17. \( \text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al} \quad E^0 = -1.662\text{V} \)
Reducing Al\(^{3+}\) is very unfavorable.
Oxidizing Al is very favorable.
\( \text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^- \quad -E^0_{\text{an}} = 1.662\text{V} \).

Al is easily oxidized; it is a good reducing agent.

19. Good oxidizing agents are easily reduced.
\( \text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^- \quad E^0 = 1.358\text{V} \)
\( \text{Br}_2 + 2\text{e}^- \rightarrow 2\text{Br}^- \quad E^0 = 1.066\text{V} \)

The reduction of \( \text{Br}_2 \) is less favorable than the reduction of \( \text{Cl}_2 \). Therefore, \( \text{Br}_2 \) is a poorer oxidizing agent than \( \text{Cl}_2 \).

27. \( \text{Pb}^{2+} + 2\text{Cr}^{3+} \rightarrow \text{Pb} + 2\text{Cr}^{2+} \)
\[ \Delta E^0 = E^0_{\text{cat}} - E^0_{\text{an}} = -0.126\text{V} - (-0.407\text{V}) = 0.281\text{V} \]

\[ \Delta E = \frac{\Delta E^0 - 0.0257 \ln Q}{2} = \frac{0.281 - 0.0257 \ln \frac{[\text{Cr}^{2+}]^2}{[\text{Cr}^{3+}]^2 [\text{Pb}^{2+}]} }{2} \]

\[ = 0.281 - 0.0257 \frac{\ln (0.0200)^2}{(0.20)^2 (0.15)} = 0.2065\text{V} \]
\[ E = E^0 - \frac{0.0599 \ln (\frac{1}{[Cr^{2+}]/[Cr^{3+}]})}{n} \]

\[ E = E^0 - 0.0599 \ln \left( \frac{1}{\frac{0.019}{0.15}} \right) = -0.295 \text{V} \]

33. \text{Cd}^{2+} | \text{Cd} \quad E^0 = -0.403 \text{V}

The \text{Cd}^{2+} | \text{Cd} \text{ reduction is less favorable than the } \text{Cr}^3^+ (0.15 \text{ M}) | \text{Cr}^{2+} (0.0019 \text{ M}) \text{ reduction. Therefore, the } \text{Cd}^{2+} | \text{Cd} \text{ half-cell will be the anode when the half-cells are joined.}

6.605 \text{ cm} \text{ HCl} 0.21 \text{ M HClO} \quad E^0_{\text{cell}} = 1.615 \text{V}

\[ \text{Cr}_2\text{O}_7^{2-} | \text{Cr}^{3+} \quad -E^0 = -1.232 \text{V} \]

\[ \Delta E^0 = 0.413 \text{V} \]

\[ 0 = \Delta E^0 - 0.0257 \ln K \]

\[ \ln K = \frac{-0.413 \text{V}}{0.0257 \text{V}} = 96.142 \]

\[ K = 7.5 \times 10^{41} \]

b. The equilibrium lies far to the right; some expect the mixture to have the
dichromate color (orange) at equilibrium.

\[
K = \frac{[\text{H}_2\text{Cr}_2\text{O}_7]^2 [\text{H}^+]^8}{[\text{HClO}_2]^3 [\text{Cr}^{3+}]^2}
\]

\[
\begin{align*}
[\text{H}_2\text{Cr}_2\text{O}_7] &= 0.50 \\
[\text{Cr}^{3+}] &= 0.25 \\
[\text{HClO}_2] &= -2y \\
[\text{H}^+] &= +3y \\
\Sigma \text{c}_{2\text{Cr}^{3+}} &= 2y \\
\Sigma \text{c}_{2\text{HClO}_2} &= 2y \\
\Sigma \text{c}_\Sigma &= 8y
\end{align*}
\]

Maximun value of \( y \) is 0.125

Using \( y = 0.12 \)

\[
Q = \frac{(0.38)^3 (0.12)(0.96)}{(0.14)^3 (0.01)} = 1.5 \times 10^4
\]

At 90% conversion, we haven't even reached eq.

\[
\begin{align*}
0.600 & \quad \text{Hg}_2^+ + 2e^- \rightarrow \text{Hg}^0 \\
46.9 & \quad \text{Hg}_2^+ + 2e^- \rightarrow 2\text{Hg} \\
& \quad \text{Hg}_2^{2+} \rightarrow 2\text{Hg}^2+ + 2e^- \\
& \quad 2\text{Hg}_2^{2+} \rightarrow 2\text{Hg} + 2\text{Hg}^{2+} \\
& \quad \text{Hg}_2^+ \rightarrow \text{Hg} + \text{Hg}^{2+}
\end{align*}
\]

\( \Delta \varepsilon = -0.123 \, V \)

\( \varepsilon^0 = 0.797 \, V \)

\( \varepsilon^\circ = -0.920 \, V \)
Problem asks about:

\[ \text{Hg}^{2+} + \text{Hg} \rightarrow \text{Hg}_{2}^{2+} \quad \Delta E = +0.123 \text{V} \]

b. Addition of ammonia removes \( \text{Hg}^{2+} \) from the solution. The rxn shifts left to replace \( \text{Hg}^{2+} \) and must produce \( \text{Hg} \) at the same time.

57. The concentration of sulfate ion in the battery acid is diminished as the electrode reactions produce \( \text{Pb}^{2+} \) that, in turn, forms a ppt of \( \text{PbSO}_4 \). Adding more \( \text{H}_2\text{SO}_4 \) does not replenish the \( \text{Pb} \) and \( \text{PbSO}_4 \) needed for the electrode reactions.

59. At the level of approximation used in our equilibrium calculations, all solids are represented by "1". The value does not change while the battery operates.

60. In the dry cell, the zinc ions leave the anode and become trapped in complex form, they can not be returned to elemental state by reversing the polarity of the battery. In the alkaline battery, the zinc ions are trapped as \( \text{Zn(OH)}_2 \) which does not adhere to the electrode (as \( \text{PbSO}_4 \) does).
67. Nickel batteries suffer from discharge memory (recharging prior to full discharge may lead to a need for frequent recharges). Also, cadmium is an environmental hazard.

67. Sodium would be oxidized in preference to steel. However, it is active enough to replace H from water in a very exothermic reaction \( 2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 \). The reaction is energetic enough to cause the hydrogen produced to burst into flame.

68. \[ \text{Fe}^{2+} + 2e^- \rightarrow \text{Fe} \quad E^0 = -0.447 \text{V} \]

68. \[ \text{Fe}^{3+} + 3e^- \rightarrow \text{Fe} \quad E^0 < -0.447 \text{V} \]

71. As the iron filings placed in the landfill are oxidized to ferrous \( \text{Fe}^{2+} \) compounds, the toxic chlorinated hydrocarbons are reduced to \( \text{C}_2 \) and non-toxic or less toxic hydrocarbons.