

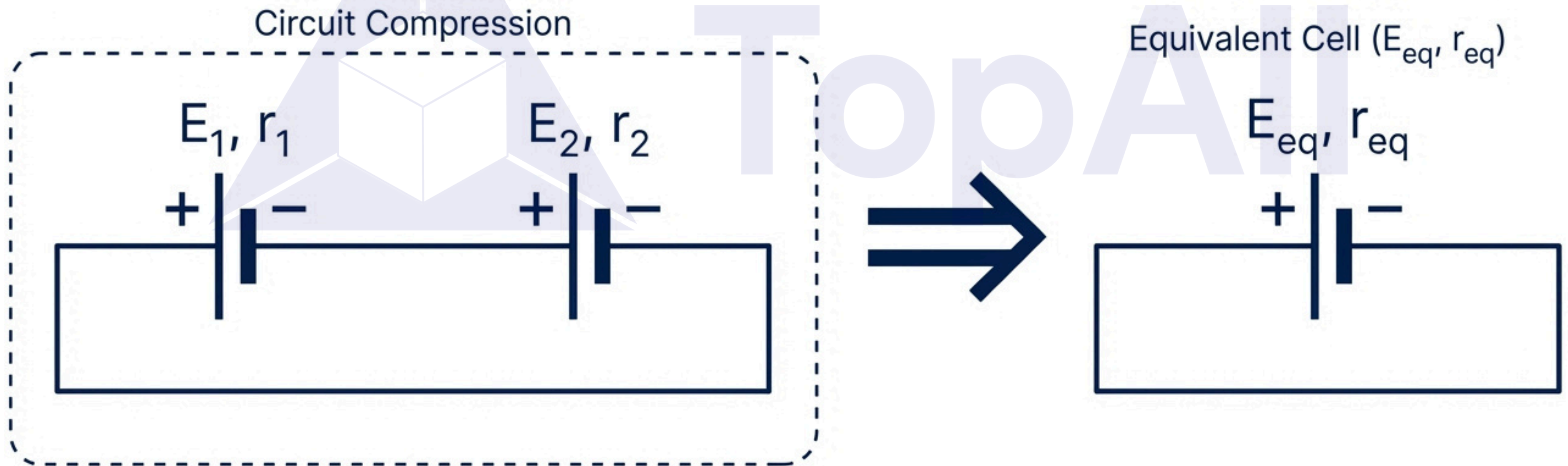
CHAPTER 3: CURRENT ELECTRICITY

Cells in Series & Parallel

Simplifying multi-cell circuits using equivalent electromotive force (E_{eq}) and internal resistance (r_{eq}).

Series Combination

In a series connection, cells are joined end-to-end. The exact same current (I) flows through each cell, while the total potential difference is the algebraic sum of the individual potential differences across each cell.



Equivalent Values for Series

Equivalent Internal Resistance

$$r_{eq} = r_1 + r_2 + \dots + r_n$$

Internal resistances simply add up, exactly like standard resistors in series.

Equivalent EMF

$$E_{eq} = E_1 + E_2 + \dots + E_n$$

The total equivalent EMF is the algebraic sum of the individual EMFs, assuming positive-to-negative connections.

