Outcome 2
Topic 2 - Electrolytic Cells - pg 639-650

- A cell that involves a non-spontaneous reaction is called an **electrolytic cell**

- Consists of a combination of **two electrodes**, an **electrolyte**, and an external **power source**

- They use a process called **<u>electrolysis</u>**

  - the process of supplying electrical energy to force a nonspontaneous redox reaction to occur

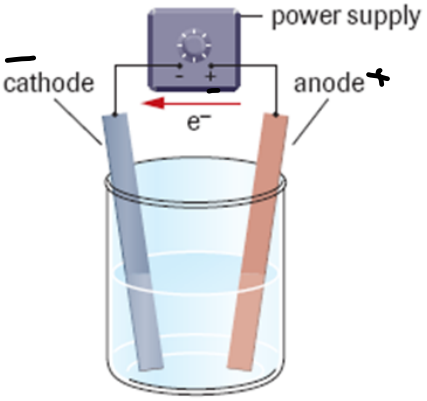
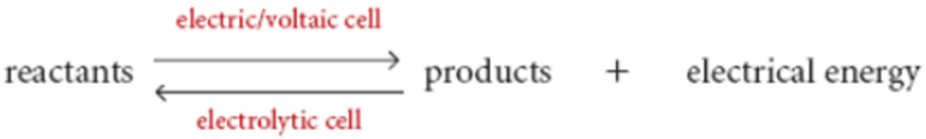


Table 1 Comparing Electrochemical Cells: Voltaic and Electrolytic

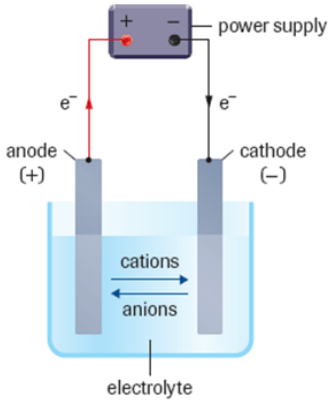
	Voltaic cell	Electrolytic cell
spontaneity	spontaneous reaction	nonspontaneous reaction
standard cell potential, $E°_{cell}$	positive	negative
cathode	• strongest oxidizing agent present undergoes a *reduction* • positive electrode	• strongest oxidizing agent present undergoes a *reduction* • negative electrode
anode	• strongest reducing agent present undergoes an *oxidation* • negative electrode	• strongest reducing agent present undergoes an *oxidation* • positive electrode
direction of electron movement	anode → cathode	anode → cathode
direction of ion movement	anions → anode cations → cathode	anions → anode cations → cathode



- In an electrolytic cell, there is no porous boundary, and only one electrolyte solution

- Therefore the shorthand notation is different

anode | electrolyte | cathode



INVESTIGATION 14.4 *Introduction*

A Potassium Iodide Electrolytic Cell

Electrolytic cells were discovered before the science was understood. However, as with all successful technological inventions, the important criteria was that it worked, not why it worked. Eventually, chemists understood the science and were able to explain why electrolytic cells work.

In the Evaluation, suggest changes to the Design, Materials, and Procedure that would improve the Evidence.

Purpose

The purpose of this investigation is to use diagnostic tests to determine the reaction products of an electrolytic cell.

Report Checklist

○ Purpose	○ Design	● Analysis
○ Problem	○ Materials	● Evaluation (1, 3)
○ Hypothesis	○ Procedure	
○ Prediction	● Evidence	

Problem

What are the products of the reaction during the operation of an aqueous potassium iodide electrolytic cell?

Design

Inert electrodes are placed in a 0.50 mol/L solution of potassium iodide, and a battery or power supply provides a direct current of electricity to the cell. The litmus and halogen diagnostic tests are conducted to test the solution near each electrode before and after the reaction.

