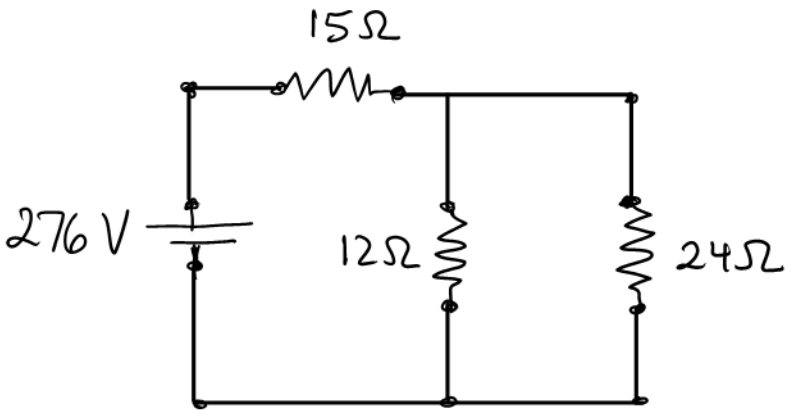
PhysicsTutor

Resistor Circuit

Problem:

- How much current flows through the battery in the given circuit?
- What is the current in the 12 Ω resistor?



Relevant ideas:

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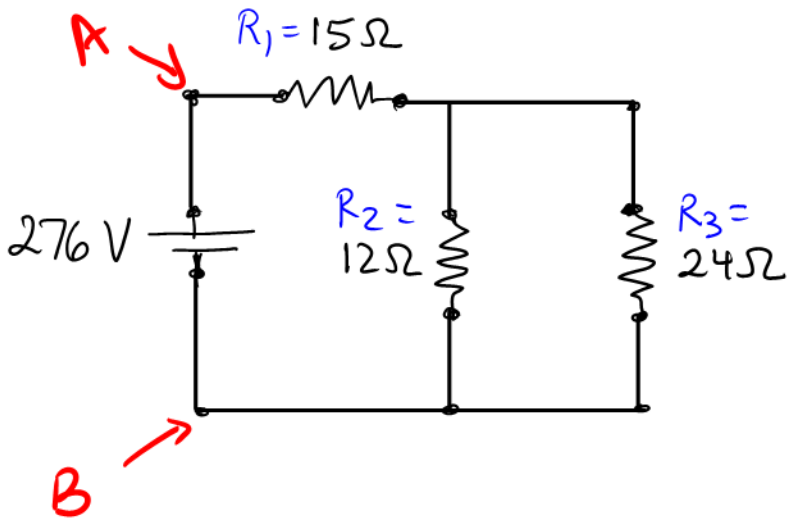
- Equivalent resistance for the entire circuit.



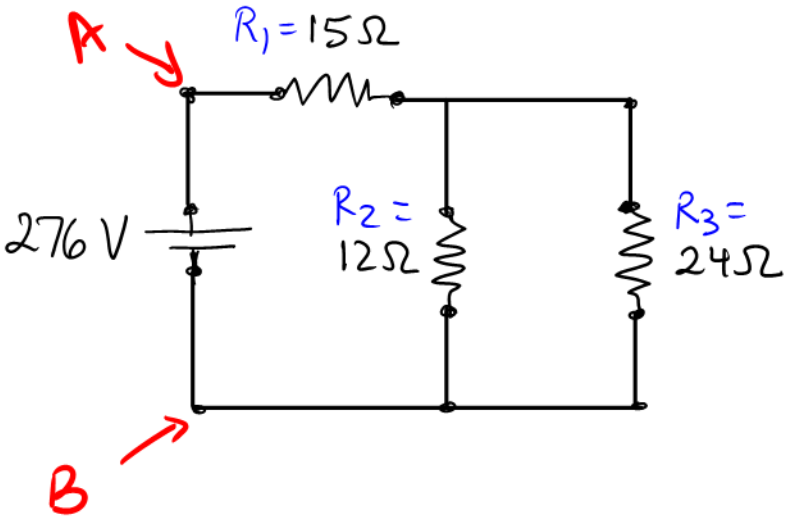
$R_{AB} = R_{eq}$

R_{23}^{eq} : R_2 / R_3 are parallel

R_{AB} : R_1 and R_{23}^{eq} are in series

Relevant ideas:

- Equivalent resistance for the entire circuit.
- Use Ohm's law for the equivalent resistance.



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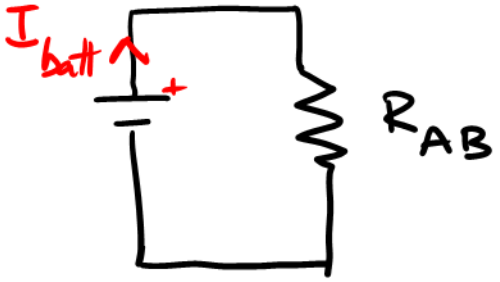
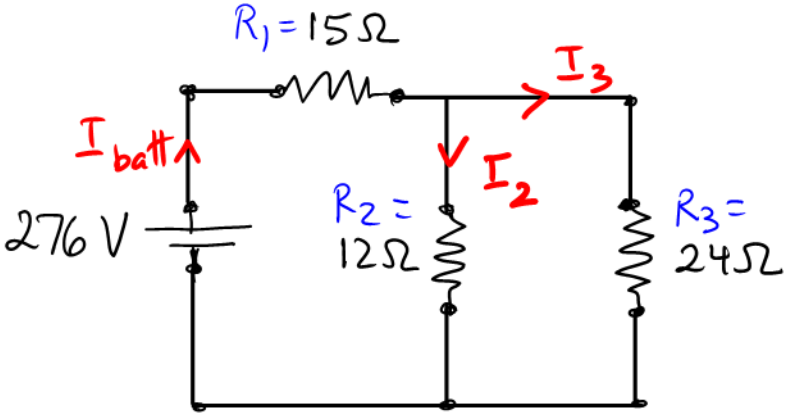


$$\Delta V_B = R_{AB} \cdot I_{batt}$$

Relevant ideas:

- Equivalent resistance for the entire circuit.
- Use Ohm's law for the equivalent resistance.
- Kirchhoff junction and loop rules:
- Voltage drop across 12Ω resistor?
- Again Ohm's law.



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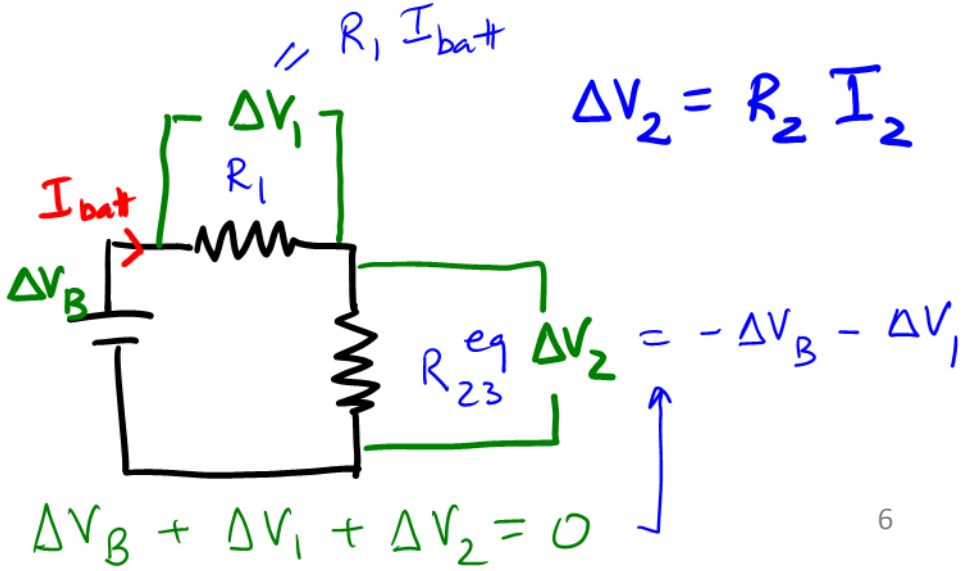


$\Delta V_2 = R_2 I_2$

Equations associated with ideas:

series - R :

$$R_{eq} = R_1 + R_2$$

parallel - R :

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

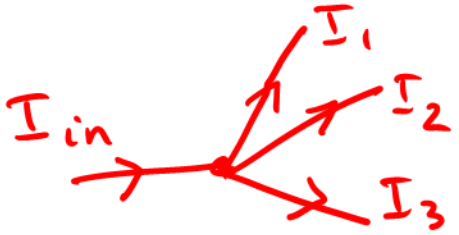
$$\therefore \; R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

Ohm: $\Delta V_i = R_i \, I_i$

Kirchhoff loop :

$$\Delta V_B + \Delta V_1 + \Delta V_2 = 0$$

Kirchhoff junction:



$$I_{in} = I_1 + I_2 + I_3$$

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- 15 Ω resistor is in series with the parallel pair.
- Battery current splits after the 15 Ω resistor.
- Voltage drops across ($12/24\Omega$) resistor pair and across (15Ω) resistor add up to ΔV_B. Calculate them from Ohm's law, then get the current through (12Ω) resistor from Ohm.

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- $R_{AB} = R_1 + R_{23}^{eq} = 15 + 8.0\,\Omega = 23\,\Omega\,;\; I_B = \frac{276\,V}{23\,\Omega} = 12\,A$
- $|\Delta V_1| = R_1 I_B = 180\,V \;\therefore\; |\Delta V_2| = \Delta V_B - |\Delta V_1| = 96\,V$

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- $R_{23}^{eq} = \frac{R_2 R_3}{R_2 + R_3} = \frac{12 \cdot 24}{12+24}\,\Omega = 8.0\,\Omega$
- $R_{AB} = R_1 + R_{23}^{eq} = 15 + 8.0\,\Omega = 23\,\Omega$; $I_B = \frac{276\,V}{23\,\Omega} = 12\,A$
- $|\Delta V_1| = R_1 I_B = 180\,V \;\therefore\; |\Delta V_2| = \Delta V_B - |\Delta V_1| = 96\,V$
- $I_2 = \frac{96\,V}{12\,\Omega} = 8.0\,A$

cross check: $I_3 = (12 - 8.0)\,A = 4.0\,A$ by junction rule

$\Delta V_3 = \Delta V_2 = 96\,V$ $\quad R_3 \cdot I_3 = 24\,\Omega \cdot 4.0 = 96\,V$ ✓