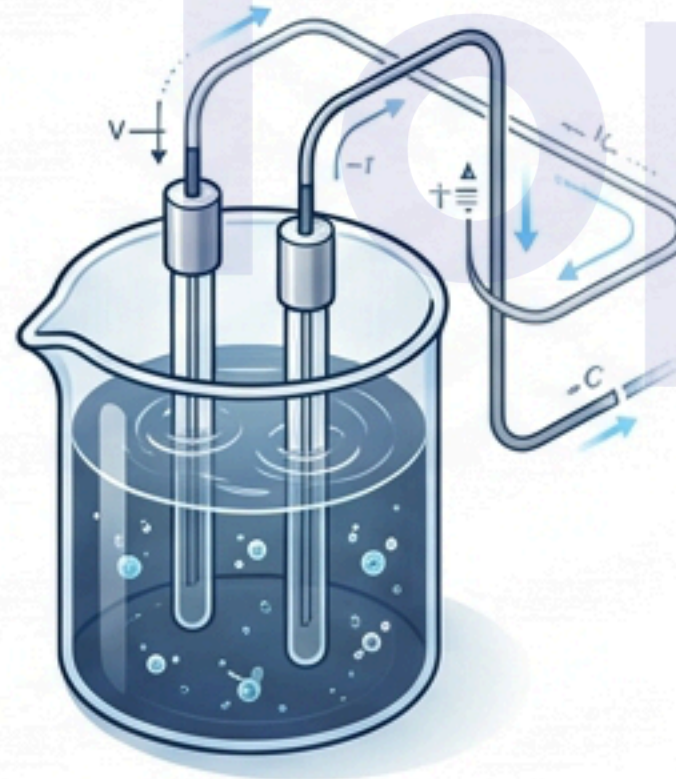


Measurement of the Conductivity of Ionic Solutions

A laboratory framework for determining resistance, cell constants, and conductivity using alternating current and Wheatstone bridge networks.



Two Critical Problems with Measuring Solutions

The DC Problem



Passing Direct Current (DC) through an **ionic solution** triggers **electrochemical reactions** (electrolysis).

Insight: Applying a voltage forces non-spontaneous reactions ($\Delta G > 0$). The solution becomes an electrolytic cell, altering its concentration and ruining the conductivity measurement.

