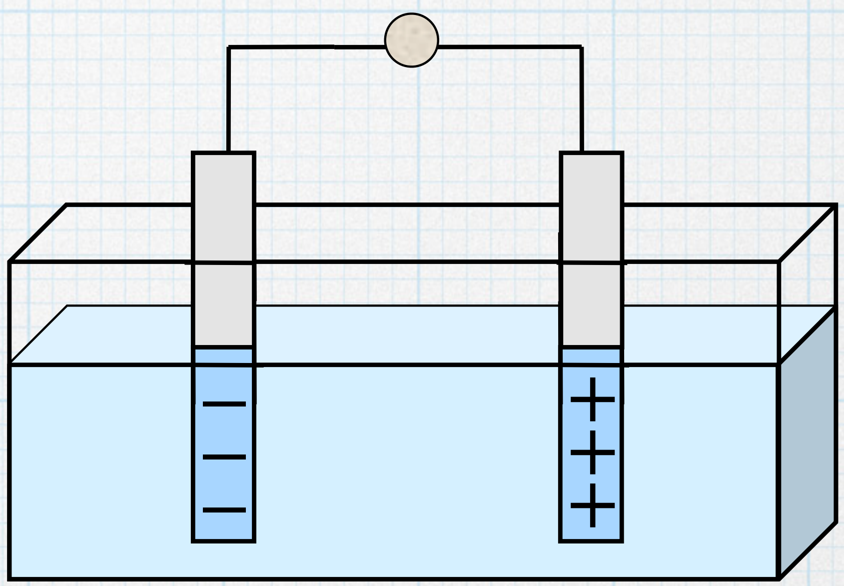
Galvanic Cells

Overview

* "Cells" are containers of liquid with electrodes:

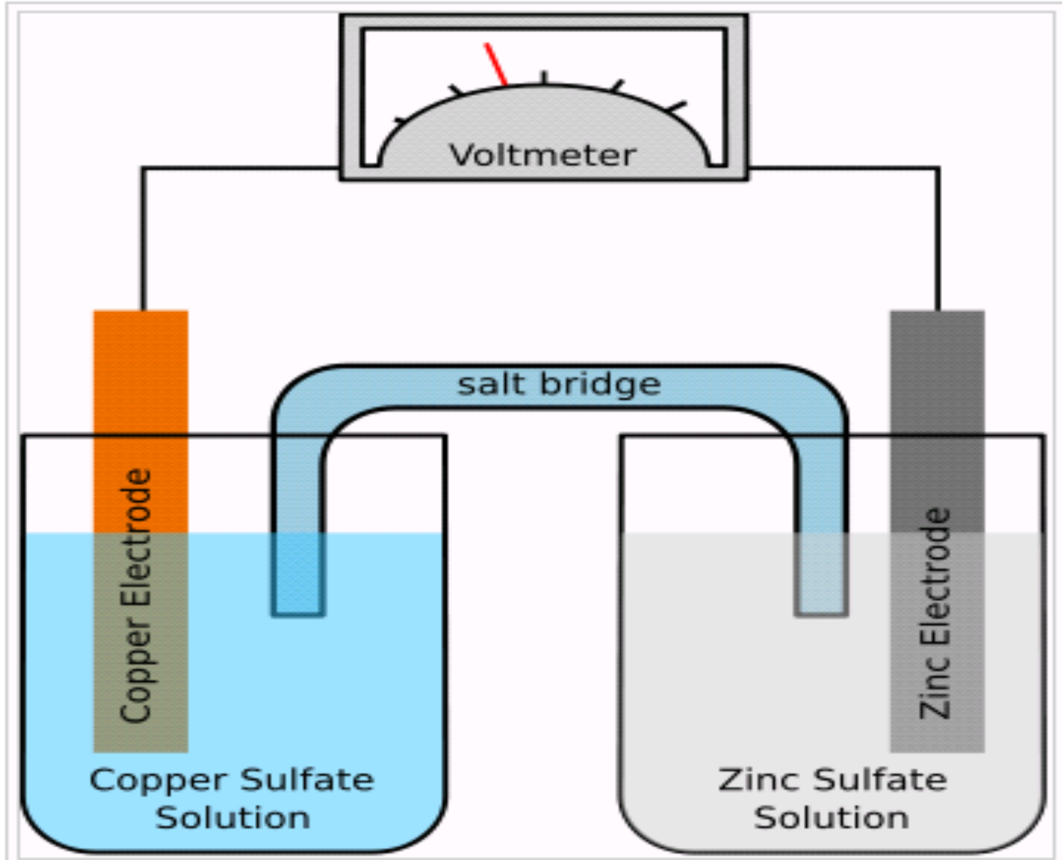


* In electrolytic cells, electricity is used to force chemicals to undergo a redox reaction

* In galvanic cells, electricity is produced spontaneously from a redox reaction

Galvanic Cell

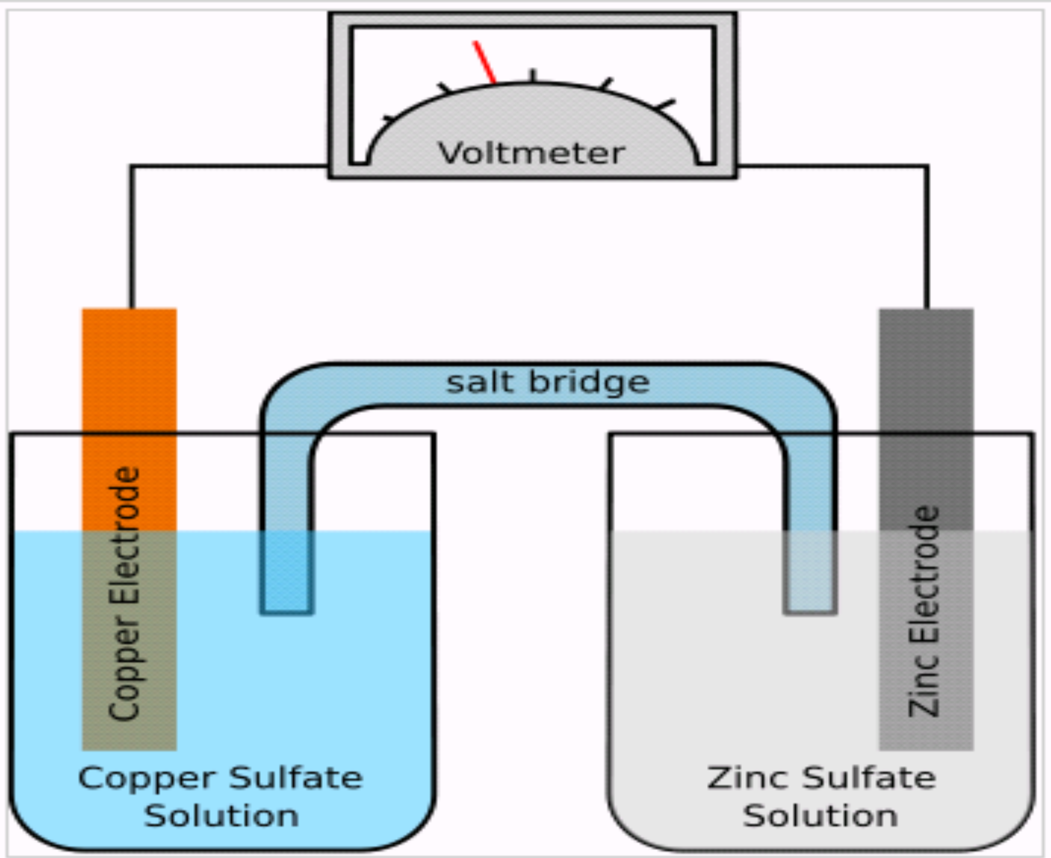
* An arrangement of two half-cells that can produce electricity spontaneously.



