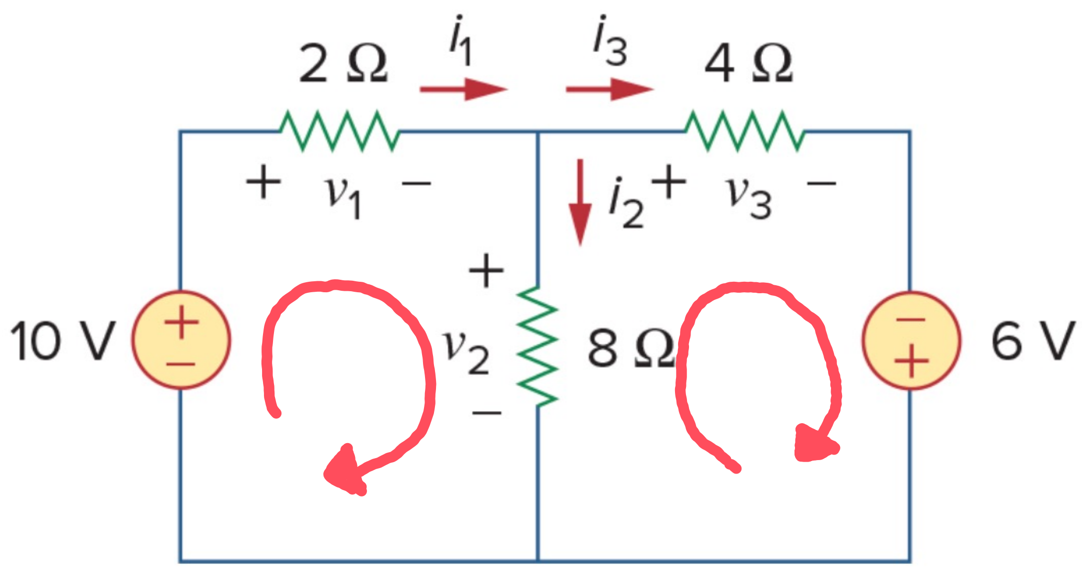
Last Class…

Apply KCL, KVL, and Ohm's Law to find i_1, i_2 and i_3.



$i_1 - i_2 - i_3 = 0$

$10V = V_1 + V_2$

$10V = V_3 - V_2$

$V_1 =$

$V_2 =$

$V_3 =$

$i_1 = \frac{10}{2} = 5A$

$i_2 = \frac{8}{2} = 4A$

$i_3 = \frac{6}{1} = 6A$

$V_2 = 10V - V_1 = V_3 - 10V$

THE OHIO STATE UNIVERSITY

COLLEGE OF ENGINEERING

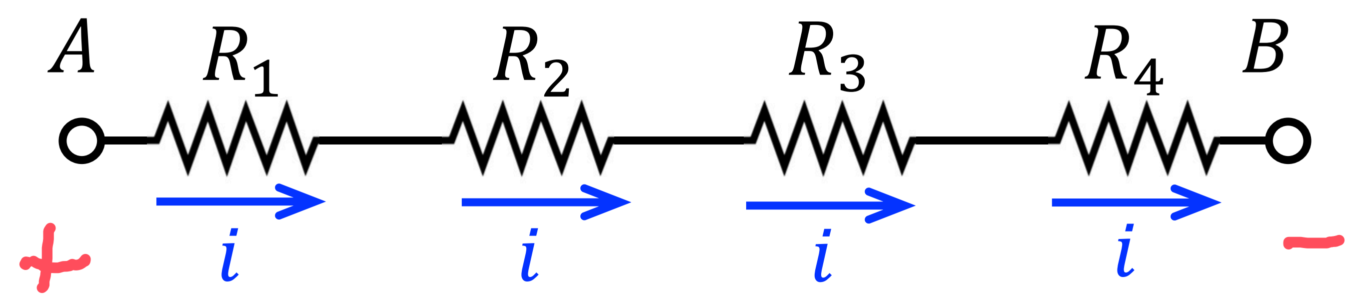
Equivalent Resistance

This Lecture…

- Learning Objectives:
  - Combine resistors in series and in parallel.
  - Find equivalent circuits for resistive circuits.
  - Understand the difference between open, closed, and short circuit.

