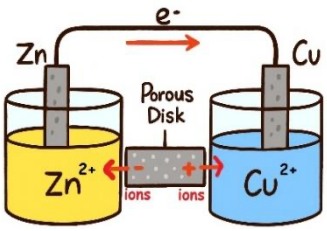
Electrochemistry **Name**_____

Galvanic Cells

Read from **Lesson 2 Part a:** [What is a Galvanic Cell?] in the **Chemistry Tutorial** Section**, Chapter 18** of **The Physics Classroom.**



- A **galvanic cell** (or **voltaic cell**) converts **chemical energy** from a **spontaneous redox reaction** into **electrical energy**.
- It works because **oxidation and reduction occur in separate locations**, forcing electrons to travel through an external circuit. This electron flow *is* electricity.

1. Structure of a Galvanic Cell

A galvanic cell contains **two half-cells**, each hosting one half-reaction.

Key Components

A. **Anode**

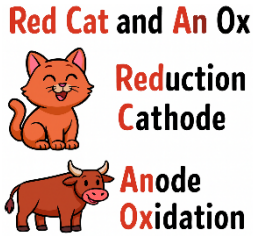
- Site of **oxidation**
- Electrode where electrons are **released**
- **Negative** electrode in a galvanic cell
- **Loses mass** as reaction proceeds

B. **Cathode**

- Site of **reduction**
- Electrode where electrons are **accepted**
- **Positive** electrode in a galvanic cell
- **Gains mass** as reaction proceeds

C. **External wire**

- Pathway for **electron flow** (always from anode → cathode)



D. **Salt bridge / porous disk**

- Allows **ion flow** to maintain charge balance
- **Cations** move from anode to **cathode**.
- **Anions** move from cathode to **anode**.
- Prevents solutions from mixing
- Ensures the reaction continues by preventing charge buildup

2 Gaseous Half-Cells

- When no solid reactant/product exists, an **inert electrode** (usually Pt) is used.
  - Example: $2\ H^+(aq) + 2\ e^- \rightarrow H_2(g)$
- Pt provides a surface for electron transfer but does not react.

3. Line Notation (Cell Notation) (A shorthand way to represent a galvanic cell)

- **Rules**
  - **Anode on the left**, cathode on the right
  - **Single line (|)** separates phases
  - **Double line (||)** represents the porous disk
  - **Ions** are listed closest to the porous disk
  - **Concentrations** may be included in parentheses

- Example: Zn-Cu Cell (Zn is oxidized to $Zn^{2+}$and Cu^{2+} is reduced to Cu.)
  - Line Notation: Zn (s) | Zn^{2+} (aq) || Cu^{2+} (aq) | Cu (s)
- Example: Zn-H^+ Cell (Zn is oxidized to $Zn^{2+}$and H^+ is reduced to H_2 (g))
  - Line Notation: Zn (s) | Zn^{2+} (aq) || H^+(aq) | H_2(g) | Pt(s)

Electrochemistry

Questions

1. Why does isolating the oxidation and reduction half-reactions in separate compartments enable a galvanic cell to generate an electric current?

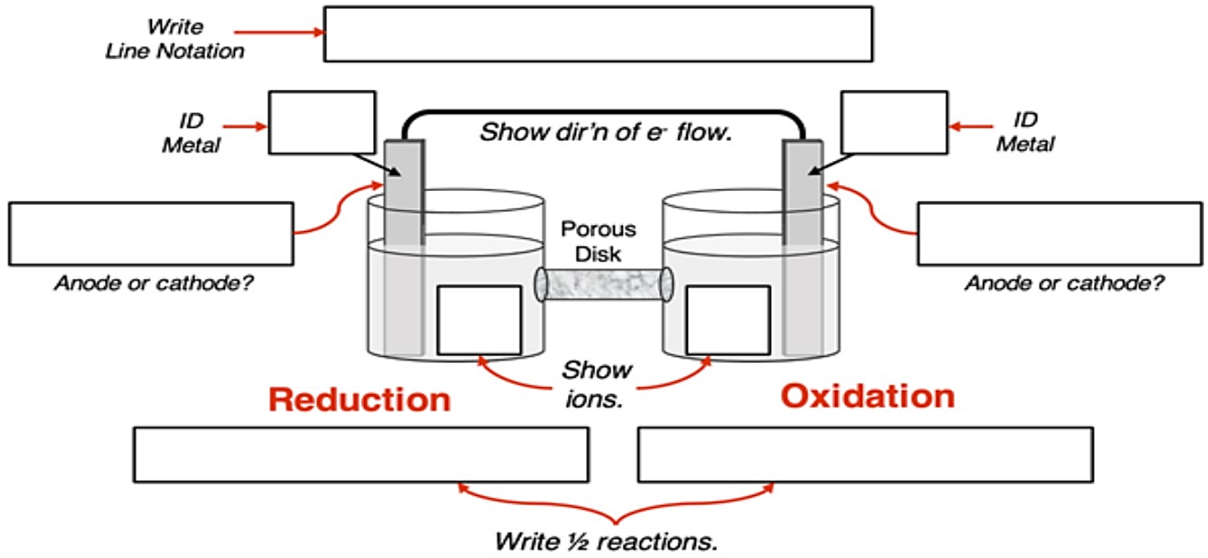
2. In chemistry lab, Aaron Agin tells Ellie Element that electrons flow through the porous disk to complete the circuit in a galvanic cell. Is Aaron's explanation accurate? If not, how might Ellie help him understand the actual role of the porous disk and the correct path of electron flow?

3. Why does the mass of one electrode increase while the mass of the other decreases during operation of a galvanic cell? Identify which electrode gains mass and which loses mass.