Schematic of Zn-Cu galvanic cell

Galvanic Cell

* Contain:
* Salt Bridge: connection between half cells, allows current flow but prevents contact



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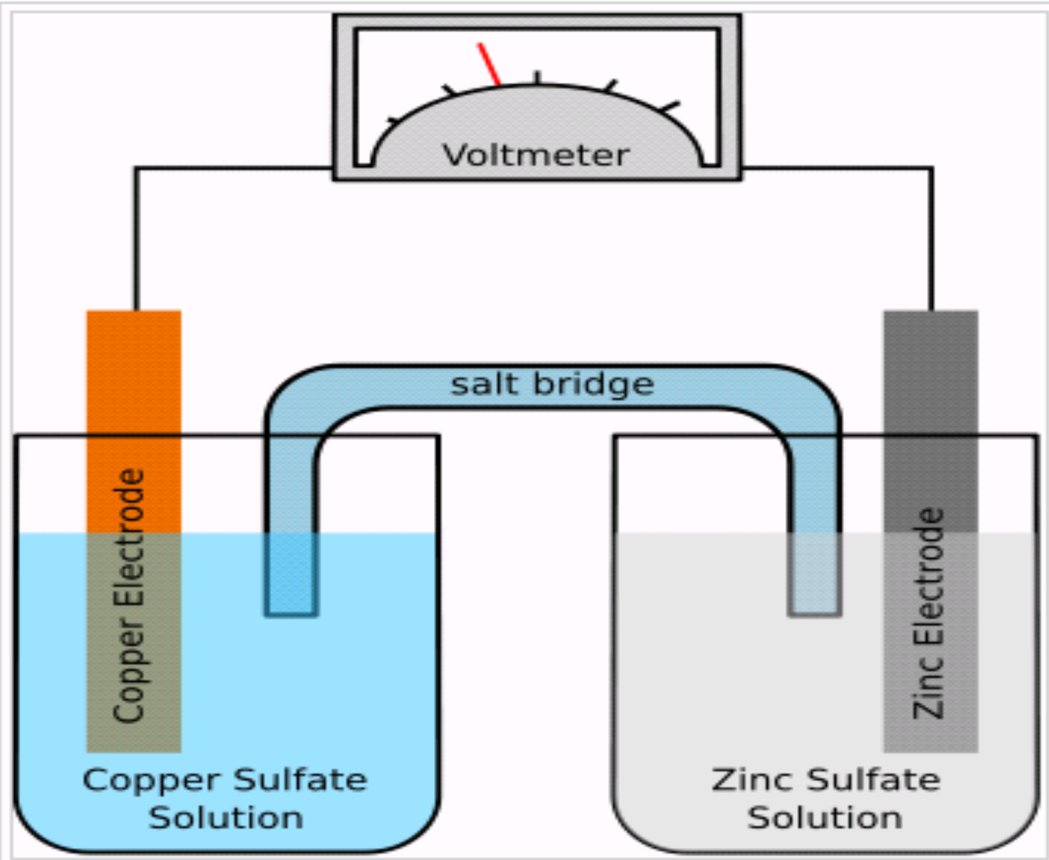


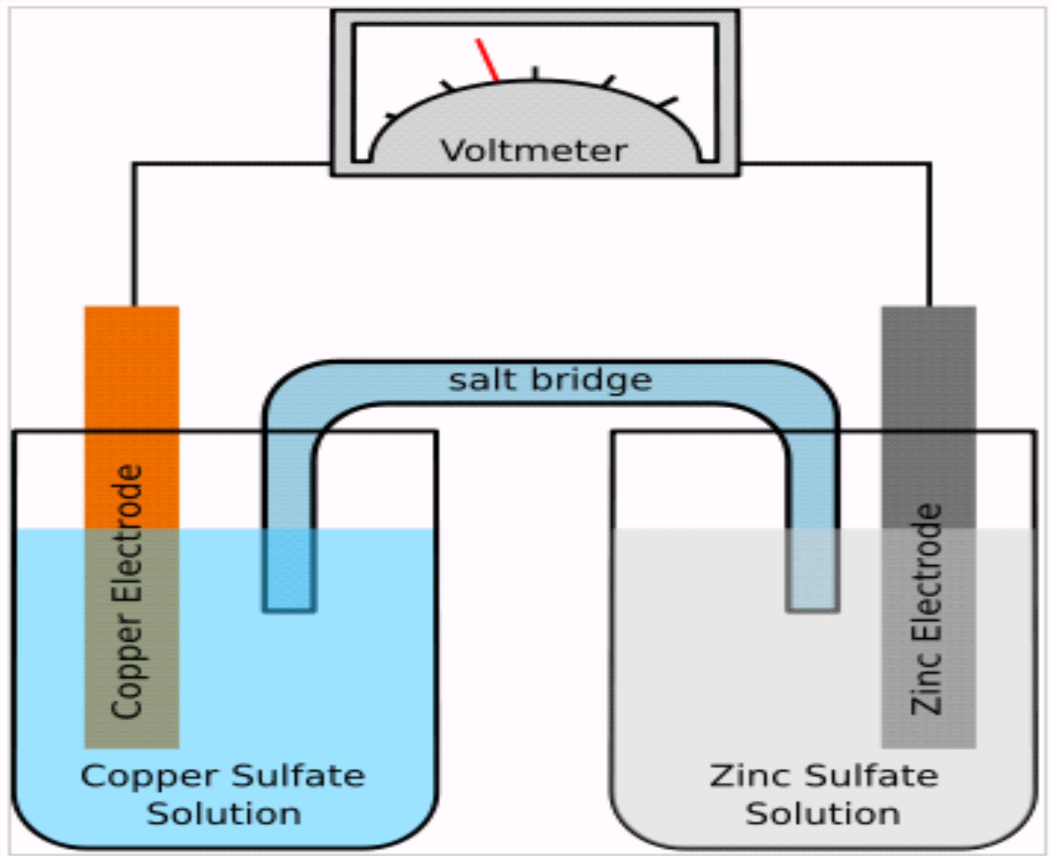
Schematic of Zn-Cu galvanic cell

Salt Bridge

* Salt bridges which maintains the neutrality of the cell.