Resistors in Series

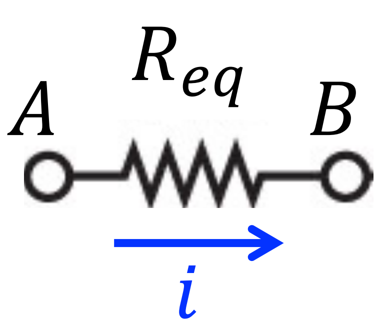
- Recall: Components on the same branch are said to be in series.



Same current flows through all of the resistances in series.

Equivalent circuits:

- Simplify analysis.
- Voltage and Current between A and B do not change.



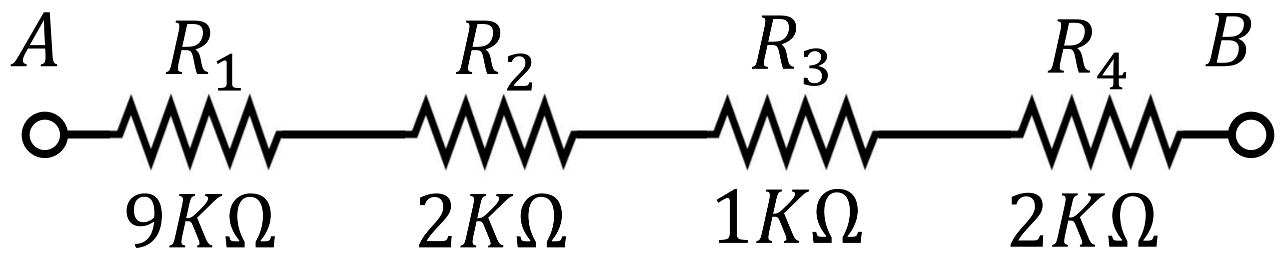
R_{eq} = sum of all resistors

$$R_{eq} = \sum_{\text{series}} R_i = R_1 + R_2 + \ldots + R_n$$

ONLY for resistors in series

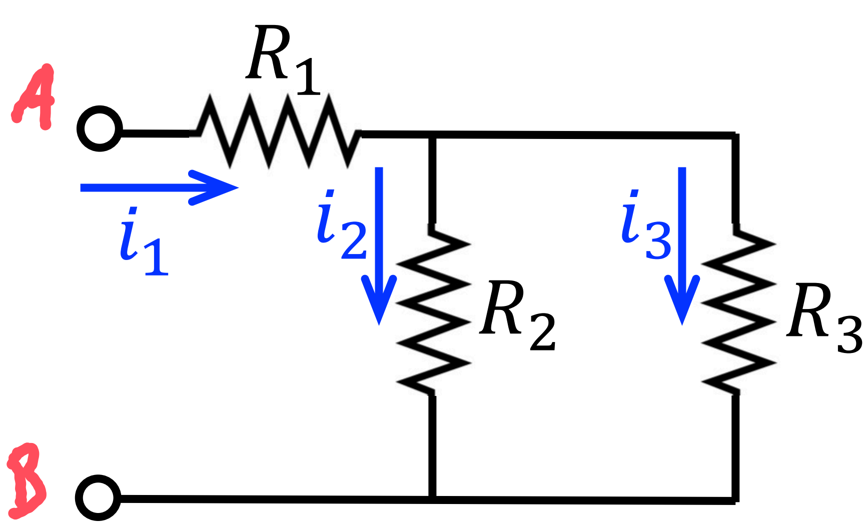
Test Your Knowledge

- What is R_{eq} between A and B?



$R_{eq} =$ 14 KΩ

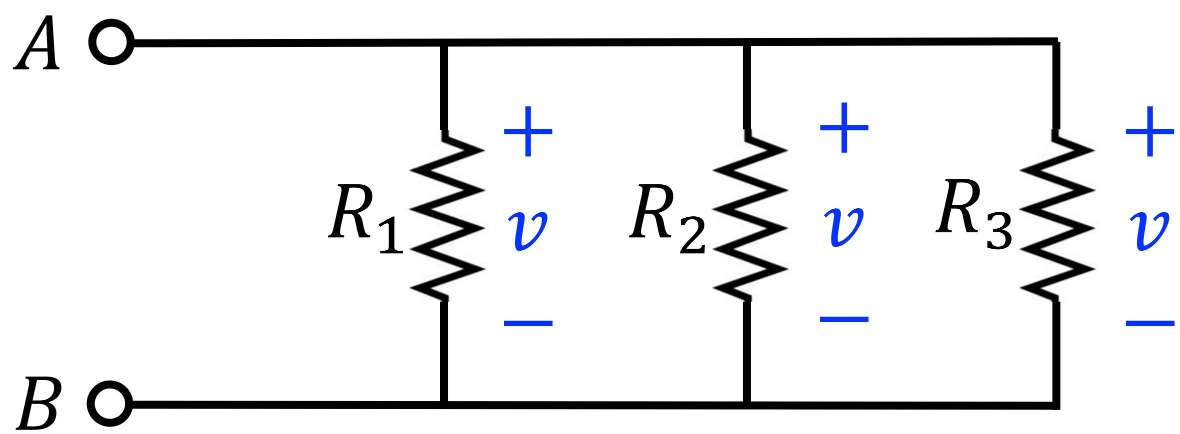
- What is R_{eq} between A and B?



