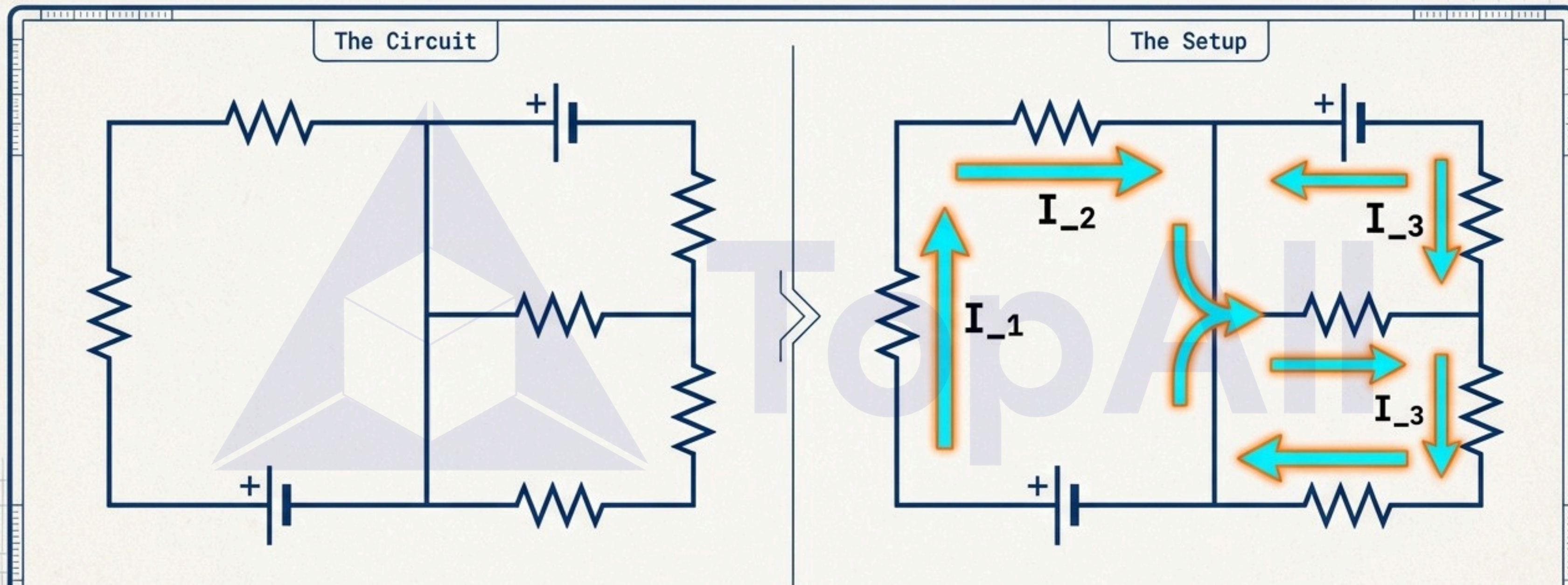


Kirchhoff's Rules for Complex Circuits

Subtitle: Navigating Multi-Loop
Networks: Rules, Sign Conventions, and
Application