Galvanic Cell

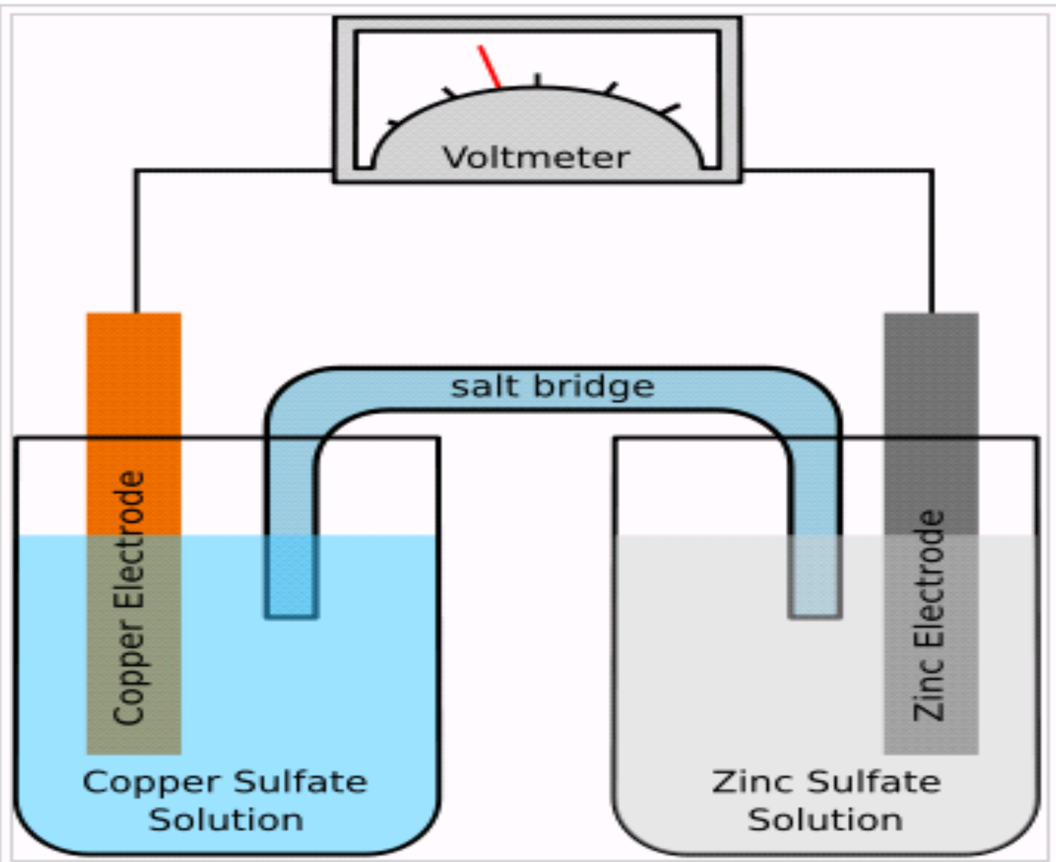
* Contain:
* **Electrodes:** conductor that carries electrical current in and out of the cell



Schematic of Zn-Cu galvanic cell

Galvanic Cell

* Contain:
* Electrolytes: substance when dissolved in water conducts electricity



Schematic of Zn-Cu galvanic cell

Background

* Let's look at the reaction:
  * $Ni(s) + CuCO_3 \longrightarrow NiCO_3 + Cu(s)$

Background

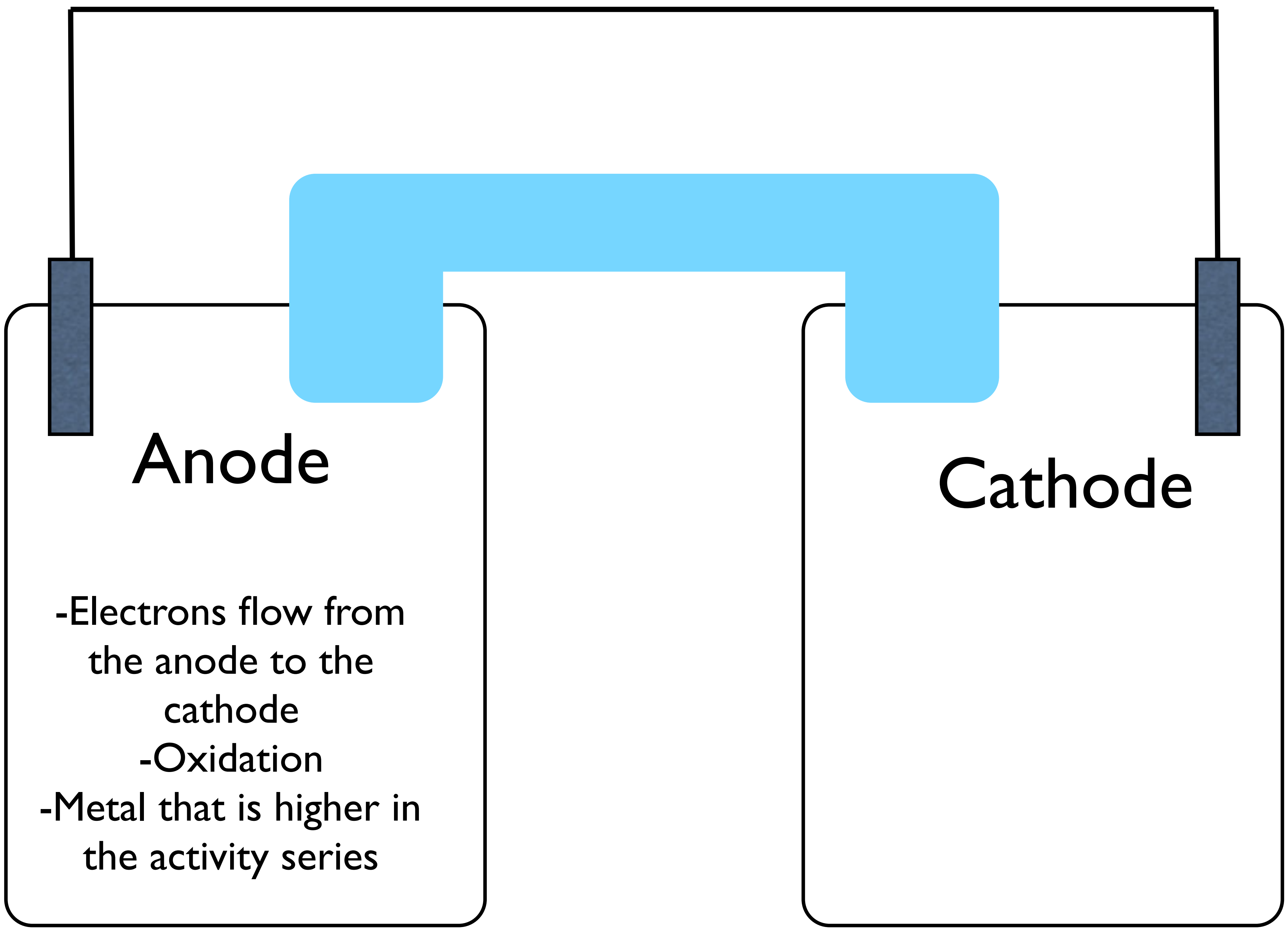
* Break it down into net ionic
  * $Ni_{(s)} + Cu^{2+} + CO_3^{2-} \rightarrow Ni^{2+} + CO_3^{2-} + Cu_{(s)}$
  * $Ni_{(s)} + Cu^{2+} \rightarrow Ni^{2+} + Cu_{(s)}$