Resistors in Parallel

- Recall: Components sharing the same nodes on both sides are said to be in parallel.

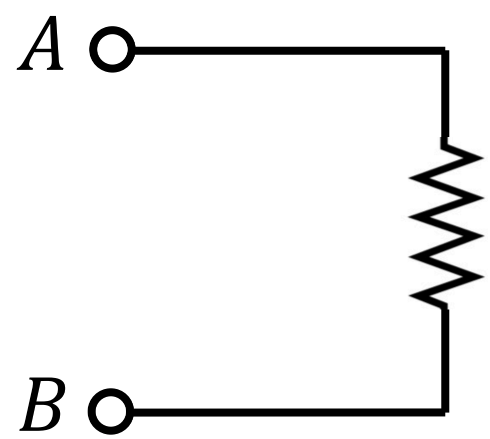
$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$



Same voltage across them.

Equivalent circuits:

- Simplify analysis.
- Voltage and Current between A and B do not change.

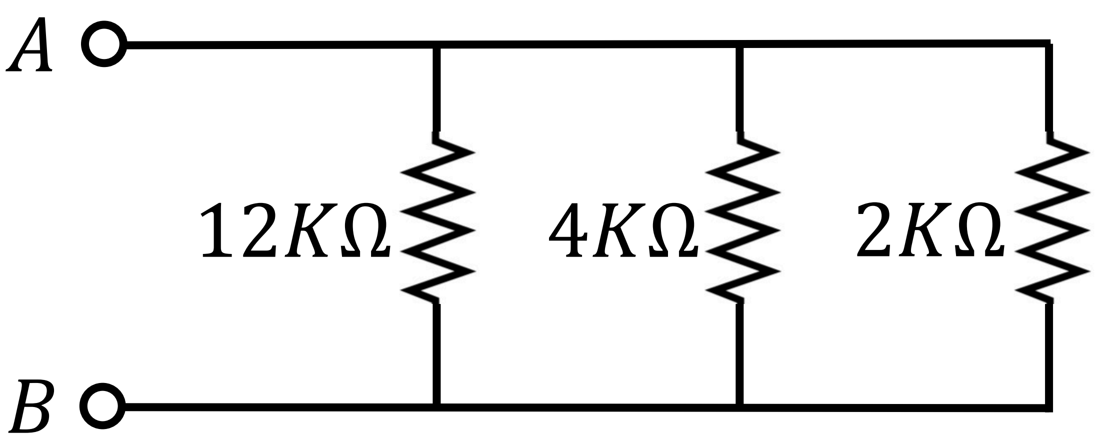


R_{eq} = one over sum of the inverse of all resistors.

$R_{eq} =$

Test Your Knowledge

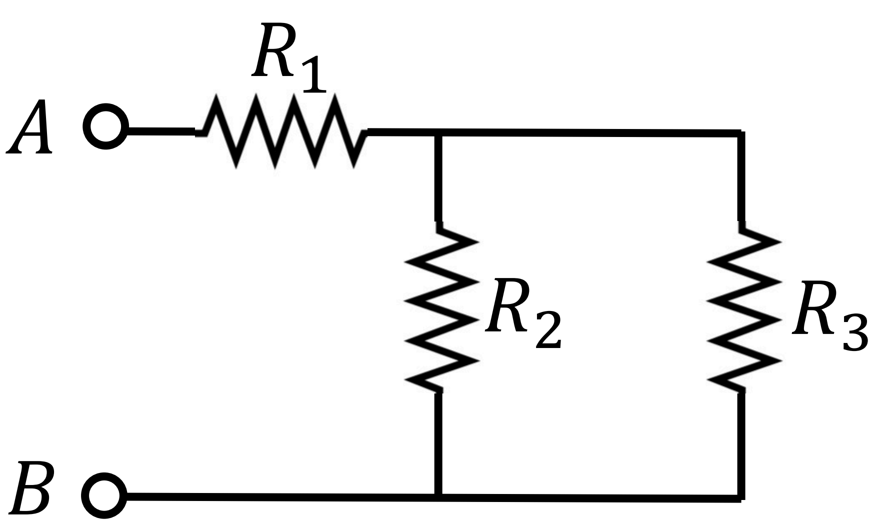
- What is R_{eq} between A and B?



