Chemistry 12

Electrochemistry IV

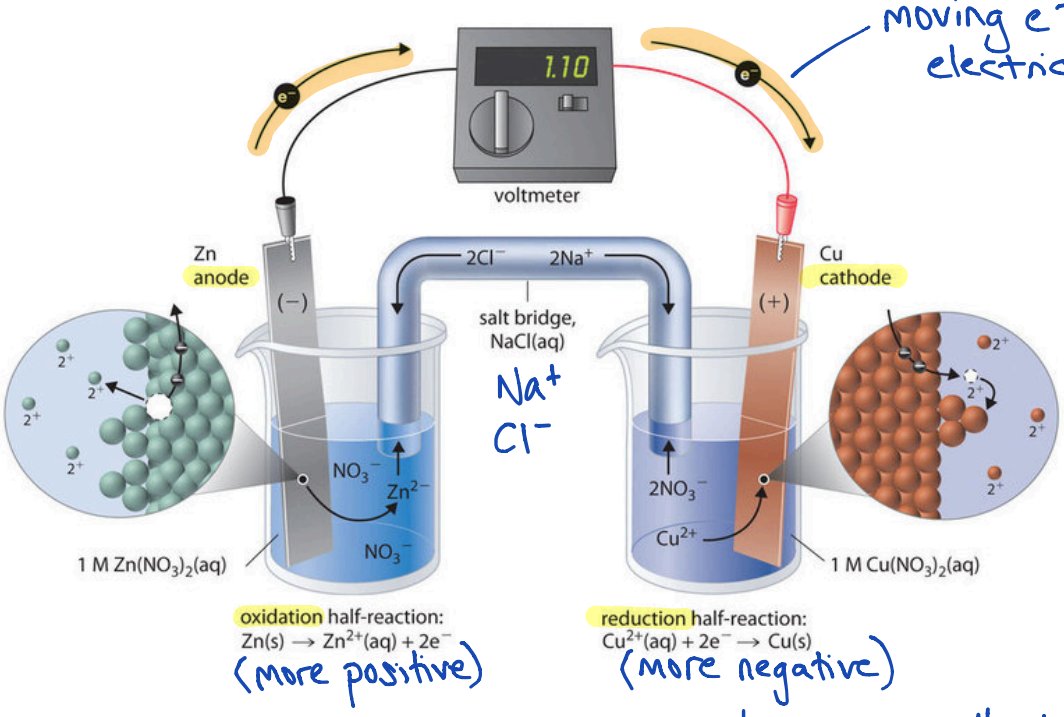
Name: Notes
Date:
Block:

1. **The Electrochemical Cell**
2. **Standard Cell Potentials**

The Electrochemical Cell

- Portable source of electricity in which electricity is produced by a spontaneous redox reaction within the cell
- Also referred to as a voltaic cell or galvanic cell.
- Oxidation half-reaction and the reduction half-reaction are separated.
- Electrons can only travel from the reducing agent to the oxidizing agent when the two are connected through an external circuit.

Basic Components:



Electrons flow from the anode to the cathode

- **Cathode:**
  - The site of reduction.
  - The metal gains mass.
  - If the metal is being coated by a different ion, then we call it plating.
- **Anode:**
  - The site of oxidation.
  - The metal loses mass.
- **Salt Bridge:**
  - Consists of spectator ions.
  - Cations flow towards the cathode and anions flow towards the anode.

Standard Cell Potentials

When electrons flow throughout a system, a voltage, or electrical potential is produced. This can be measured by comparing the difference in electrical potential between two half-cells.

- Write the half-reaction the way it occurs and then add the half-cell potentials together.
- A half-cell potential **doesn't change** when its half reaction is multiplied by an integer.

Example:

Determine the voltage of a standard cell consisting of a $Ni \mid Ni^{2+}$ half cell and an $I_2 \mid I^-$ half cell.

ox RA OA — red OA RA — * OA higher than RA for spont. rxn

- Write the oxidation half-cell reaction and its oxidation potential.

$Ni \rightarrow Ni^{2+} + 2e^-$ $\quad E^\circ = +0.26\,V$ (flipped)

- Write the reduction half reaction and its reduction potential.