Background

* Now let's break these into HALF REACTIONS
  * $Ni_{(s)} \rightarrow Ni^{2+} + 2e^-$ OXIDATION
  * $2e^- + Cu^{2+} \rightarrow Cu_{(s)}$ REDUCTION

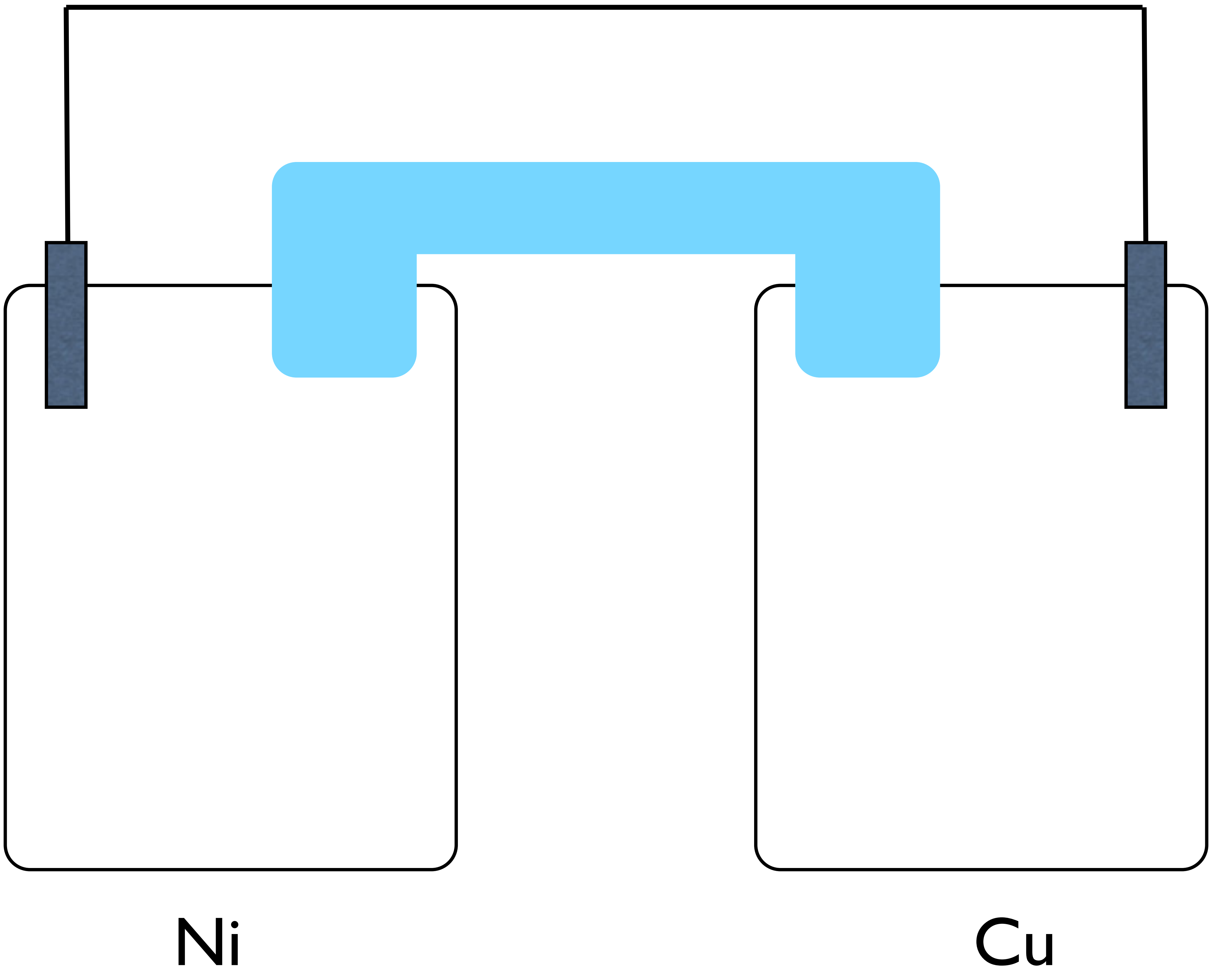
Anode/Cathode

* Anode: Negative electrode, where oxidation occurs
* Cathode: Positive electrode, where reduction occurs

