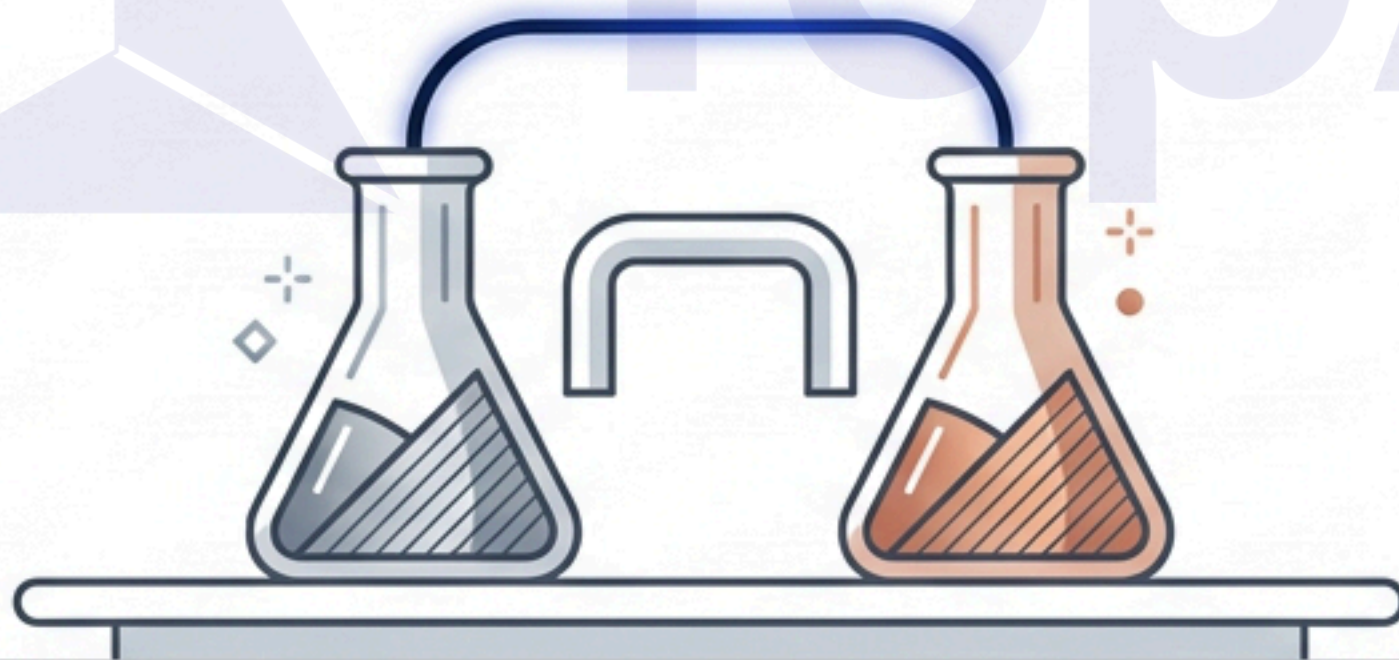


CHAPTER 2.2 — ELECTROCHEMISTRY

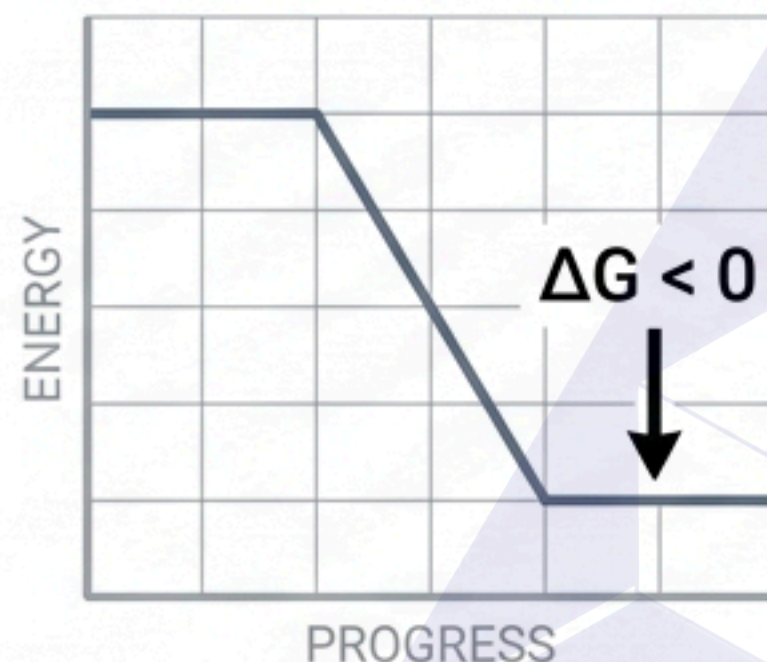
Galvanic Cells

Converting Spontaneous Chemical Energy
into Useful Electrical Work.



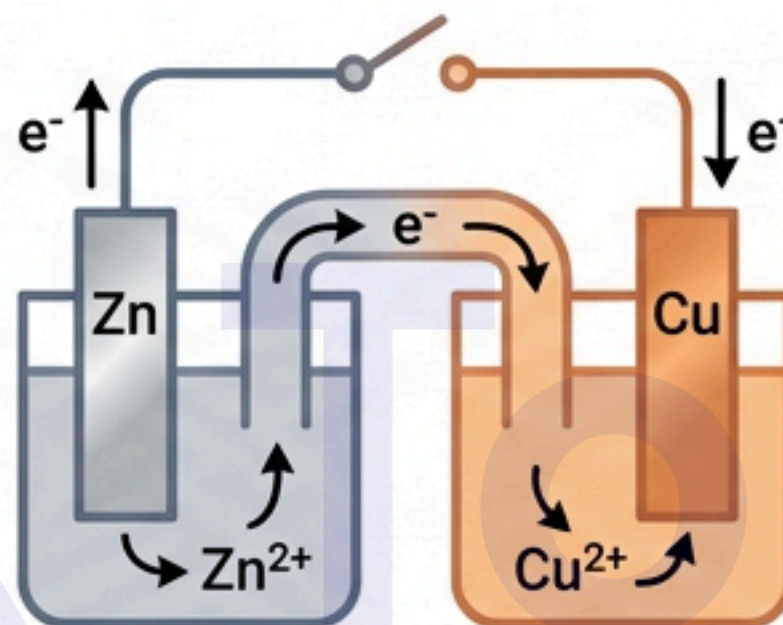
The Energy Conversion Engine

Spontaneous Redox Reaction