4. In some galvanic cells, inert electrodes (like platinum) are used when a half-cell lacks a solid metal. Explain why an inert electrode is required in these situations and describe how its presence affects the overall performance of the cell.

Electrochemistry

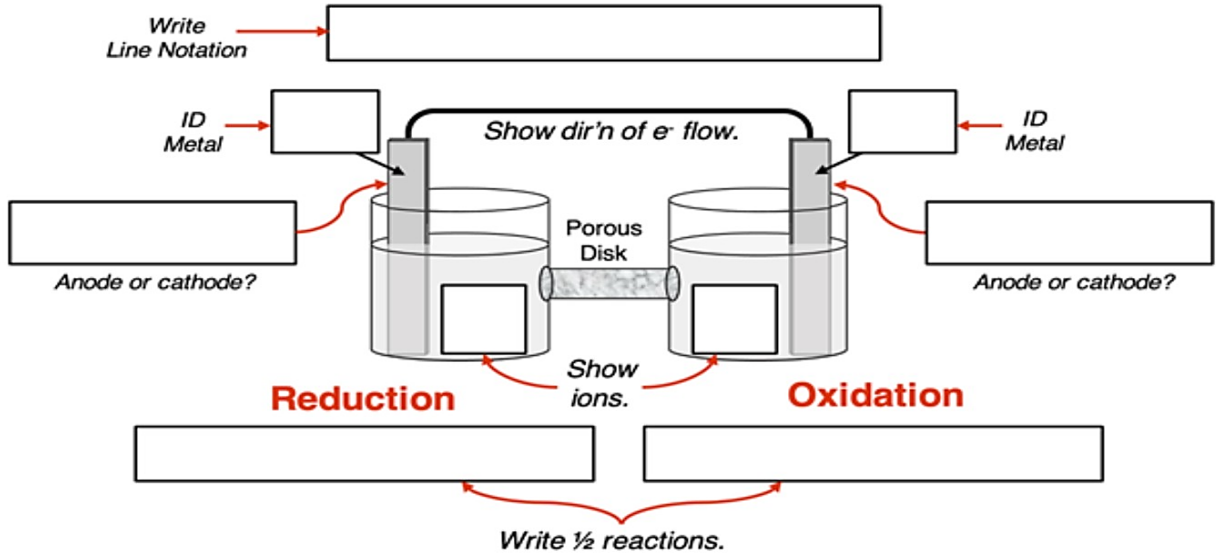
5. The following redox reaction occurs in a galvanic cell: $Co(s) + 2\ Ag^{+}(aq) \rightarrow Co^{2+}(aq) + 2\ Ag(s)$
Complete the schematic diagram of the galvanic cell by filling in all labeled boxes. Then answer the accompanying questions about the cell.



Which electrode/metal gains mass?_____

Which electrode/metal loses mass?_____

6. The following redox reaction occurs in a galvanic cell: $2\ Al(s) + 3\ Zn^{2+}(aq) \rightarrow 2\ Al^{3+}(aq) + 3\ Zn(s)$
Complete the schematic diagram of the galvanic cell by filling in all labeled boxes. Then answer the accompanying questions about the cell.

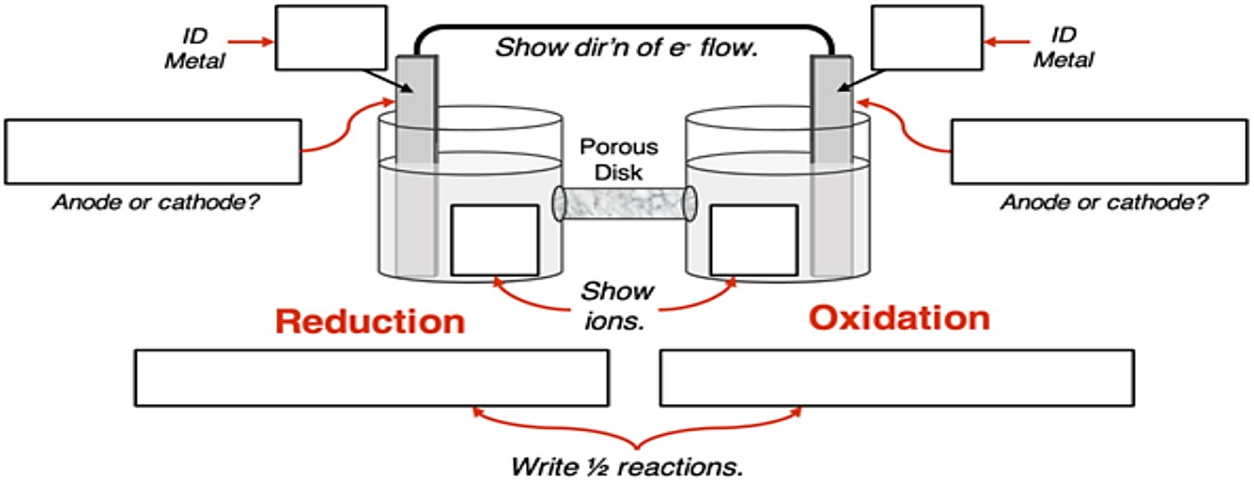


Which electrode/metal gains mass?_____

Which electrode/metal loses mass?_____

Electrochemistry

7. A galvanic cell is represented by the following line notation: Cd (s) | Cd^{2+} (aq) || Sn^{2+} (aq) | Sn (s)
Complete the schematic diagram of the galvanic cell by filling in all labeled boxes.



8. The following redox reaction occurs in a galvanic cell: 2 Cr(s) + 3 Ni^{2+} (aq) → 2 Cr^{3+} (aq) + 3 Ni (s)
In the space below, sketch the galvanic cell. Label the anode, cathode, direction of electron flow, and the porous disk. Then write the oxidation and reduction half-reactions and provide the corresponding line notation for the cell.