

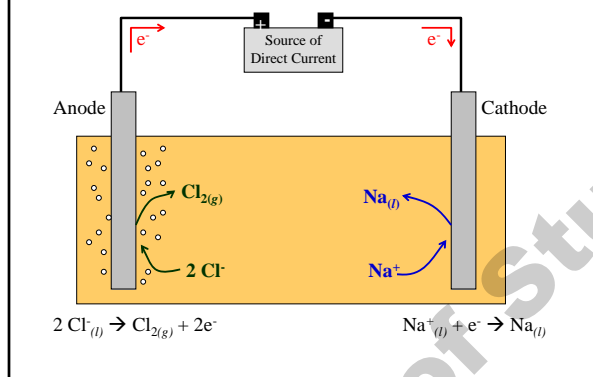
## Electrochemistry 13.4

### Electrolytic Cells

### Electrolytic Cell

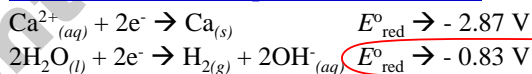
- Non-spontaneous redox reactions ( $E_{\text{cell}} < 0$ ).
- Requires a source of direct electrical current hooked up to two electrodes.
- The electrodes are immersed in a molten salt or an electrolytic solution.
- The anode takes electrons from one species in the solution (**oxidation**).
- The cathode gives electrons to another species in the solution (**reduction**).

### Electrolysis of Molten NaCl



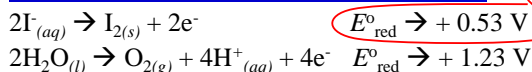
### Electrolysis of Aqueous $\text{CaI}_2$

#### Reduction could be a positive ion or water



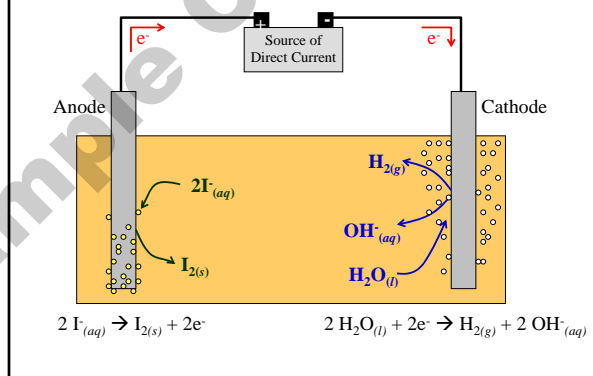
- The species with the **most positive**, least negative, **reduction potential** is reduced.

#### Oxidation could be a negative ion or water



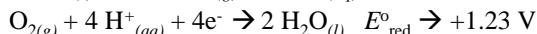
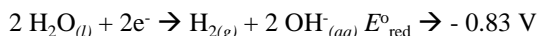
- The species with the **most positive**, least negative, **oxidation potential** is oxidized.

### Electrolysis of Aqueous $\text{CaI}_2$



### Ex) Electrolysis

Ex) A direct current is applied to an aqueous copper (II) bromide solution.

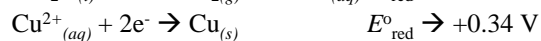
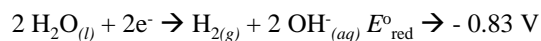


- What is the reduction half-reaction?
- What is the oxidation half-reaction?
- What is the overall reaction?
- Calculate  $E^{\circ}_{\text{cell}}$  for the reaction.

## Ex) Electrolysis (cont.)

## a) Reduction half-reaction

i) Look at the  $E^\circ_{\text{red}}$  values for the reduction of water and all positive ions.

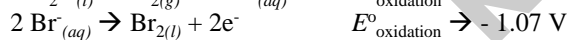
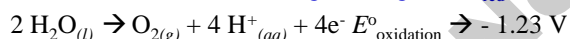


ii) Choose the most positive/least negative  $E^\circ_{\text{red}}$ .

## Ex) Electrolysis (cont.)

## b) Oxidation half-reaction

i) Change the reduction reactions where  $\text{O}_{2(g)}$  forms  $\text{H}_2\text{O}_{(l)}$  and other species form negative ions into oxidation reactions. Change the sign of  $E^\circ_{\text{red}}$ .



ii) Choose the most positive/least negative  $E^\circ_{\text{oxidation}}$ .

## Ex) Electrolysis (cont.)

## c) The Overall Reaction

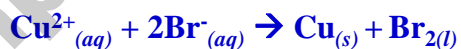
## Ex) Electrolysis (cont.)

d) Calculate  $E^\circ_{\text{cell}}$ 

## Metal Refinement and Electrolysis

## Metals can be refined through electrolysis

- In the previous example, solid copper was plated out on the cathode.



- Calculations can be made to determine how long it will take to produce certain quantities of pure metals.

## Ex) Quantitative Electrolysis

Ex) How long would it take to plate out 3.56 g of  $\text{Ag}_{(s)}$  from a solution containing  $\text{Ag}^+$  ions when a current of 2.5 amps is applied?