Chemical energy is released as reactants seek a more stable state.

The Galvanic Cell



By physically separating the reactants, the cell forces electrons to travel through an external wire.

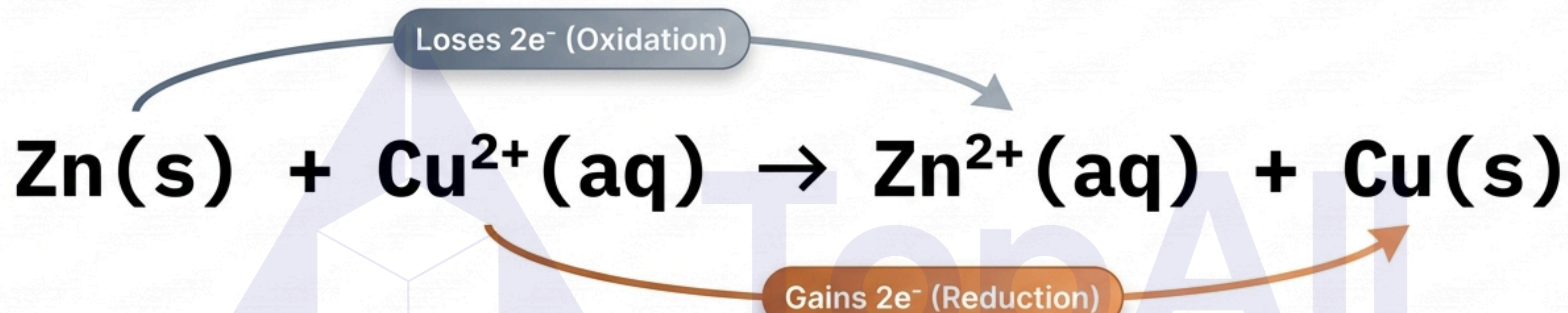
Electrical Energy



The electron flow is captured as useful electrical work.

