycle of scientific understanding and technological development continues.

Try This Activity: A Nonspontaneous Reaction

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- (a) There is no initial evidence of reaction.
- (b) Near the positive terminal of the battery, the colourless solution changes to a yellow-brown solution (with some black precipitate). Near the negative terminal of the battery, bubbles of gas form.
- (c) The evidence for chemical reaction is both the colour change and gas formation. (A precipitate may also be observed.)
- (d) The battery supplies energy to cause the reaction.
- (e) The colour change means at least one new substance (and probably two substances) is/are formed at the negative battery terminal.
- (f) The two substances might be hydrogen or oxygen (the gas) and iodine (the brown colour). Diagnostic tests for hydrogen and oxygen can be done with a lit or glowing splint. A diagnostic test for iodine can be done by dissolving it in a nonpolar liquid like a hydrocarbon. (Appendix A6)
- (g) To improve this design, the gas produced should be collected by downward displacement of water.
- (h) Forcing a nonspontaneous reaction to occur is a way of producing new substances.

10.1 ELECTROLYSIS

PRACTICE

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Understanding Concepts

1. (a) (cathode) $\text{Ni}_{(\text{aq})}^{2+} + 2 \text{e}^- \rightarrow \text{Ni}_{(\text{s})}$ $E_r^\circ = -0.26 \text{ V}$
 (anode) $2 \text{I}_{(\text{aq})}^- \rightarrow \text{I}_{2(\text{s})} + 2 \text{e}^-$ $E_r^\circ = +0.54 \text{ V}$

 (net) $\text{Ni}_{(\text{aq})}^{2+} + 2 \text{I}_{(\text{aq})}^- \rightarrow \text{Ni}_{(\text{s})} + \text{I}_{2(\text{s})}$
 $\Delta E^\circ = E_r^\circ (\text{cathode}) - E_r^\circ (\text{anode})$
 $= -0.26 \text{ V} - (+0.54 \text{ V})$
 $\Delta E^\circ = -0.80 \text{ V}$

The minimum applied potential difference required to make this cell operate at standard conditions is 0.80 V.