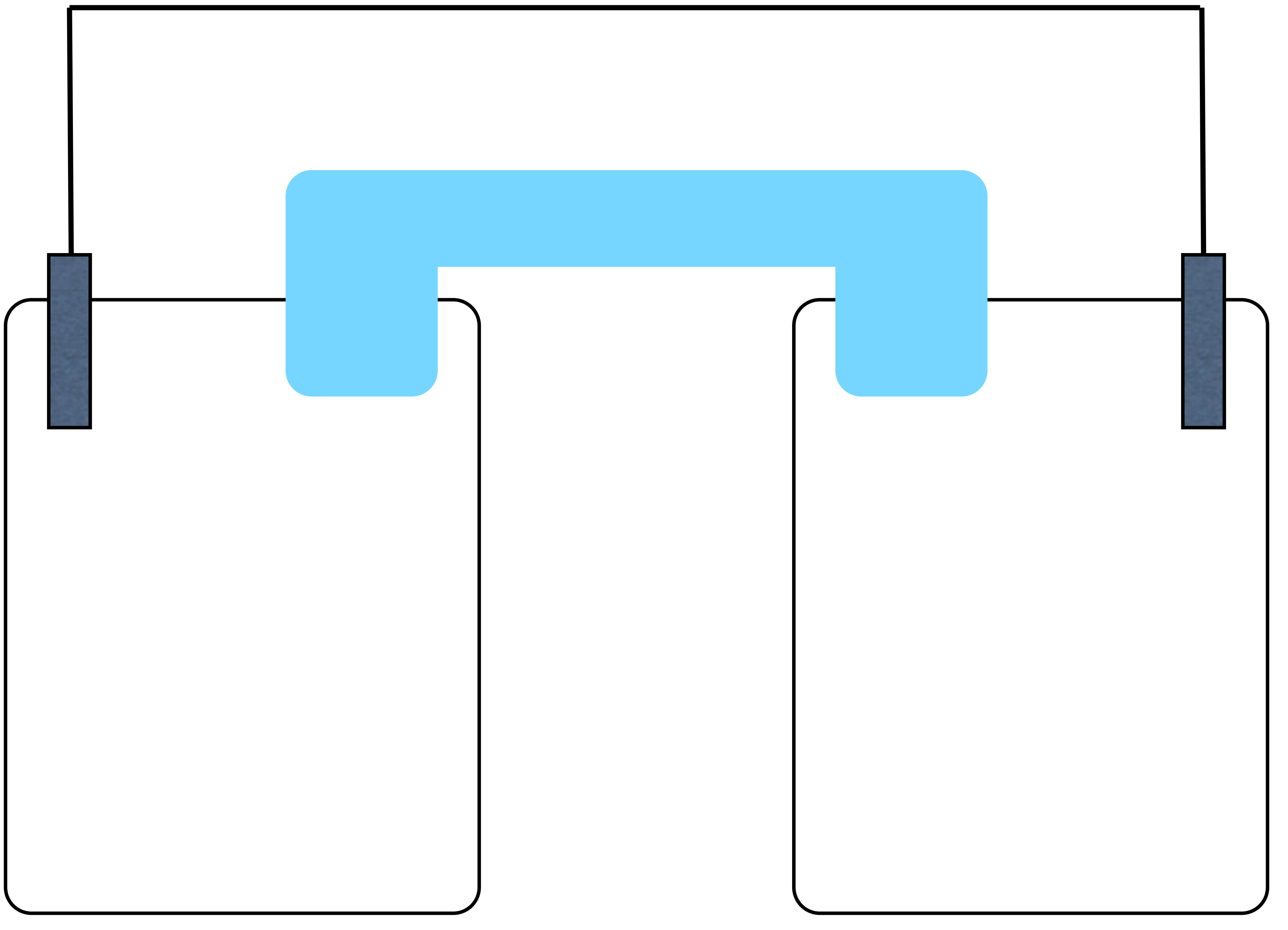

Anode
-Electrons flow from the anode to the cathode
-Oxidation
-Metal that is higher in the activity series
Cathode

Create a diagram of a Galvanic cell using copper and nickel

Create a diagram of a Galvanic cell using copper and nickel
-Nickel is higher than copper on the activity sequence, nickel goes at the anode.