Step 1: Labelling the Circuit

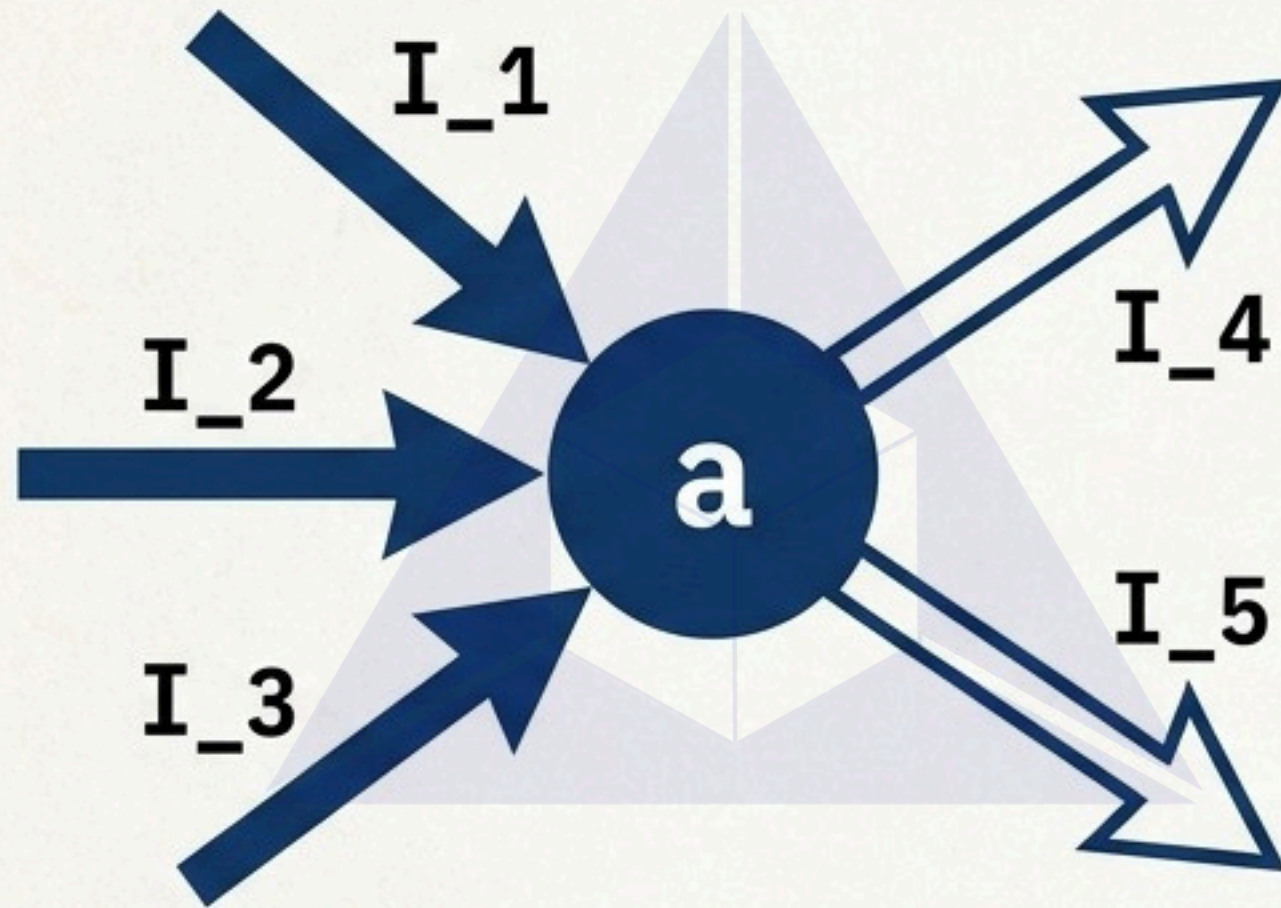


PRO-TIP / PROCEDURAL RULE

THE RULE OF FREEDOM: You can assume ANY direction for the current in any branch. Just commit to it for the entire calculation. The mathematics will automatically correct you at the end.

Kirchhoff's First Rule: The Junction

The Junction Rule (KCL)



$$\sum I_{\text{in}} = \sum I_{\text{out}}$$
$$I_1 + I_2 + I_3 = I_4 + I_5$$

⚠ TRAP ALERT

KCL is based on the Conservation of CHARGE, not energy. Steady currents mean there is no accumulation or spontaneous creation of charge at any junction.