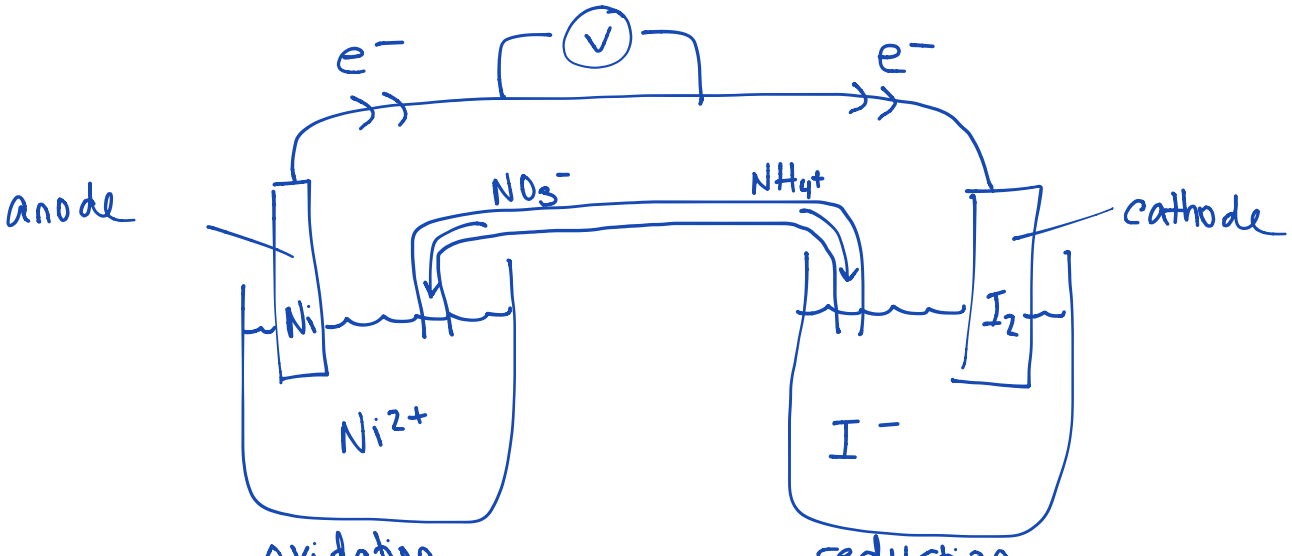
$I_2 + 2e^- \rightarrow 2I^-$ $\quad E^\circ = +0.54\,V$

- Add the reduction potential to the oxidation potential.

$Ni + I_2 \rightarrow Ni^{2+} + 2I^-$ $\quad E^\circ_{total} = +0.80\,V$

If the standard cell potential (E°) is positive for a redox reaction, the reaction is expected to be spontaneous.

Draw an electrochemical cell for the above reaction:

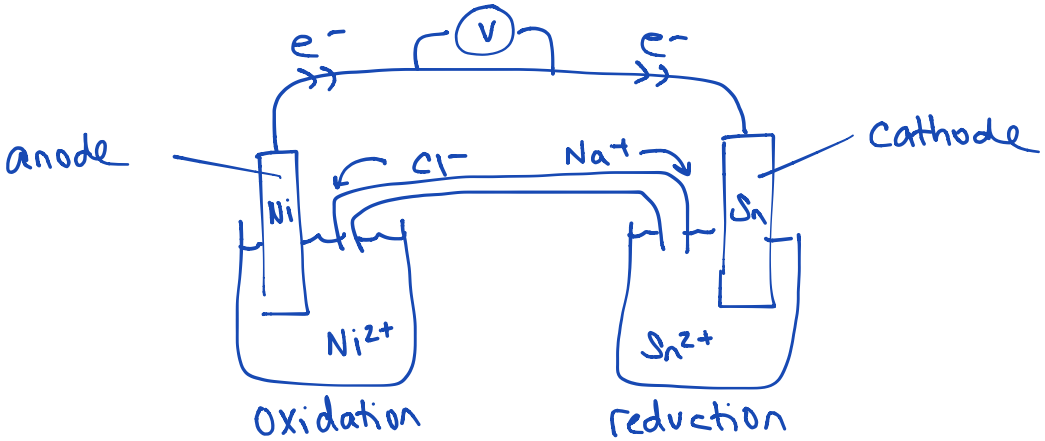


Practice:

Determine the standard cell potential of each of the following combinations of half-cells. Show the oxidation and reduction half-reactions as well as the overall redox reaction occurring in each cell. Draw the electrochemical cell and the movement of electrons.