Ni
Cu

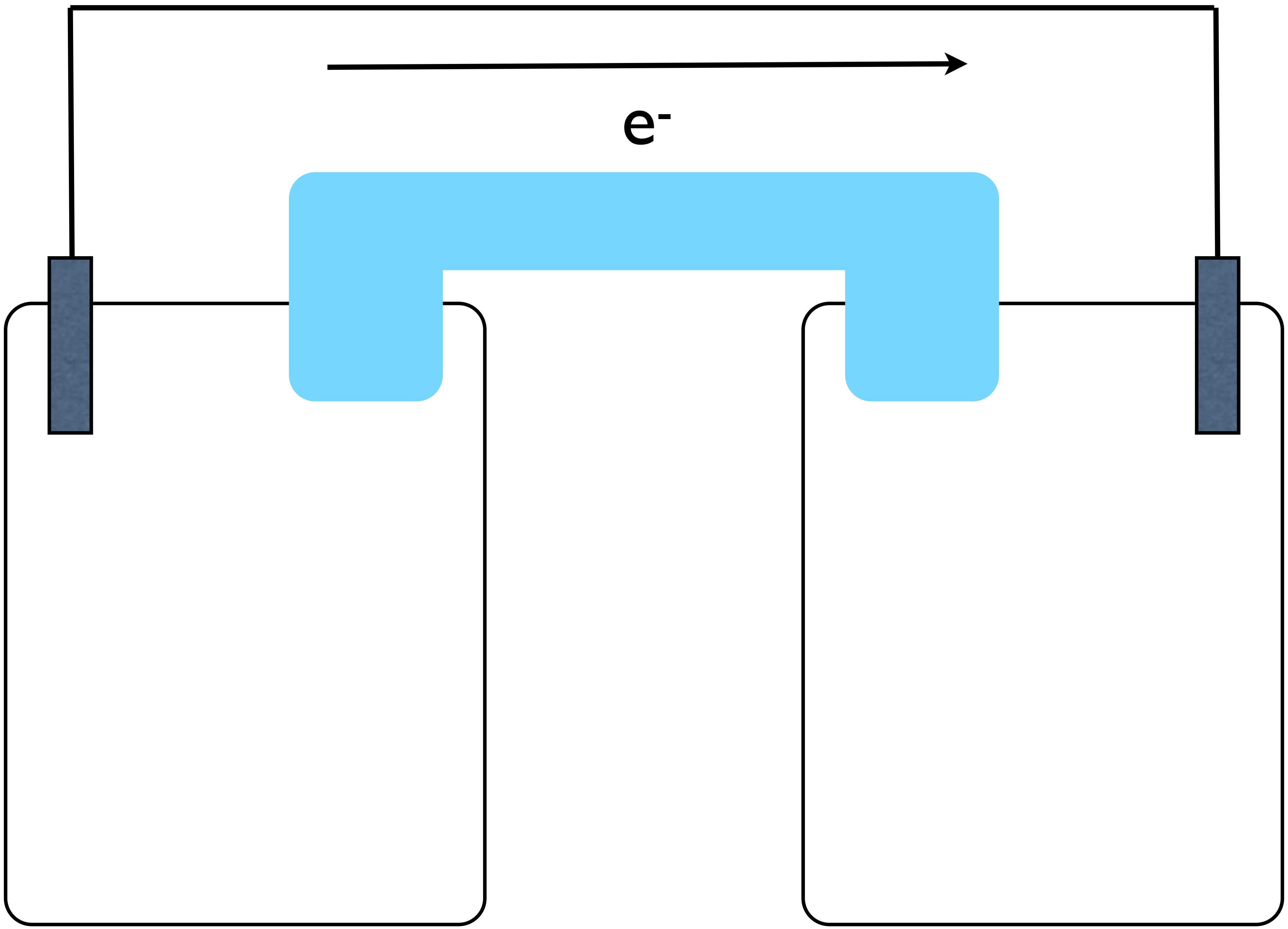
Write the half reactions



$Ni_{(s)} \longrightarrow Ni^{2+}{}_{(aq)} + 2e^-$

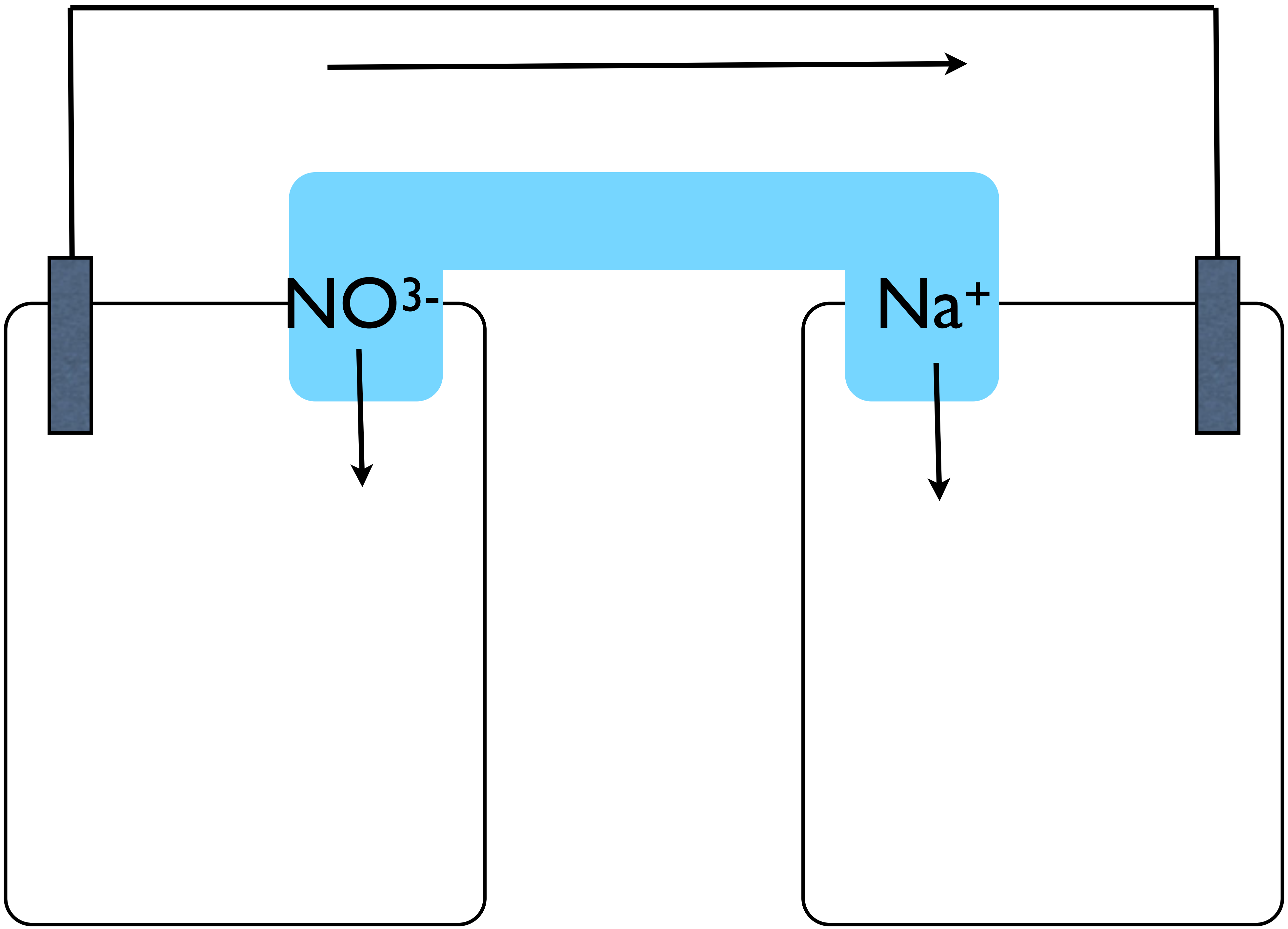
$Cu^{2+}{}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$

Now show the flow of electrons



$Ni_{(s)} \longrightarrow Ni^{2+}_{(aq)} + 2e^-$ $\quad$ $Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$

Now show the flow of ions



$Ni_{(s)} \longrightarrow Ni^{2+}_{(aq)} + 2e^{-}$

$Cu^{2+}_{(aq)} + 2e^{-} \longrightarrow Cu_{(s)}$

Cell Potentials

Cell Potentials

* **Electrical potential difference:** amount of energy that a unit charge would gain from moving from one point to another.

Cell Potentials

* Cell potential: the electrical potential difference between the two electrodes of the cell

Cell Potentials

* Cell potential: the electrical potential difference between the two electrodes of the cell
    * Depend on:
        * Nature of oxidizing/reducing agents
        * Concentration of salt solution
        * Temperature, pressure

Standard Cell Potential

* Standard cell potential: cell potential when the salt concentrations at 1M and standard temperature and pressure

Standard Cell Potential

- Standard cell potential can be calculated as follows:
  - $E_{cell} = E_{cathode} - E_{anode}$

Standard Cell Potential

* A positive standard cell potential will tell you a reaction will occur spontaneously (meaning stronger reducing agent is on the left)

Calculate the standard cell potential in a galvanic cell where the following reaction occurs:

$$2I^-_{(aq)} + Br_{2(l)} \longrightarrow I_{2(s)} + 2Br^-_{(aq)}$$

Draw a galvanic cell that represents the reaction using NaCl as the salt bridge.

First write half reactions:

$$2I^{-}_{(aq)} \longrightarrow I_{2(s)} + 2e^{-}$$

$$Br_{2(l)} + 2e^{-} \longrightarrow 2Br^{-}_{(aq)}$$

Identify oxidation and reduction:

Oxidation $2I^-_{(aq)} \longrightarrow I_{2(s)} + 2e^-$

Reduction $Br_{2(l)} + 2e^- \longrightarrow 2Br^-_{(aq)}$

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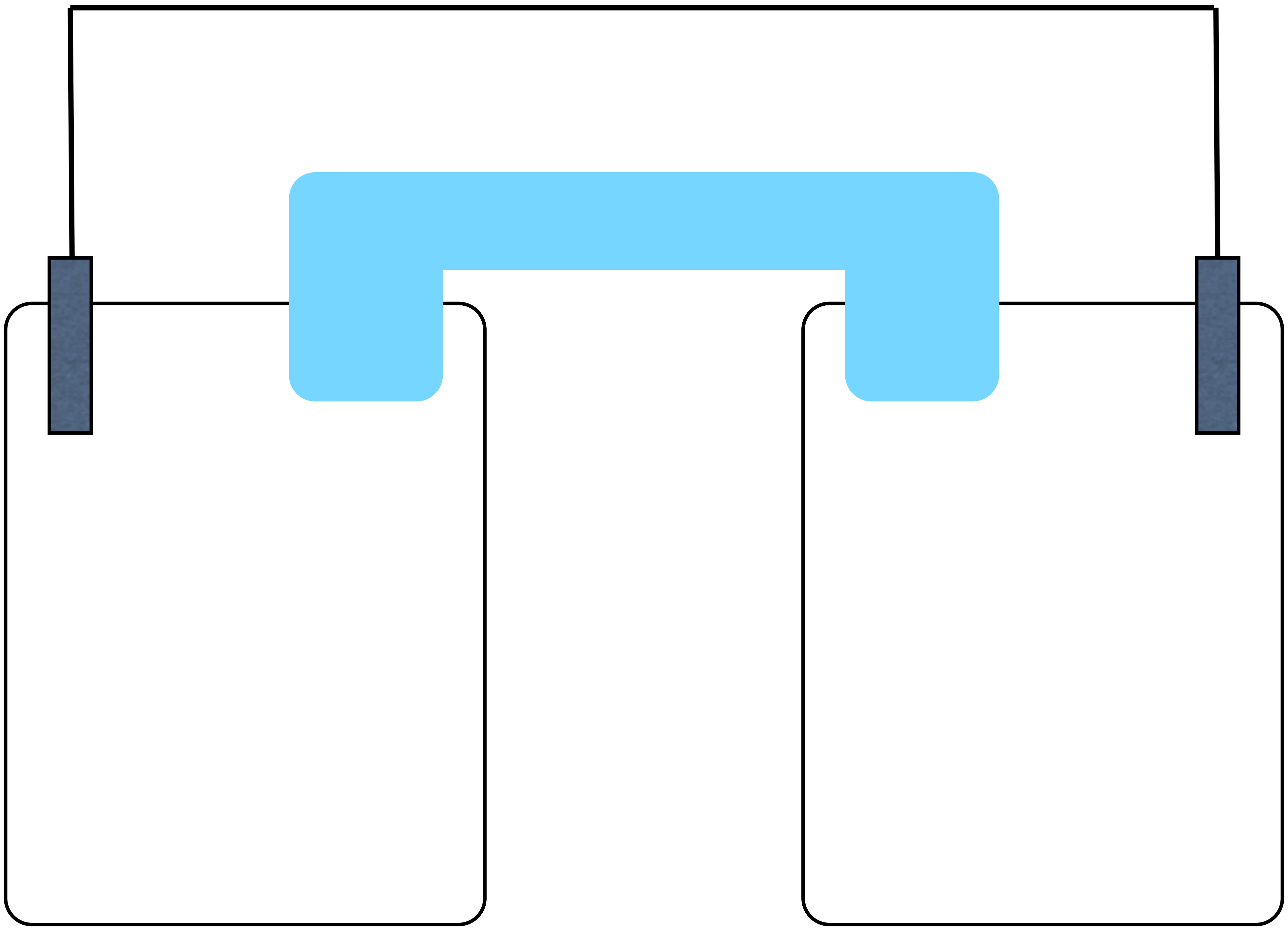
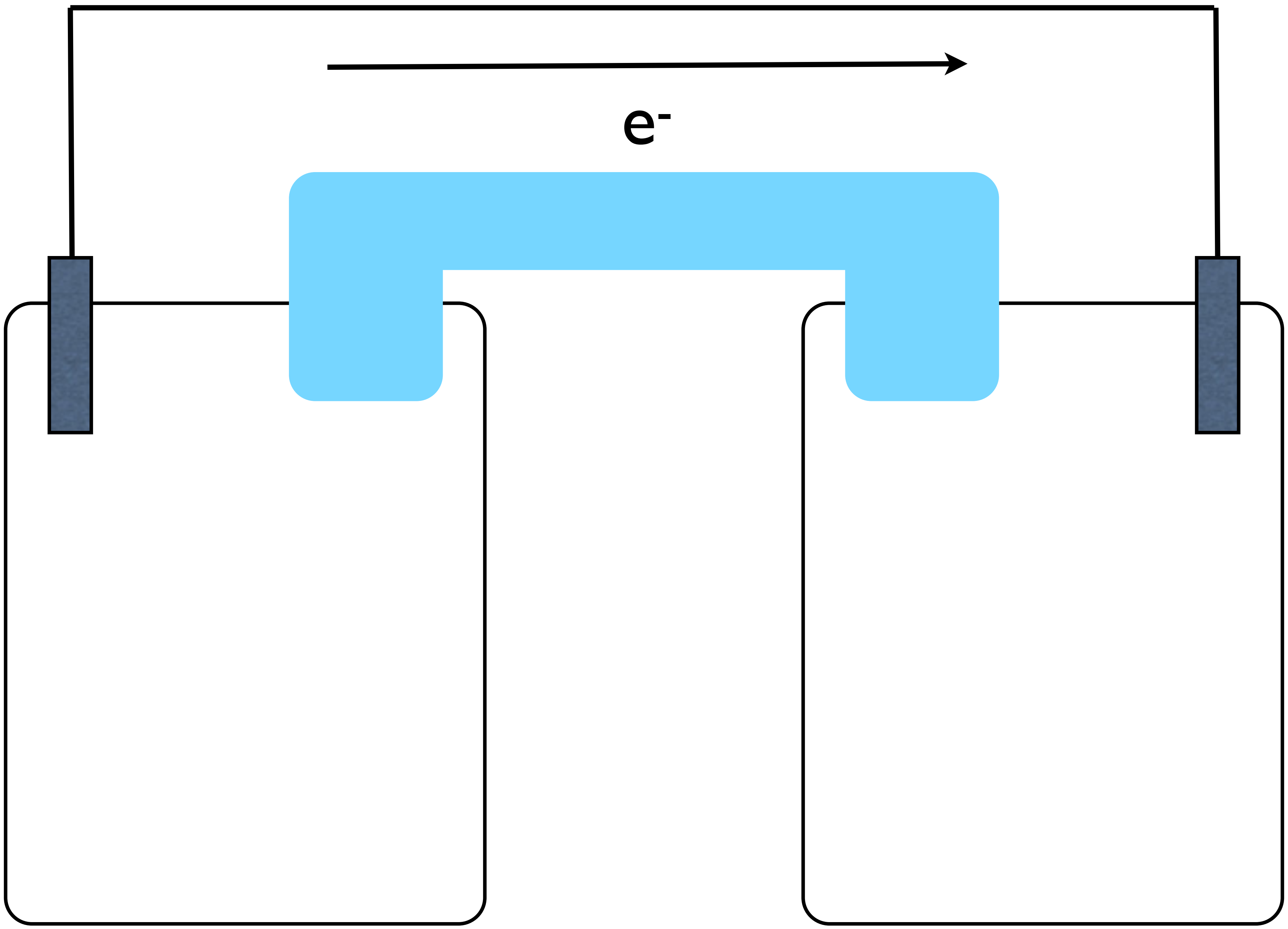
Now place these on your galvanic cell:



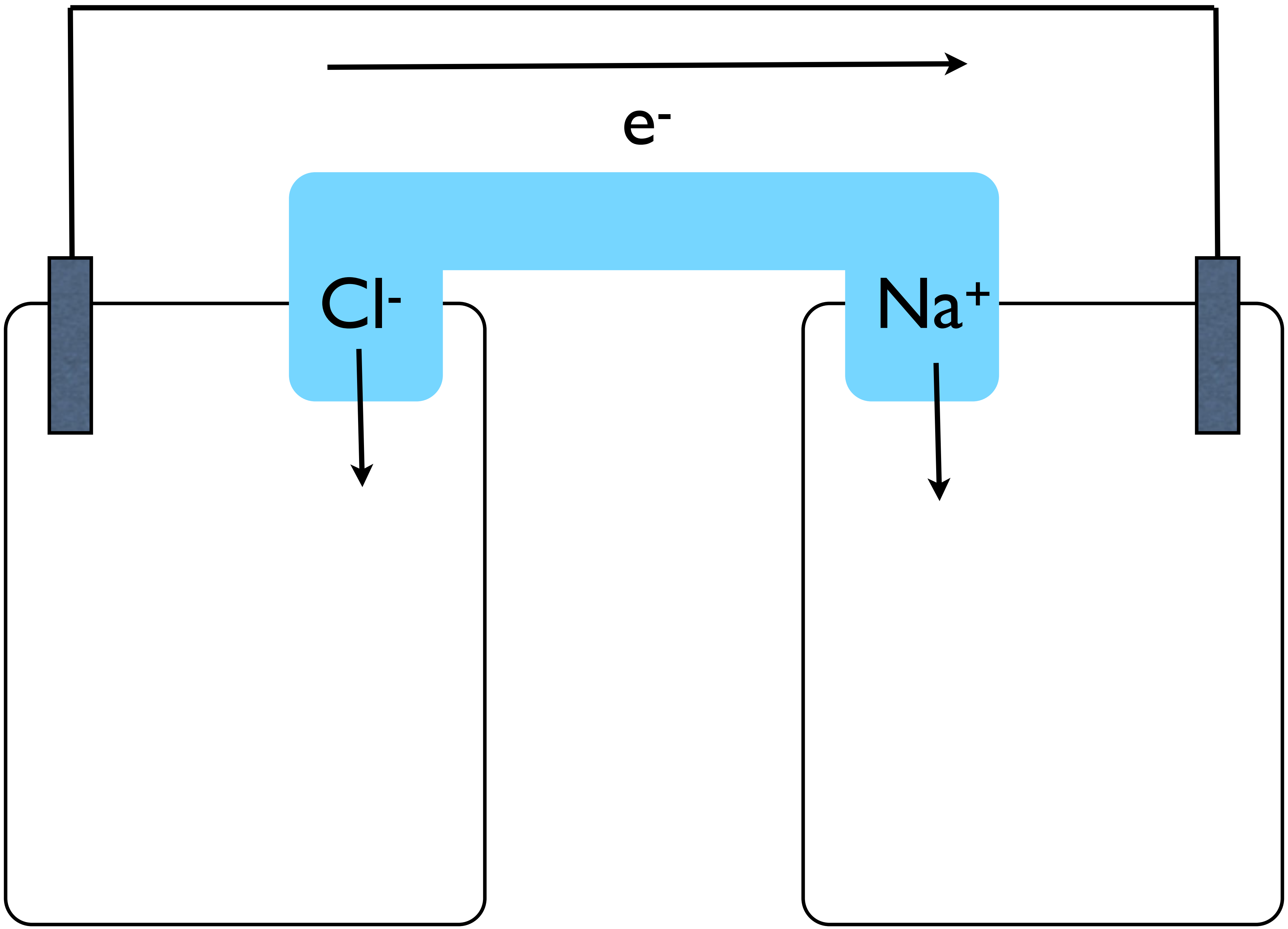
$2I^-_{(aq)} \longrightarrow I_{2(s)} + 2e^-$ $Br_{2(l)} + 2e^- \longrightarrow 2Br^-_{(aq)}$

Now show the flow of electrons



$2I^-_{(aq)} \longrightarrow I_{2(s)} + 2e^-$ $Br_{2(l)} + 2e^- \longrightarrow 2Br^-_{(aq)}$

Now show the flow of ions



$2I^{-}_{(aq)} \longrightarrow I_{2(s)} + 2e^{-}$ $\quad$ $Br_{2(l)} + 2e^{-} \longrightarrow 2Br^{-}_{(aq)}$

Locate the reduction potentials in a table of standard reduction potentials

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$2I^-_{(aq)} \longrightarrow I_{2(s)} + 2e^-$

Eanode = +0.54 V

$Br_{2(l)} + 2e^- \longrightarrow 2Br^-_{(aq)}$

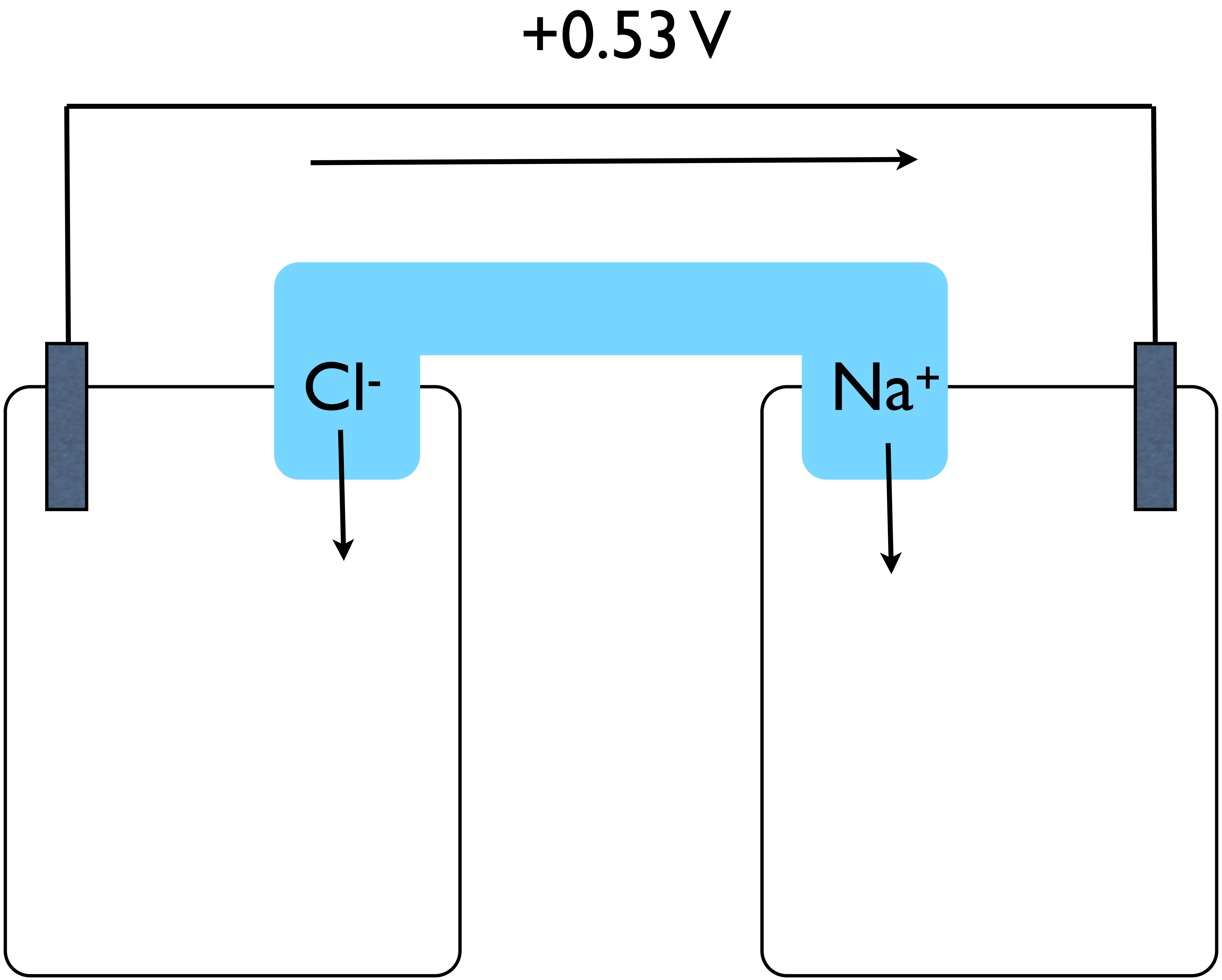
Ecathode=+1.07 V

Calculate the cell potential

$$E_{cell} = E_{cathode} - E_{anode}$$

$$E_{cell} = +1.07\,V - 0.54\,V$$

$$E_{cell} = +0.53V$$



$2I^-_{(aq)} \longrightarrow I_{2(s)} + 2e^-$ $Br_{2(l)} + 2e^- \longrightarrow 2Br^-_{(aq)}$