The Connection Problem

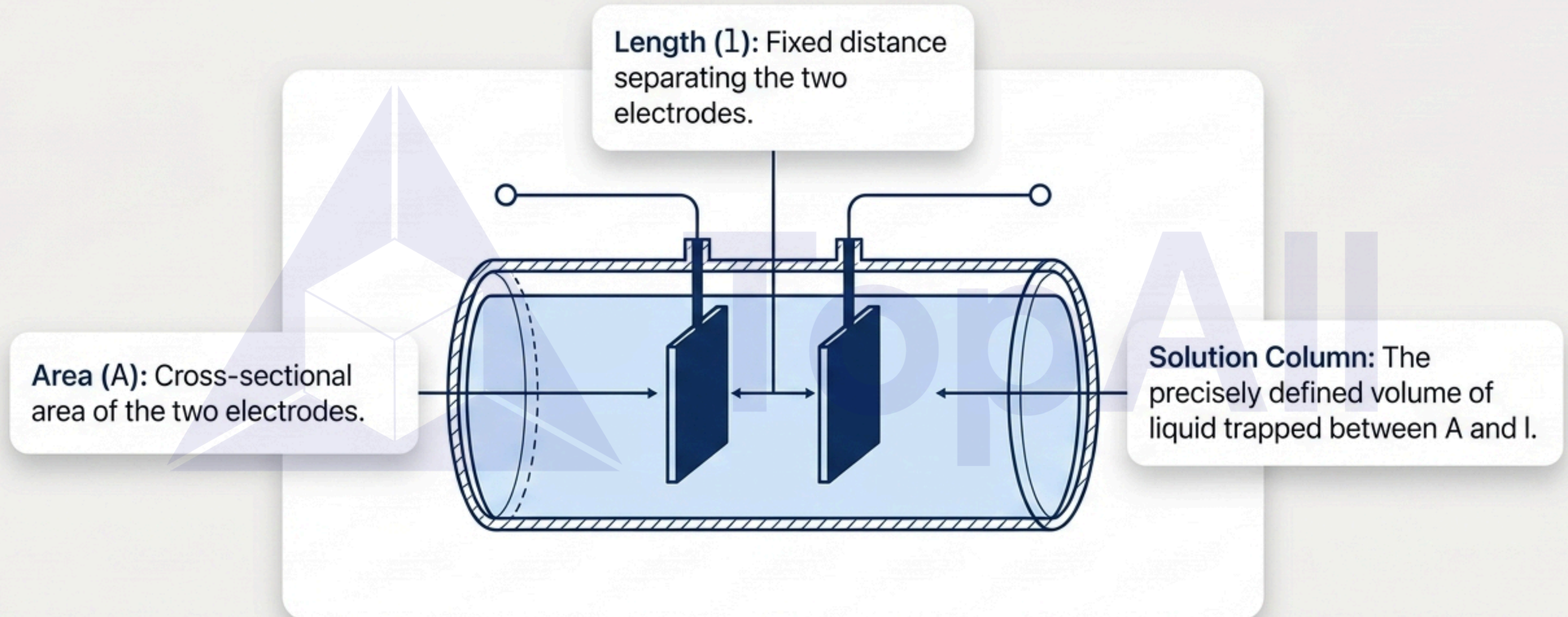


A liquid solution **cannot be physically** clamped to a standard Wheatstone bridge like a solid metallic wire.

Insight: Liquids lack fixed geometric boundaries. Measuring resistance requires confining the liquid to a specific, measurable volume.

Solution Matrix: We must replace DC power with an **Alternating Current (AC) source** and replace standard wire clamps with a specialized **Conductivity Cell**.

The Conductivity Cell



$$R = \rho(1/A) = (1/\kappa)(1/A)$$

The physical geometry defines the resistance.



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

$$E=mc^2$$



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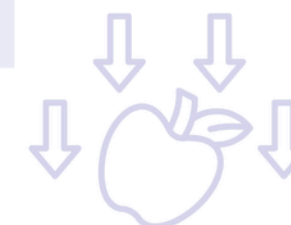
Practice Now