The **Daniell Cell** is the classic example, generating exactly 1.1 V of electrical potential when zinc and copper ions are at standard concentrations (1 mol dm^{-3}).

The Daniell Cell Overall Reaction



The Core Mechanism

Energy is released because electrons transfer from a higher-energy state in the Zinc atoms to a lower-energy state in the Copper ions. Mixing them directly wastes this energy as heat; the Galvanic cell captures it.



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$$E=mc^2$$



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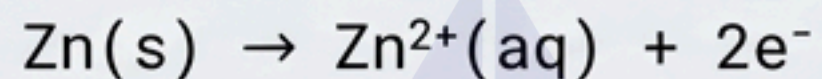
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Separating the Reaction: The Half-Cells

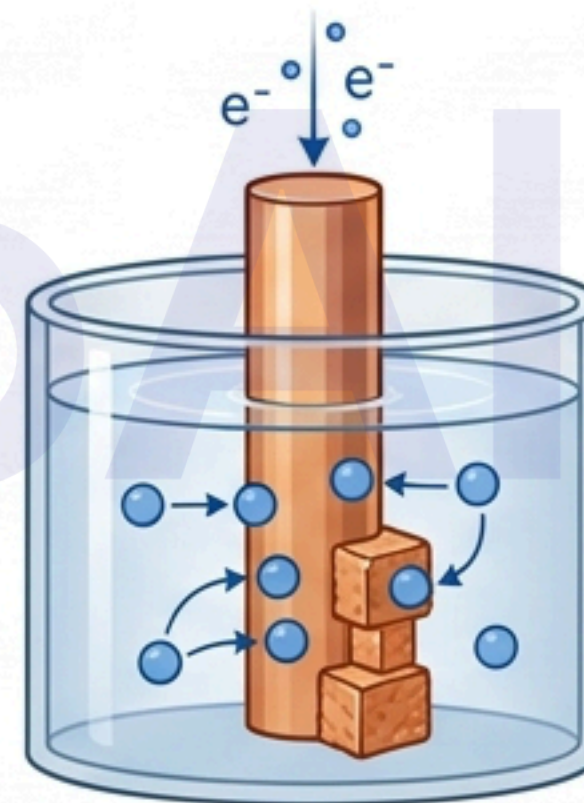
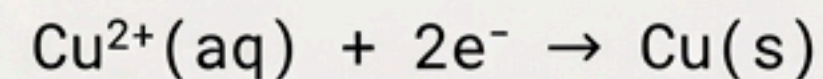
Zinc / Oxidation Half-Cell



Zinc atoms lose electrons to become ions. The metal electrode actively dissolves into the electrolyte.

