

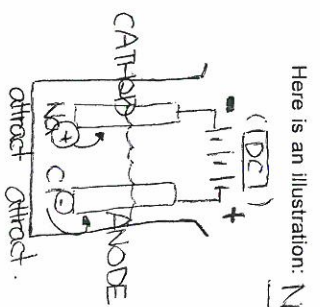
Name: Ivy Lin  
 Bk: C Date: Sep 30 01

\* Compare electrochemical  
 electrolysis | spontaneous  
 • non-spontaneous | spontaneous  
 • require external E | no  
 • no battery / salt bridge | has  
 • has battery | no

Chemistry 12  
 Electrochemistry Lesson #13

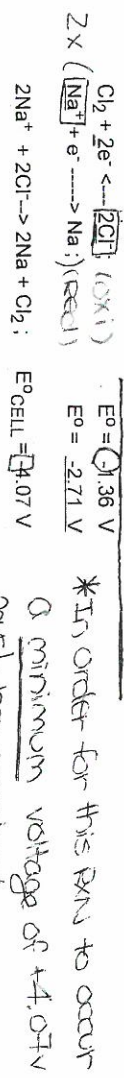
Electrolysis is the process of supplying electrical energy to either a molten ionic compound or to a solution (melted + TEMP) containing ions in order to produce a chem rxn.  
 Electrolytic Cell or Electrolysis Cell  
 is simply the apparatus in which electrolysis can occur... impd. there is no need for a proton carrier or salt bridge.  
 (Battery Presented)  
 IMPT!!! Electrolysis supplies energy to NON-SPONTANEOUS electrochemical reactions ( $E^{\circ}_{CELL} < 0$ ), allowing them to occur.

A SIMPLE ELECTROLYTIC CELL: OF A MOLTEN BINARY SALT



Here is an illustration: NaCl(s) heated  
 (ions free flow, no H<sub>2</sub>O present)  
 L Anion attract to anode  
 Cation = CATHODE  
 \* Note: the electrodes are made of INERT materials such as Pt or C!  
 \* Note: - charge battery end → CATHODE  
 end → ANODE.

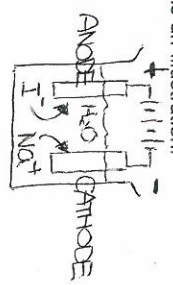
ONLY REACTANTS PRESENT ARE: Na<sup>+</sup> and Cl<sup>-</sup>  
 \*\*\*\*\*THIS IS A NON-SPONTANEOUS REACTION\*\*\*\*\*



\* In order for this rxn to occur a minimum voltage of +4.07V must be supplied.

FOR HOMEWORK: Do Exercise 64.

ELECTROLYSIS OF AQUEOUS NaI  
 \*\*\*\*\*THE ADDITION OF WATER\*\*\*\*\*



Here is an illustration:

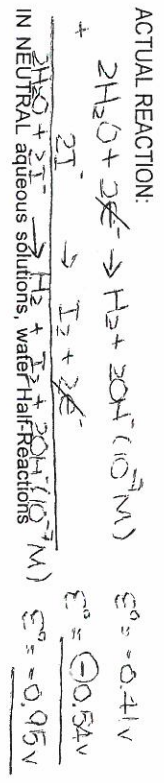
\* The species that can react are: Na<sup>+</sup>, I<sup>-</sup>, H<sub>2</sub>O (acidic or neutral no H<sup>+</sup>)

IN THE ELECTROLYSIS OF AN AQUEOUS SOLUTION YOU MUST ALWAYS CONSIDER THE REDUCTION/OXIDATION OF WATER!!!!

Possible Reductions: (higher on left side - more tendency to red)  
 $2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^- (10^{-7} M)$   $E^{\circ} = -0.41 V$   
 $Na^+ + e^- \rightleftharpoons Na(s)$   $E^{\circ} = -2.71 V$

Possible Oxidations  
 $1/2 O_2 + 2H^+ (10^{-7} M) + 2e^- \rightleftharpoons H_2O$   $E^{\circ} = 0.82$   
 $I_2 + 2e^- \rightleftharpoons 2I^-$   $E^{\circ} = 0.54 V$  (lower, right side)

WHEN SELECTING THE PREFERRED REACTION:  
 Select the rxn requiring the LEAST voltage input!



see H<sub>2</sub>O highlight in data booklet  $E^{\circ} = +0.82 V$   
 $E^{\circ} = -0.41 V$   
 IN ACIDIC aqueous solutions, water Half-reactions  
 see H<sup>+</sup> highlight in data booklet  $E^{\circ} = +1.23 V$   
 $E^{\circ} = 0.00 V$

\* you will NOT be asked to consider BASIC solutions in electrolysis cells.

**NOT** MOLTEN  $\therefore$  **aqueous**  $\rightarrow$  **consider** WATER **ACIDIC**

**Example.** What products are formed at the anode and cathode and what is the overall reaction when a solution containing HBr (aq) is electrolyzed using inert electrodes? Determine the minimum voltage which must be applied before the reaction will occur.

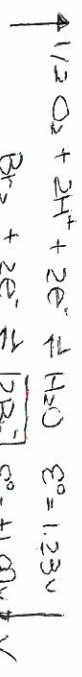
Step 1.  $H^+$ ,  $Br^-$ ,  $H_2O$  (acidic)

\* list all species present & determine acidic / neutral \*

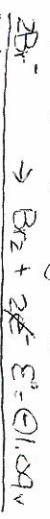
Step 2. Select RXN that undergo RED (left side) higher.



Step 3. = RXN = OXI. (right side) lower.



Step 4. ADD.



Step 5.  $2H^+ + 2Br^- \rightarrow H_2(g) + Br_2(l) \quad E^\circ = -1.09V$

At the Anode (OXI)  $\rightarrow Br_2(l)$  is formed  
= CATHODE (RED)  $\rightarrow H_2(g)$

for the RXN to occur a minimum of  $\oplus 1.09V$  must be supplied.  
ANSWER QUESTIONS.  
For SEATWORK/HOMEWORK: Do Exercises: 64-70  
PLO's W1 - W4, W8 + W5

**REMEMBERS:**

UNIT TEST IS ON Monday, Oct 5  
PLO'S ARE DUE FRI, Oct 2

★ Criteria ★

★ Compare & contrast electrochemical cell & electrolysis cell.

★ define electrolysis & electrolytic cell.

★ design & label electrolytic cell (MOLTEN binary salt / aqueous solution)

$\rightarrow$  must contain: 2 electrodes

$\rightarrow$  external voltage  $\therefore E^\circ = -$  non-spontaneous

$\rightarrow$   $\textcircled{1}$  electrolytic solution.

$\rightarrow$  electrodes often inert.

★ determine the min. voltage require.

Step 1. list all species, determine acidic / neutral.

2. RXNs most likely to go RED & OXI.

3. Add (OXI - charge sign)

4. answer as (products on Anode / CATHODE, which one is Anode / CATHODE, minimum voltage)