$$R_{eq} = \frac{1}{\frac{1}{12} + \frac{1}{4} + \frac{1}{2}}$$

$$= \frac{1}{\frac{1+3+6}{12}} = \frac{12}{10} = \boxed{1.2\,k\Omega}$$

- What is R_{eq} between A and B?



Only R_2 & R_3 in parallel

Equivalent Resistance

Recall - Equivalent circuits:

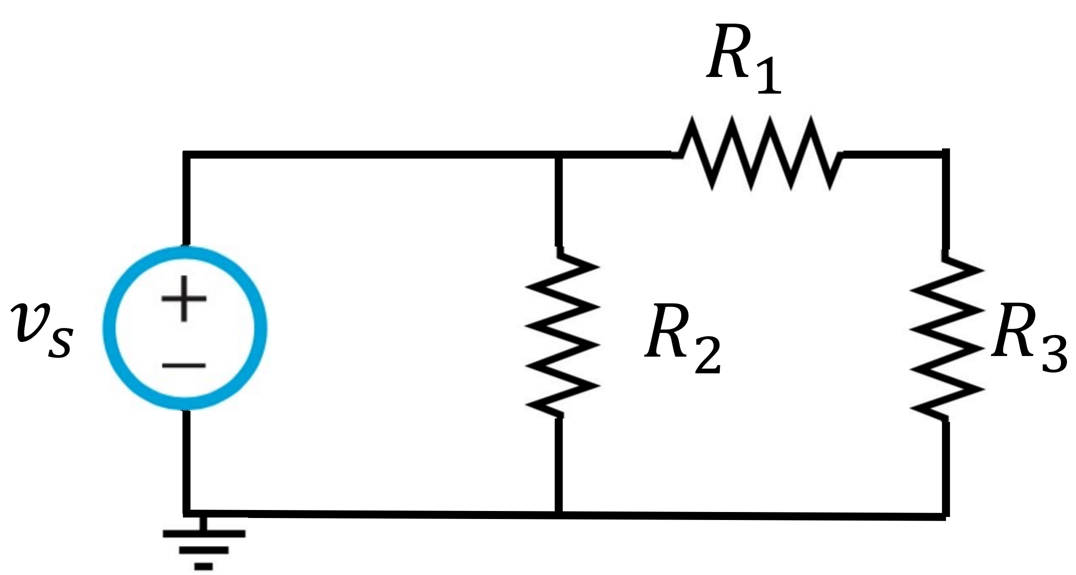
- Simplify analysis.
- Voltage and Current between 2 nodes do not change.