1. Ni | Ni^{2+} and an Sn | Sn^{2+}

RA OA RA OA
OX red

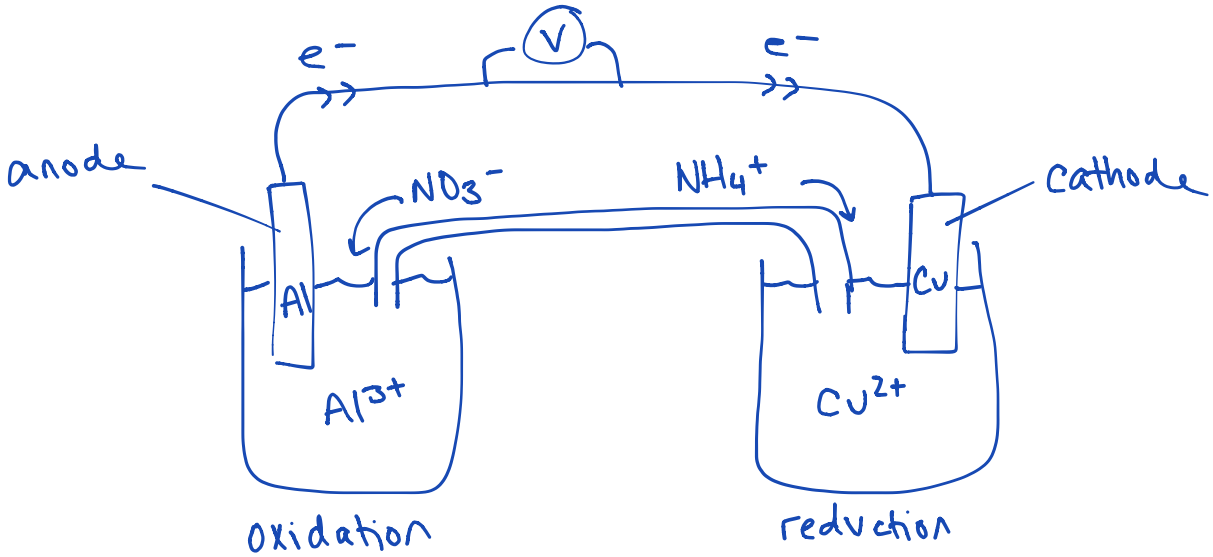


$Ni \rightarrow Ni^{2+} + 2e^-$ $\quad Sn^{2+} + 2e^- \rightarrow Sn$

$E^\circ_{total} = -0.14V + 0.26V = \boxed{+0.12V}$

2. Cu | Cu^{2+} and an Al | Al^{3+}

RA OA RA OA
red ox

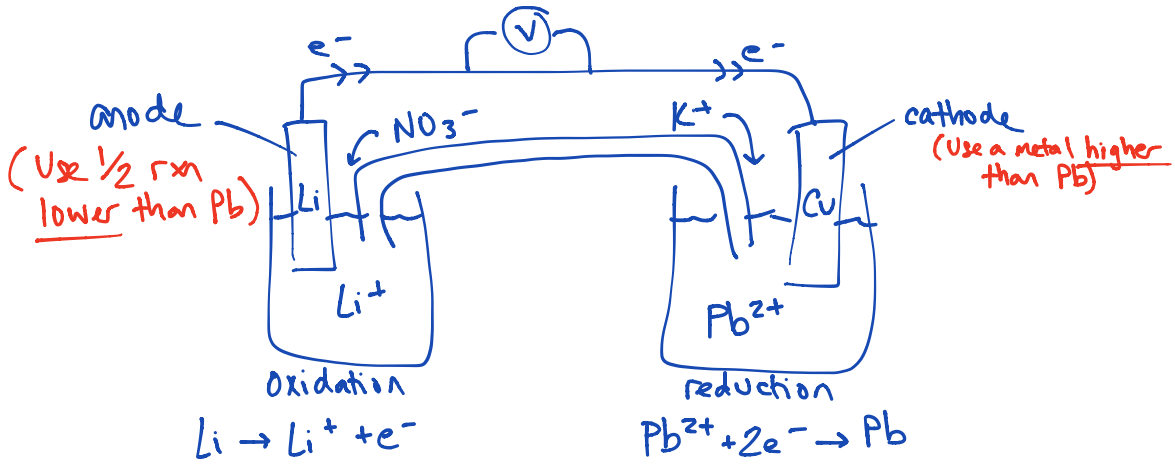


$Al \rightarrow Al^{3+} + 3e^-$ $\quad Cu^{2+} + 2e^- \rightarrow Cu$

$E^\circ_{total} = +0.34 + 1.66V = \boxed{+2.00V}$

3. Design an electrochemical cell for lead-plating.

→ We must have $Pb^{2+} + 2e^- \rightarrow Pb_{(s)}$ on reduction side (cathode)



$E^\circ_{total} = -0.13V + 3.04V = \boxed{+2.91V}$

Calculate the SRP for the following reactions:

a) $Ag + Ni^{2+} \rightarrow Ag^{+} + Ni$

RA OA

$E^\circ_{total} = (-0.80V) + (-0.26V) = -1.06V$

b) $Ag^{+} + Ni \rightarrow Ag + Ni^{2+}$

OA RA

$E^\circ_{total} = (+0.80V) + (+0.26V) = +1.06V$

c) $Sn + Al^{3+} \rightarrow Al + Sn^{2+}$

RA OA

$E^\circ_{total} = (+0.14V) + (-1.66V) = -1.52V$

d) $F_2 + Cu \rightarrow 2F^{-} + Cu^{2+}$

OA RA

$E^\circ_{total} = (+2.87V) + (-0.34V) = +2.53V$

e) $F_2 + Mg \rightarrow Mg^{2+} + F^{-}$

OA RA

$E^\circ_{total} = (+2.87V) + (+2.37V) = +5.24V$

Hebden Workbook Pg. 224 #36-38, 40, 41, 46, Pg. 228 #47