

23

INTERPRETING GRAPHICS

USE WITH SECTION 23.3

Electrolysis is sometimes used to purify metals from mixtures. In this process, a slab or bar of impure metal, containing many types of metallic elements, is made the anode of an electrolytic cell. When external electrical energy is supplied to the cell, metallic elements in the anode are oxidized to cations which dissolve in solution. Then the cations are reduced to the pure metal at the surface of the cathode. A schematic diagram of an electrolytic cell used to purify copper is shown below. If the voltage supply is carefully regulated, less reactive metals are not oxidized at the anode, but instead collect as "mud" at the bottom of the cell below the anode. Metals more reactive than copper are oxidized at the anode, but are not reduced at the cathode; therefore, they remain dissolved as ions in the electrolyte solution (CuSO_4).

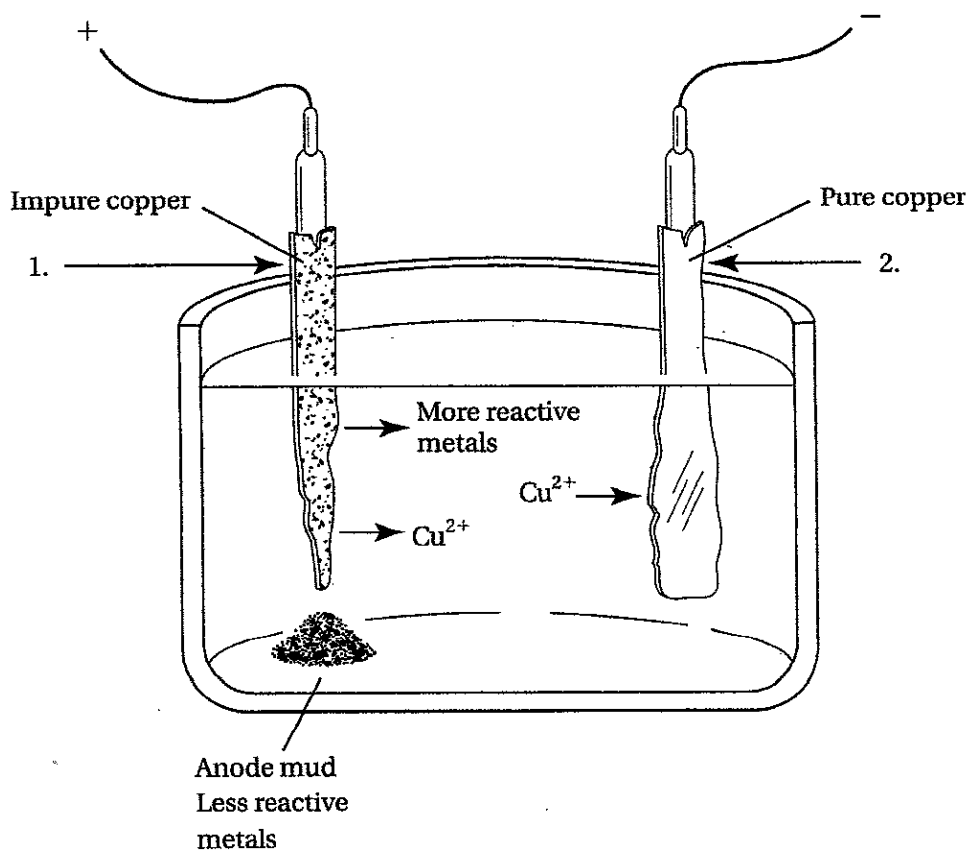


Figure 1 Purification of copper by electrolysis at 25 °C, 101.3 kPa, in 1M CuSO_4 .

Identify the anode and cathode in the diagram. Write your answers on the lines provided.

1. _____ 2. _____

3. What name is given to the technique used to obtain pure copper by electrolysis?

4. The apparatus depicted in Figure 1 is not complete, the electrolytic cell must be connected to a DC source (a battery).
- To which electrodes of the battery, positive (+) or negative (-), should the anode and cathode of the electrolytic cell be connected?

- Describe the connections in terms of the anode and cathode of the battery.

5. At which of the electrodes, numbered 1 and 2 in Figure 1, is oxidation occurring? Reduction? Label the electrodes in the diagram.

6. Using arrows, annotate the diagram in Figure 1 to show the flow of electrons out of or into the electrodes.

The E_{red}^0 values for several metals are shown below.

$E_{\text{Zn}^{2+}}^0 = -0.76 \text{ V}$	$E_{\text{Cu}^{2+}}^0 = +0.34 \text{ V}$	$E_{\text{Au}^{3+}}^0 = +1.50 \text{ V}$
$E_{\text{Fe}^{2+}}^0 = -0.44 \text{ V}$	$E_{\text{Ag}^+}^0 = +0.80 \text{ V}$	$E_{\text{Pt}^{2+}}^0 = +1.18 \text{ V}$

Assume that all of these metals are present in the impure metal anode. Use these data to answer the following questions.

7. What voltage should be applied to the electrolytic cell to purify copper in the manner described above?

8. If the voltage from the DC source is maintained at 0.40 V:
- Which metals will be found in the anode mud when the electrolysis is complete?

- Which cations will be found dissolved in the electrolyte solution?

- Which metal(s) will plate out at the cathode?