

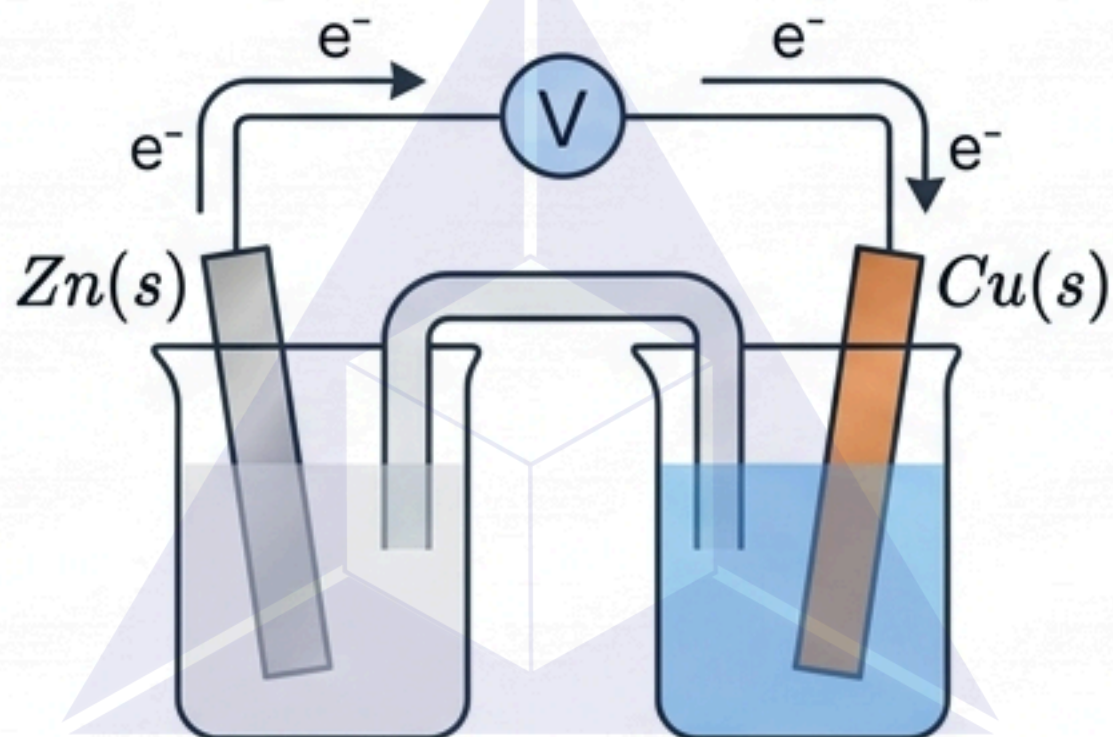
From Cell Voltage to Equilibrium Constant

Decoding the mathematics of a dead battery.



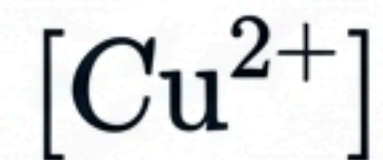
JEE MAIN + ADVANCED

What Happens With Time?

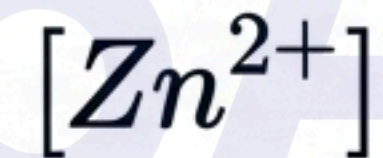


As the spontaneous reaction proceeds, the driving force decays.

REACTANT DROP



PRODUCT RISE



DRIVING FORCE DECAY

E_{cell} (Cell Voltage)





You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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Practice Now