SUMMARY Procedure for Analyzing Electrolytic Cells

1. Use the redox table to identify the strongest oxidizing and reducing agents present.
   Do not forget to consider water for aqueous electrolytes

2. Write equations for the reduction (cathode) and oxidation (anode) half-reactions.
   **Don't forget to include reduction potentials

3. Balance the electrons and write the net cell reaction including the cell potential.

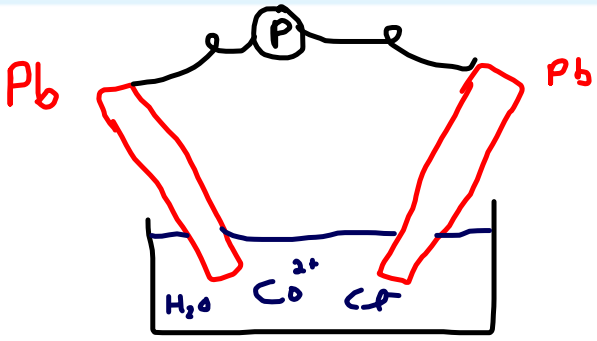
4. If required, state the minimum electric potential (voltage) to force the reaction to occur.
   The minimum voltage is the absolute value of $E°_{cell}$

5. Draw a cell diagram if required

An electrolytic cell containing cobalt(II) chloride solution and lead electrodes is assembled. The notation for the cell is as follows:

$$Pb(s) \mid Co^{2+}(aq), Cl^{-}(aq) \mid Pb(s)$$

(a) Predict the reactions at the cathode and anode, and in the overall cell.
(b) Draw and label a cell diagram for this electrolytic cell, including the power supply.
(c) What minimum voltage must be applied to make this cell work?



The Chloride Anomaly - pg 645, 648

Practice Sheet 10

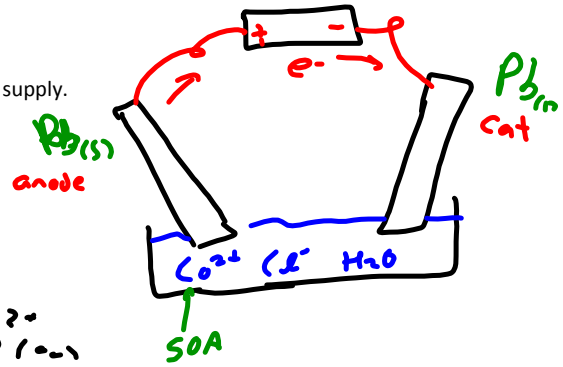
1. Describe the type of agent reacting and the process occurring at the cathode and anode of an electrolytic cell.

2. Describe the differences between the cathode and anode of an electrolytic cell and a voltaic cell.

3. Describe the direction of movement of electrons and ions within an electrolytic cell.

4. An electrolytic cell containing cobalt(II) chloride solution and lead electrodes is assembled. The notation for the cell is as follows:
   $Pb(s) \mid Co^{2+}(aq), Cl^{-}(aq) \mid Pb(s)$

(a) Predict the reactions at the cathode and anode, and in the overall cell.
(b) Draw and label a cell diagram for this electrolytic cell, including the power supply.



cat: $Co^{2+} + 2e^- \rightarrow Co_{(s)}$

anode: $Pb_{(s)} \rightarrow Pb^{2+} + 2e^-$

$Pb_{(s)} + Co^{2+}_{(aq)} \rightarrow Co_{(s)} + Pb^{2+}_{(aq)}$

(c) What minimum voltage must be applied to make this cell work?

$E^\circ_{cell} = E_{r\ SOA\ cat} - E_{r\ SOA\ an} = -0.28V - -0.13V = \boxed{-0.15V}$

1. Predict the cathode, anode, and net cell reactions for each of the following electrolytic cells. Calculate the minimum potential difference that must be applied to force the cell reaction to occur.

(a) C(s) | Ni^{2+}(aq), I^-(aq) | C(s)

(b) Pt(s) | Na^+(aq), OH^-(aq) | Pt(s)

2. List the main similarities between a voltaic cell and an electrolytic cell.

3. What is the key difference between voltaic and electrolytic cells?

4. Why is the procedure for analyzing voltaic and electrolytic cells so similar?

5. Explain why a power supply is necessary for an electrolytic cell.

6. Draw a diagram of an electrolytic cell containing a zinc iodide solution and inert carbon electrodes.
Label the power supply and electrodes, including signs, the electrolyte, and the directions of electron and ion movements. Write half-reaction and net equations. Calculate the cell potential.