Series

$$R_{eq} = R_1 + R_2 + \ldots + R_n$$

Parallel

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

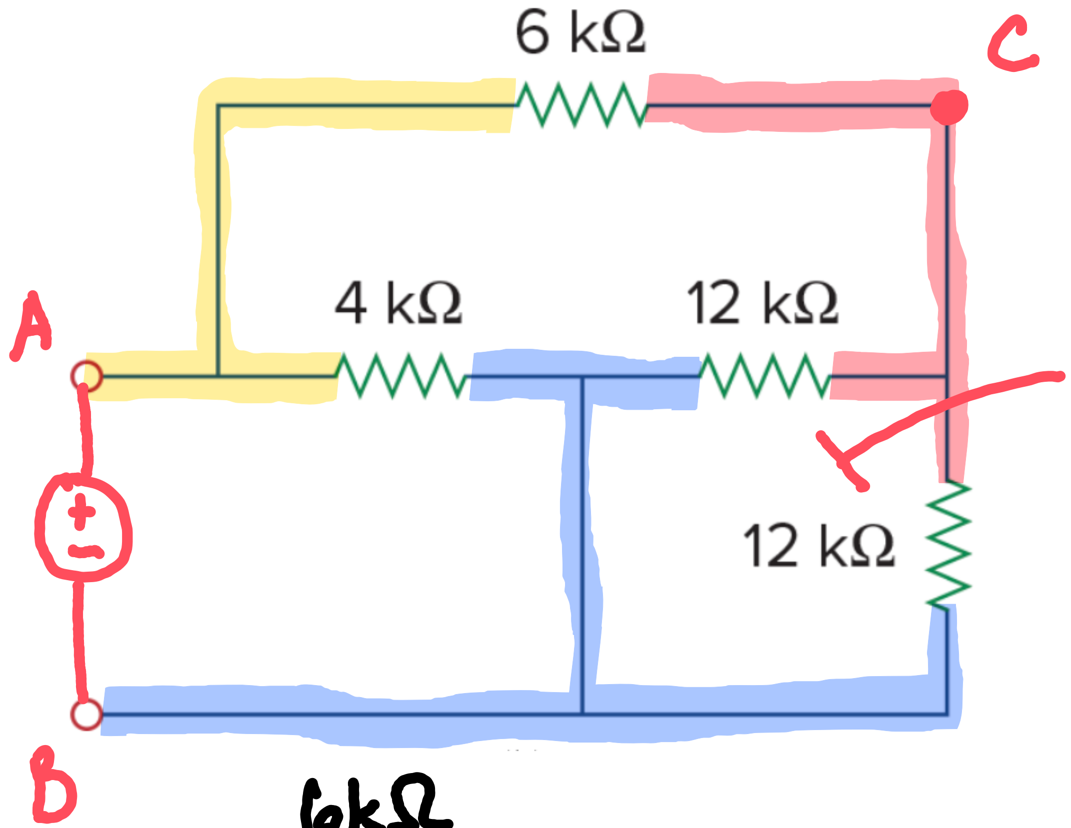


NOT in Series or Parallel

1. The current through all resistors is the same (series circuit condition).
2. The voltage across all resistors is the same (parallel circuit condition).