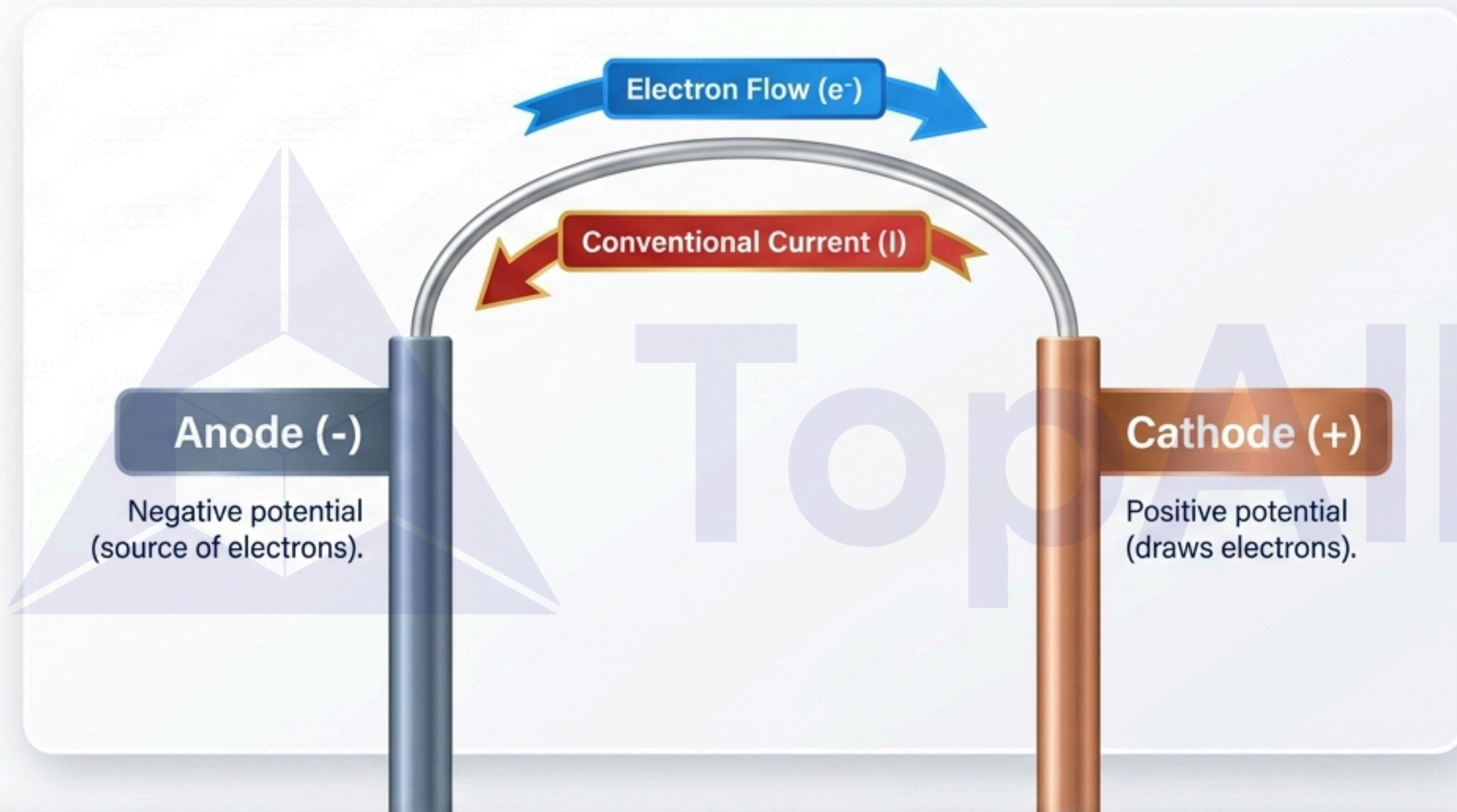
Redox Couple

Copper / Reduction Half-Cell



Copper ions in the solution gain incoming electrons. Solid copper visibly deposits onto the electrode.