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

$$E=mc^2$$



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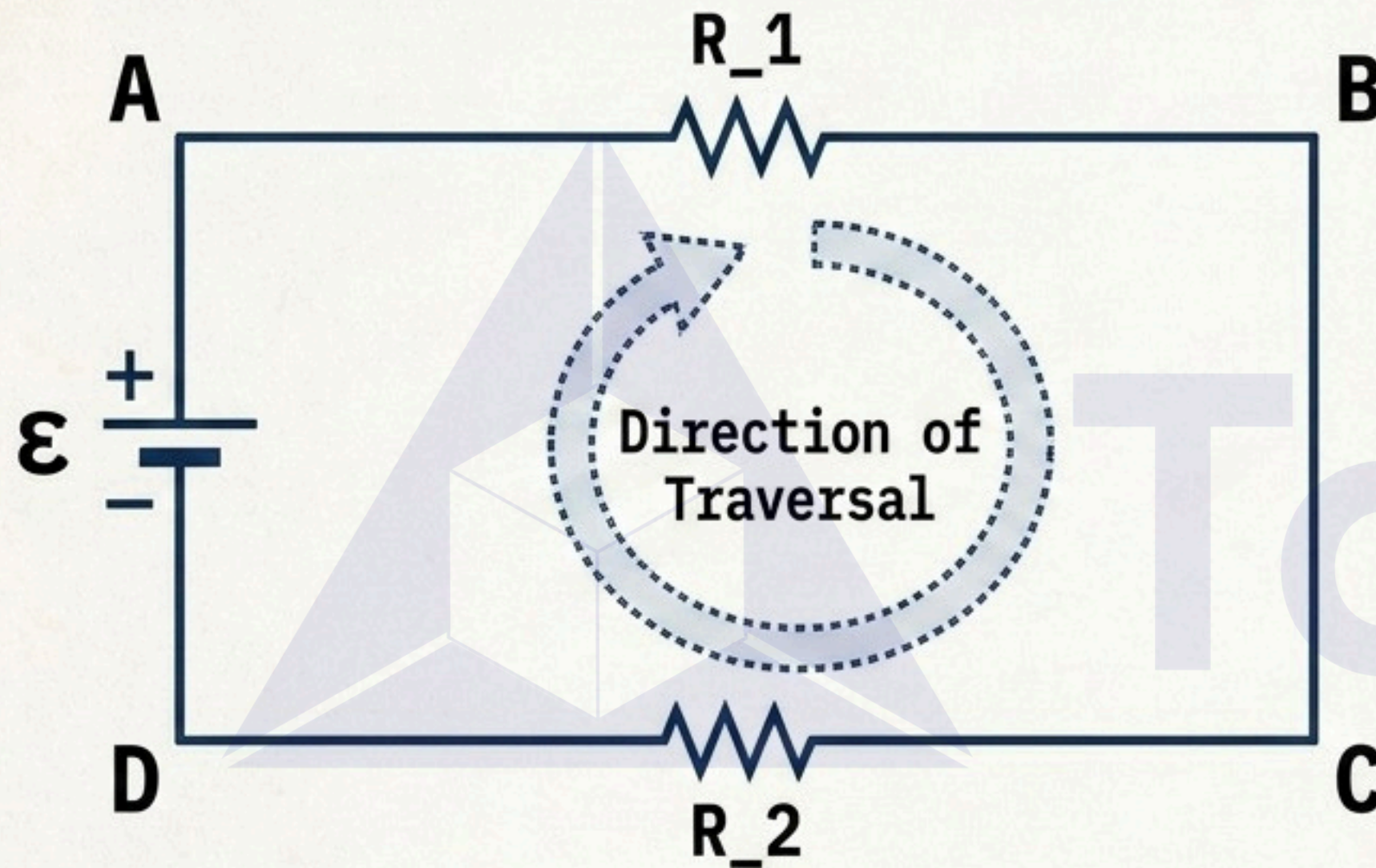
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Kirchhoff's Second Rule: The Loop Rule (KVL)



$$\sum \Delta V = 0$$

(Around any closed loop)

⚠ TRAP ALERT

KVL is strictly based on the Conservation of ENERGY. Because electric potential is location-dependent, starting and ending at the exact same node means the net change in potential energy is zero.

The Sign Convention Matrix

Resistors

Current (I)



Traversal

-IR

(Potential Drop)

Current (I)

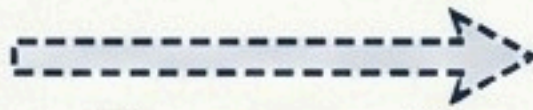


Traversal

+IR

(Potential Gain)

Cells /
Batteries



Traversal
(from - to +)

+ $\mathcal{E}$

(Potential Gain)