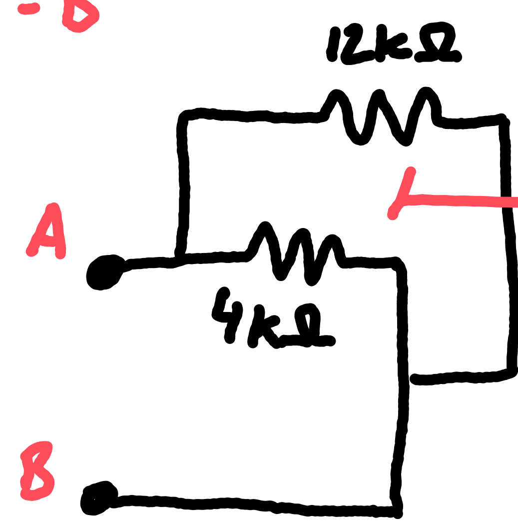
Example

Find R_{eq}



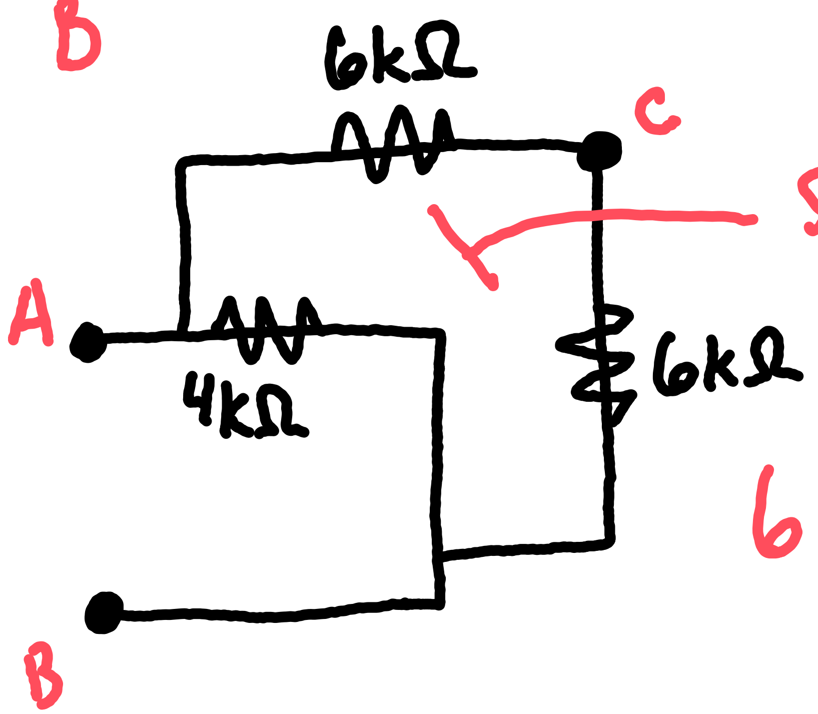
Parallel C - B

$$\frac{1}{\frac{1}{12}+\frac{1}{12}} = \frac{12}{2} = \boxed{6k\Omega}$$



Parallel A - B

$$\frac{1}{\frac{1}{4}+\frac{1}{12}} = \frac{1}{\frac{3+1}{12}} = \frac{1}{\frac{1}{3}} = \boxed{3k\Omega}$$