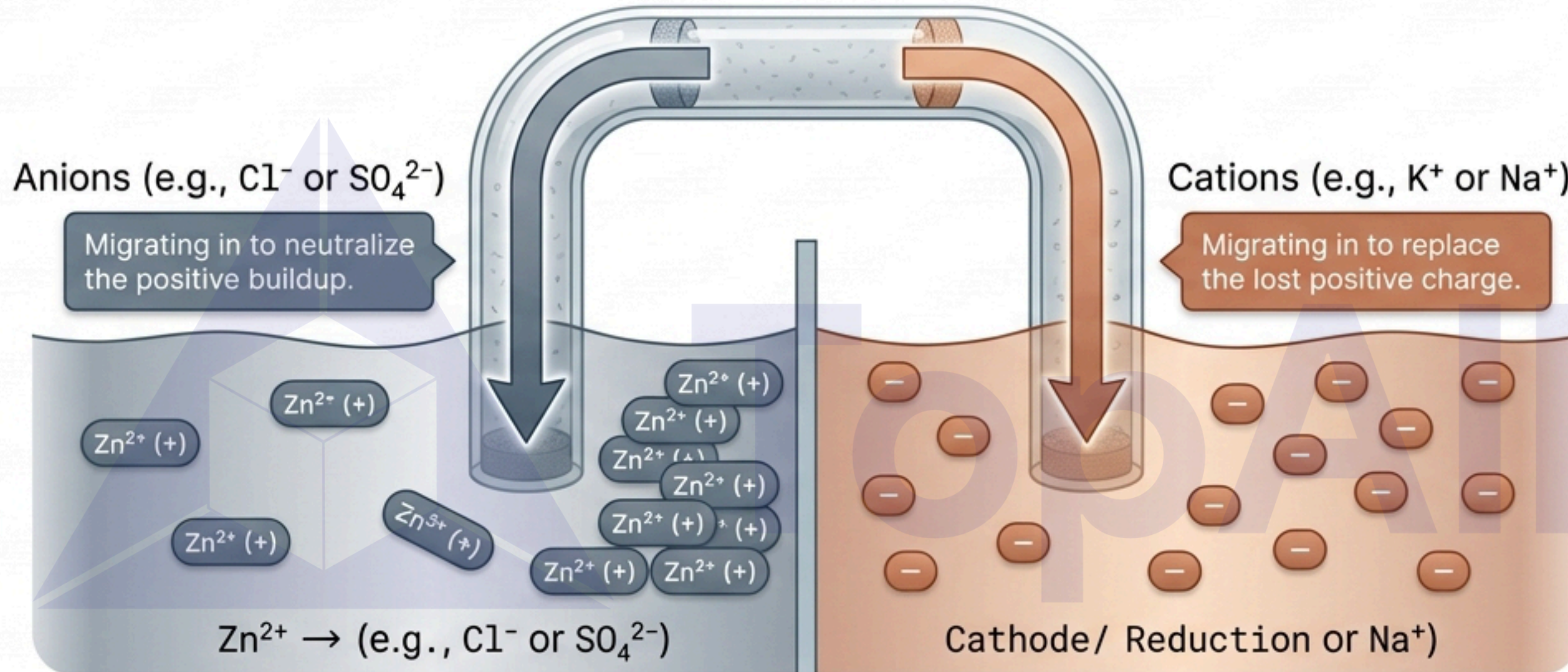
External Circuit: Mapping the Flows



Recap Strip – functional vector schematic.

Electrons always flow from Anode to Cathode. By convention, electrical current is recorded in the exact opposite direction.

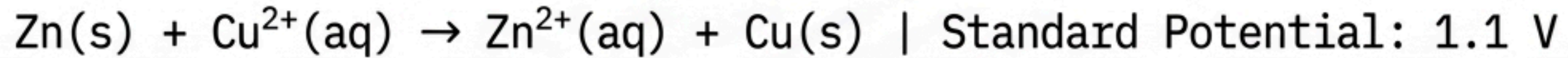
The Internal Circuit: The Salt Bridge



Why is this critical?

Without the salt bridge, the immediate charge imbalance polarizes the cell. The Anode becomes too positive to release electrons, and the Cathode becomes too negative to accept them. The circuit stops instantly.

System Integration: The Galvanic Blueprint



Anode (-)

Oxidation

Zinc dissolves

Electron Source

External Flow: e^-

Internal Flow:
Anions

Internal Flow:
Cations

Cathode (+)

Reduction

Copper deposits

Electron Sink

The Galvanic Cell: Forcing a spontaneous chemical reaction through a structured pathway to extract useful electrical energy.



You've Learned the Theory.

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