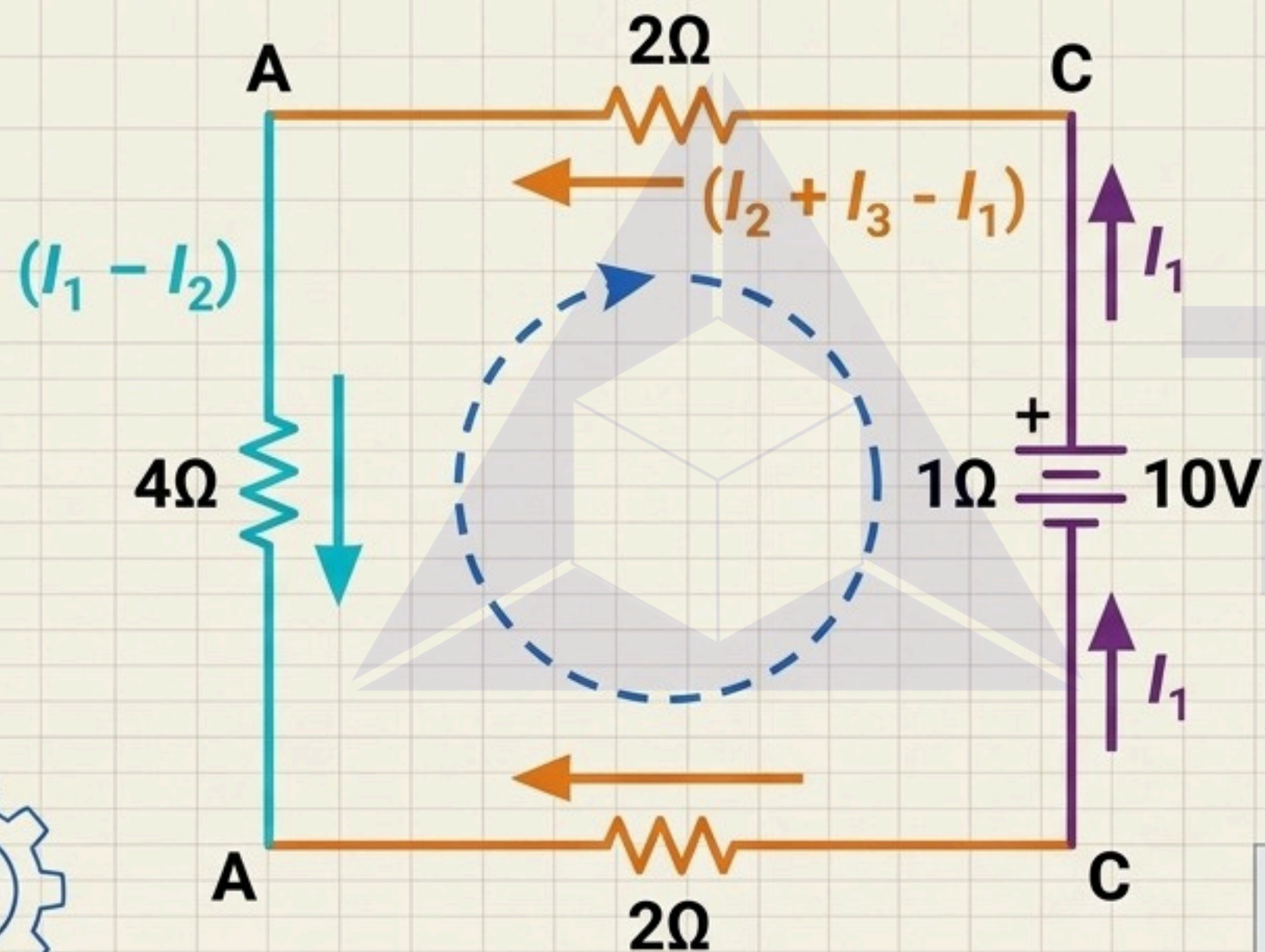


Traversal
(from + to -)

- $\mathcal{E}$

(Potential Drop)

Applying the Loop Equation



Equation Build

Path A to D:

$$-4(I_1 - I_2)$$

Path D to C:

$$+2(I_2 + I_3 - I_1) \text{ (opposing current)}$$

Path C to A:

$$-1(I_1) + 10$$

$$10 - 4(I_1 - I_2) + 2(I_2 + I_3 - I_1) - I_1 = 0$$

Interpreting Final Results: The Math vs. Reality

The Math

$$I_1 = -2.5 \text{ A}$$

The Reality



REVISION RULE

THE NEGATIVE SIGN RULE: Never erase your initial arrows halfway through a problem. If your calculated current turns out to be a negative number, your math is fine! It simply means the actual physical current flows exactly opposite to your assumed direction.



You've Learned the Theory.

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