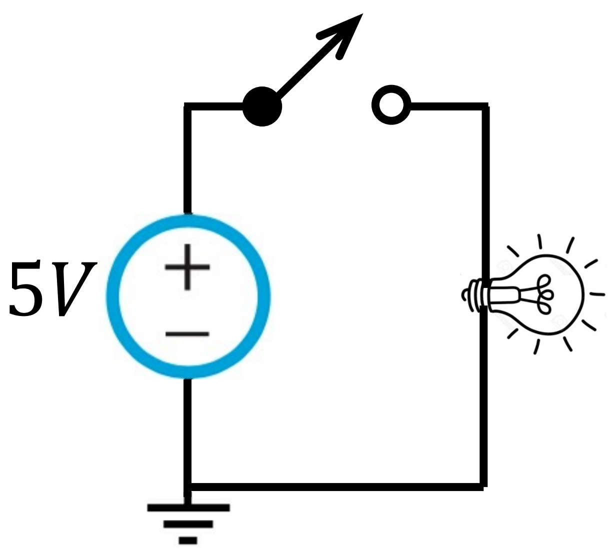


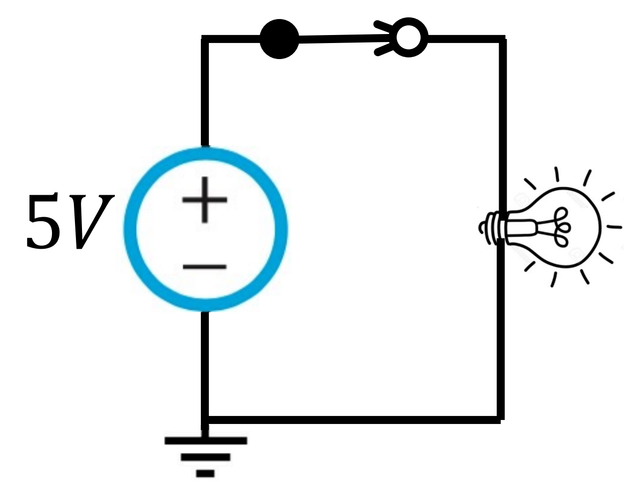
Series A - B

$6+6 = 12k\Omega$

Open and Closed Circuit

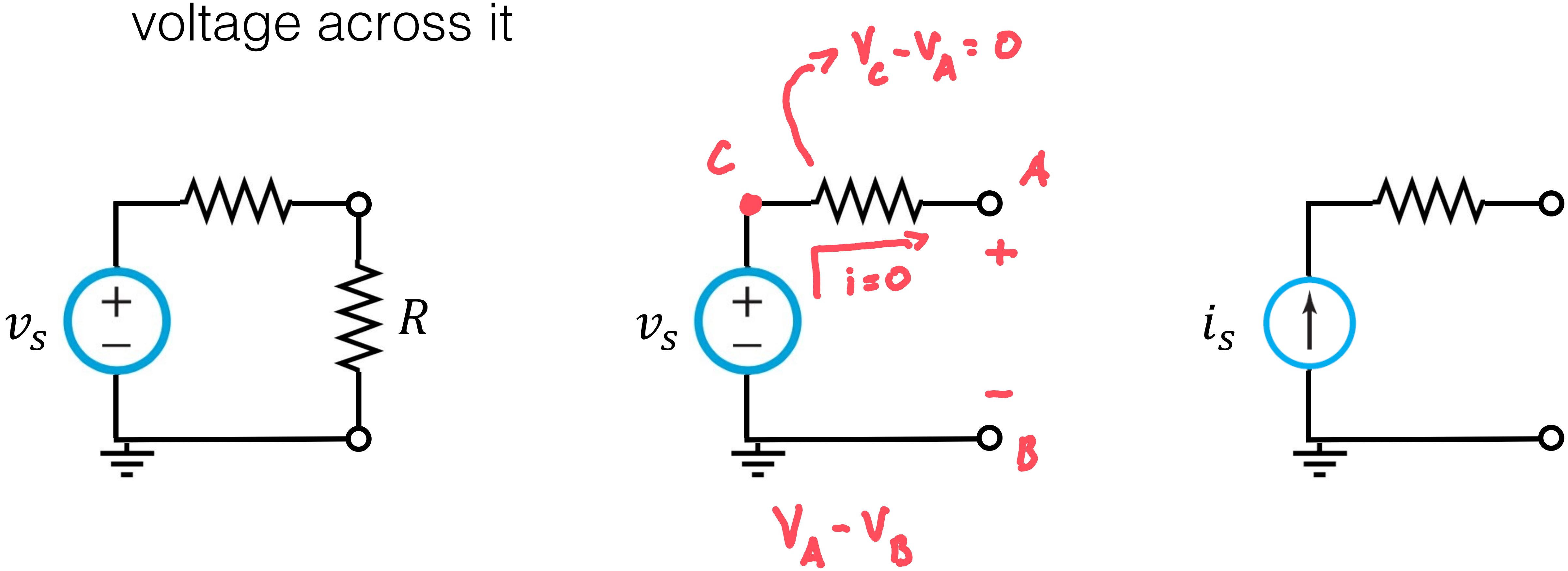
- You need a closed path, or closed circuit, to get electric current to flow.





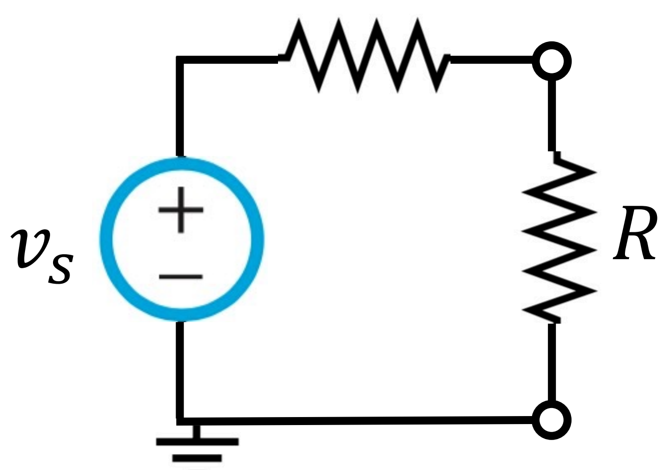
Open Circuit

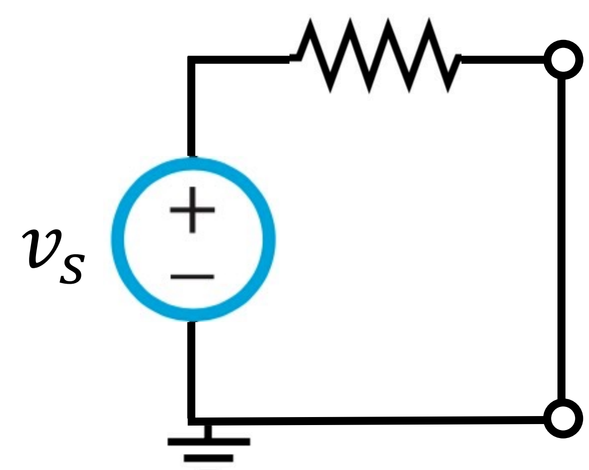
- An open circuit refers to the condition of path discontinuity (infinite resistance) between two points.
- No current can flow through an open circuit, regardless of the voltage across it



Short Circuit

- A **short circuit** constitutes the condition of complete path continuity (with zero electrical resistance) between two points.
- No voltage drop occurs across a short circuit, regardless of the magnitude of the current flowing through it.





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