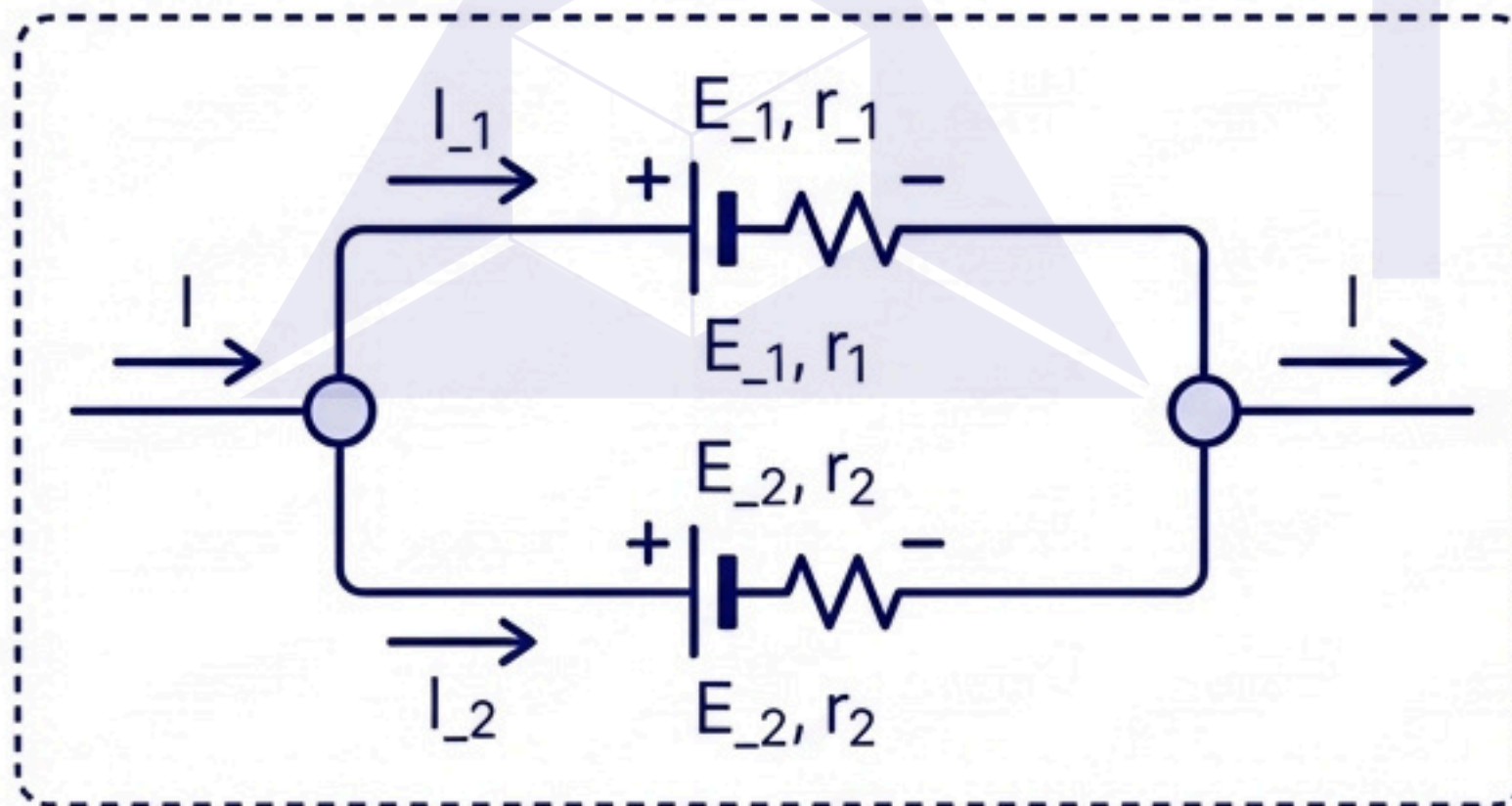
⚠ EXAM TRAP: POLARITY REVERSAL

If the current leaves from the negative electrode of a cell (e.g., negative terminal connected to negative terminal), that cell's EMF enters the expression with a negative sign: $E_{eq} = E_1 - E_2$.

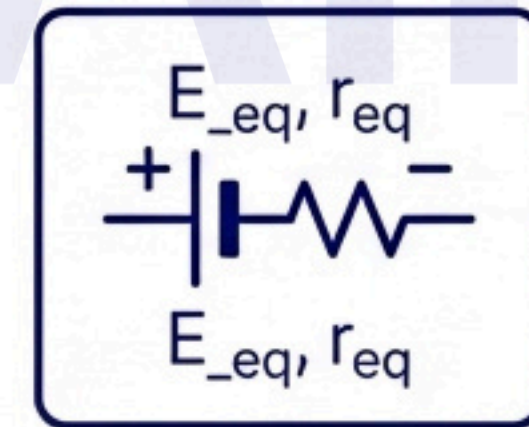
Parallel Combination

In a parallel connection, cells are joined together across common points. The potential difference (V) across the entire combination is the same, while the total current splits among the parallel branches ($I = I_1 + I_2$).

Circuit Compression



Equivalent Cell (E_{eq}, r_{eq})



Equivalent Values for Parallel

Internal Resistance

$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2} + \dots + \frac{1}{r_n}$$

EMF

$$\frac{E_{eq}}{r_{eq}} = \frac{E_1}{r_1} + \frac{E_2}{r_2} + \dots + \frac{E_n}{r_n}$$

⚡ SPEED SHORTCUT FOR 2 CELLS

For exactly two cells in parallel, cross-multiply to use these direct formulas:

$$r_{eq} = \frac{r_1 * r_2}{r_1 + r_2}$$

$$E_{eq} = \frac{E_1 * r_2 + E_2 * r_1}{r_1 + r_2}$$

If a cell's polarity is reversed (negative to positive), flip the sign of its EMF in the numerator (e.g., $E_2 \rightarrow -E_2$).

QUICK REVISION

Key Takeaways

	Series Cells	Parallel Cells
Constant Factor	Current (I) is same through all	Voltage (V) is same across all
Equivalent EMF	$E_{eq} = E_1 + E_2$	$E_{eq} = \frac{E_1 \cdot r_2 + E_2 \cdot r_1}{r_1 + r_2}$
Equivalent Int. Resistance	$r_{eq} = r_1 + r_2$	$r_{eq} = \frac{r_1 \cdot r_2}{r_1 + r_2}$
Exam Strategy	Watch out for reversed polarity (subtract E)	Memorize the 2-cell shortcut formulas