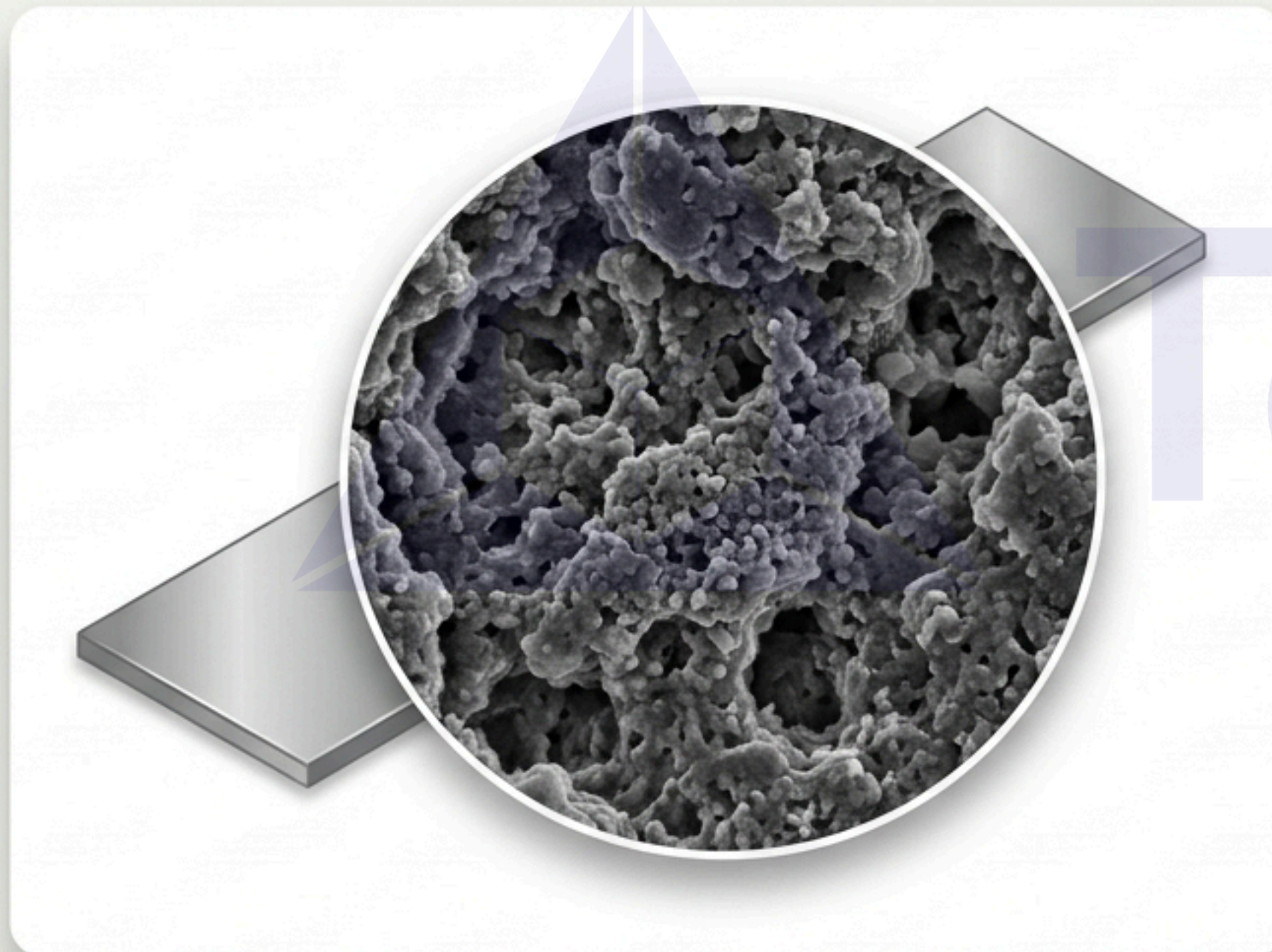
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Platinized Platinum Electrodes



The electrodes are coated with finely divided metallic platinum, known as **Platinum Black**.

Synthesis: Deposited electrochemically onto the smooth Pt base.

Primary Function: Drastically increases the effective surface area of the electrode.

Secondary Function: Reduces polarization effects that occur during AC measurement.

Deriving the Cell Constant (G^*)

Measuring l and A physically is inconvenient and highly unreliable in liquids. Instead, we mathematically bundle them into a single, permanent standard: the Cell Constant (G^*).

$$G^* = \frac{l}{A} = R \times \kappa$$

Units: cm^{-1} or m^{-1}

The Calibration Step

Node 1

Fill cell with standard KCl(aq) .

(Conductivity κ is precisely known across temperatures).