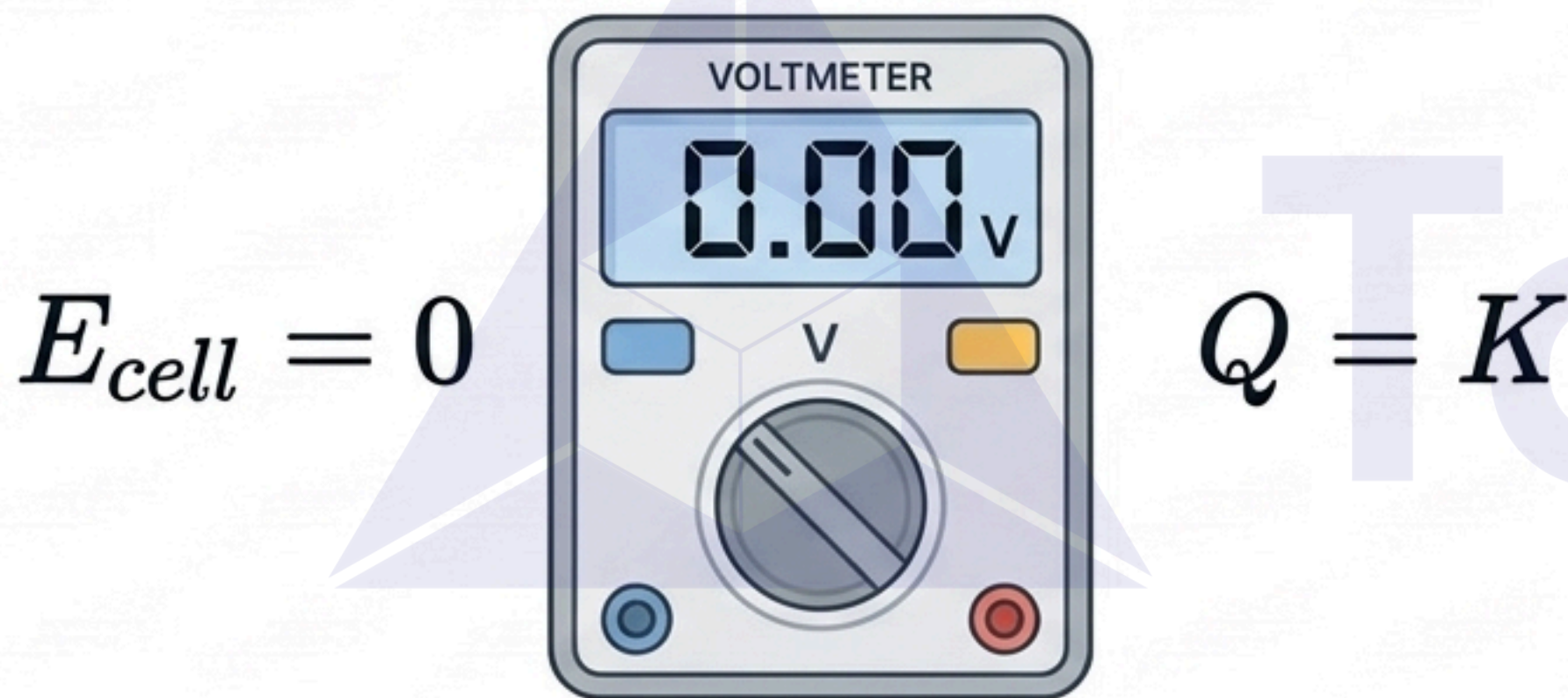
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Key Highlights

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The Equilibrium State



No net reaction. The battery is completely discharged.

⚠ JEE TRAP

Mistaking $E_{cell}^{\circ} = 0$ at equilibrium.

Only the actual potential (E_{cell}) drops to zero.

The Standard Potential (E_{cell}°) is a fixed constant derived from 1M concentrations and NEVER changes for a given cell.

Deriving the Relationship

Standard Nernst Equation

$$E_{cell} = E_{cell}^{\circ} - \frac{2.303RT}{nF} \log Q$$

Apply Equilibrium

Set $E_{cell} = 0$ and substitute $Q = K$

Transform

$$E_{cell}^{\circ} = \frac{2.303RT}{nF} \log K$$

AT 298 K (EXAM STANDARD):

$$E_{cell}^{\circ} = \frac{0.059}{n} \log K$$

Application: The Daniell Cell

$$E^{\circ} = 1.1 \text{ V}$$

$$n = 2 \text{ (electron transfer for Zn/Cu)}$$

$$\text{Step 1: } 1.1 = \frac{0.059}{2} \log K$$

$$\text{Step 2: } \log K = 37.288$$

$$K \approx 2 \times 10^{37}$$

A positive E° yields an astronomically large K . The reaction goes almost entirely to completion.

Core Revision: Equilibrium

Key Takeaways



At equilibrium, actual cell potential is dead ($E = 0$).



The reaction quotient has reached the equilibrium constant ($Q = K$).



Standard potential (E°) directly links to K , allowing us to calculate constants too extreme to measure chemically.



The Holy Trinity of Electrochemical Thermodynamics



You've Learned the Theory.

Now Let's Test It.

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