20 • Electrochemistry

20.9 Electrolysis

A voltaic cell is one in which a spontaneous chemical reaction is used to generate a voltage.

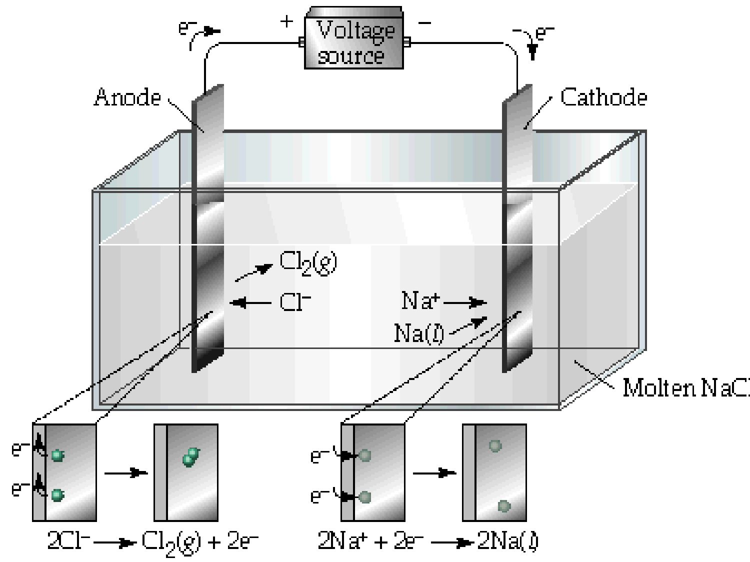
Electrolysis is the use of a voltage to drive a nonspontaneous reaction.

Reactions that are driven by an externally supplied voltage are called **electrolysis reactions**, and electrochemical cells designed for the purpose of carrying out electrolysis reactions are called **electrolytic cells**

Cathode: $2\,Na^{+}\,(l) + 2e^{-} \rightarrow 2Na\,(l)$ $\quad E^{\circ}_{red} = -2.71\ V$

Anode: $2\,Cl^{-}\,(l) \rightarrow Cl_2\,(g) + 2\,e^{-}$ $\quad E^{\circ}_{red} = 1.36\ V$

$2\,Na^{+}\,(l) + 2Cl^{-}\,(l) \rightarrow 2Na\,(l) + Cl_2\,(g)$ $\quad E^{\circ}_{cell} = -4.07\ V$



We can determine how much charge is required to make a specific amount of metal "plate out" on the cathode using some simple equations.

$1F = N_A \cdot q = (6.022 \times 10^{23}\ mol^{-1})\ (1.6 \times 10^{-19}\ C) = 96,352\ C/mol$ or roughly 96, 500 C/mol

1F = 96,500 C/mol

- This equation tells us how much charge is required to reduce 1 mole of electrons
- We can relate this to the reduction equation for a reaction to determine how much metal will plate out

Current and time It = q	Quantity of charge (C)	Moles of electrons (faradays)	Moles of substance oxidized or reduced	Grams of substance

Practice Problem:

Use diagram on the previous page and calculate the amount of Na*(l)* made when a current of 5A is passed through the electrodes for 1 hour.

<u>Electrolysis Practice Problems</u>

1. Electrolysis of AgF (aq) in acidic solution leads to the formation of silver metal and oxygen gas. (p788)

(a) What are the half-reactions that occur at each electrode?

(b) What is the minimum external emf required to cause this process to occur under standard conditions?

2. Calculate the mass of aluminum produced in 1.00 hr by the electrolysis of molten $AlCl_3$ if the electrical current is 10.0 A? (p.790)

3. The half reaction for formation of magnesium metal upon electrolysis of molten $MgCl_2$ is $Mg^{2+} + 2e^- \rightarrow Mg$. Calculate the mass of magnesium formed upon passage of a 60.0 A current for a period of 4.00×10^3 s. (p. 791)