Node 2

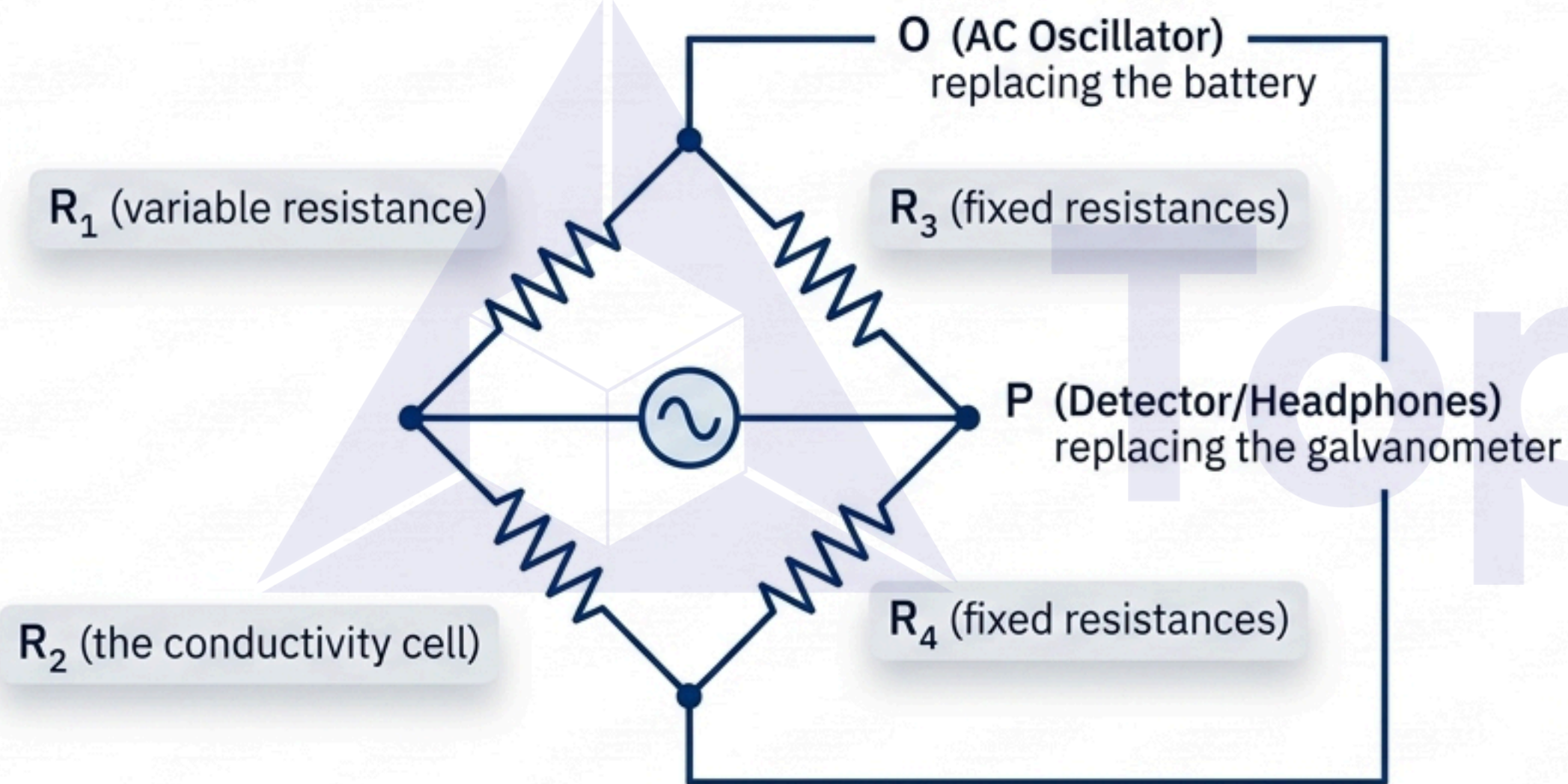
Measure Resistance (R) of the cell.

Node 3

Calculate cell constant:

$$G^* = R \times \kappa$$

Measuring Resistance (R) via AC Bridge



Power:

AC Oscillator operates in the audio frequency range (550 - 5000 Hz) to continuously reverse polarity, preventing electrolysis.

Detection:

The bridge is perfectly balanced when the null point is reached (no sound heard in detector P).

$$\text{Unknown Resistance: } R_2 = (R_1 \times R_4) / R_3$$

From Resistance to Conductivity

Node 1

Step 1: Calibrate (Determine G^*)

Action: Use standard KCl(aq) solution.

Math:

$$G^* = R_{(KCl)} \times \kappa_{(KCl)}$$

Node 2

Step 2: Measure (Determine R)

Action: Put unknown ionic solution in the same cell. Balance the AC Wheatstone Bridge.

Math:

$$R_{(\text{unknown})} = \frac{R_1 \times R_4}{R_3}$$

Node 3

Step 3: Calculate (Determine κ)

Action: Combine the fixed cell constant and the newly measured resistance.

Math:

$$\kappa = \frac{G^*}{R_{(\text{unknown})}}$$

**Protocol Complete:
Proceed to Molar
Conductivity (Λ_m)**



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