Thévenin’s Theorem

YORK COLLEGE & UNIVERSITY CENTRE

What is Thévenin’s theorem

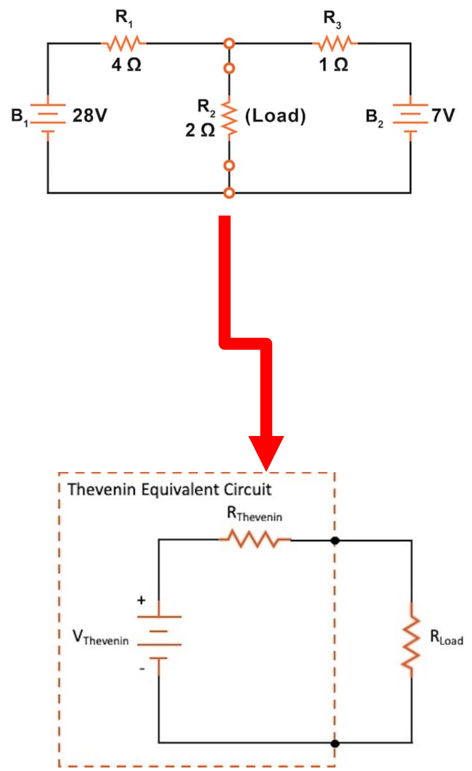
- Thévenin’s Theorem simplifies any **linear circuit into an equivalent circuit**.

- The equivalent circuit consists of:
  - A single **voltage source** (V_{th})
  - In series with a single **resistor** (R_{th}) as seen from the terminals of the load.

- This equivalent circuit is viewed from the terminals of the load resistor.

- It makes circuit analysis easier — especially when testing different load values.

- Commonly used to:
  - Simplify complex networks
  - Analyse load current, voltage, and power efficiently



How to find the $(\boldsymbol{V_{th}})$ and $(\boldsymbol{R_{th}})$

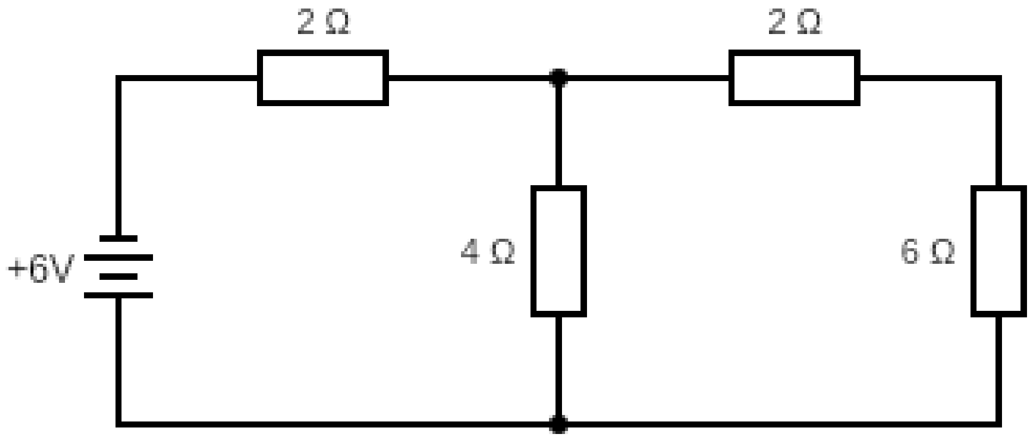
- **To find (V_{th}) (Open-Circuit Voltage)**
  - Remove the load resistor from the circuit.
  - Measure or calculate the voltage across the open terminals — this is (V_{th}).
  - All sources remain active (voltage and current sources stay connected).

- **To find (R_{th}) (Equivalent Resistance)**
  - Remove the load resistor.
  - Turn off all independent sources:
    - Replace voltage sources with short circuits (0 V).
    - Replace current sources with open circuits (0 A).
  - Then, calculate the total resistance seen from the load terminals.

Example

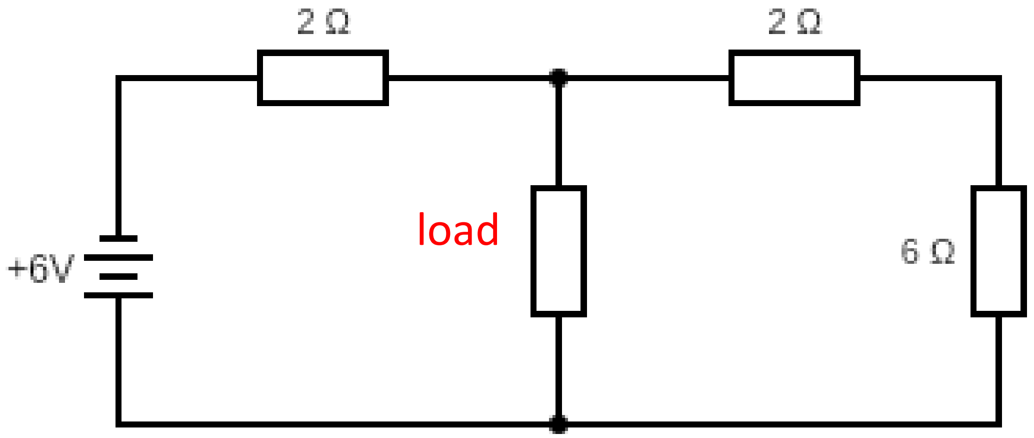
- Our first step is to decide which resistor is our load (often this is given to us but not always)

- For this we are using the 4-ohm resistor as our load



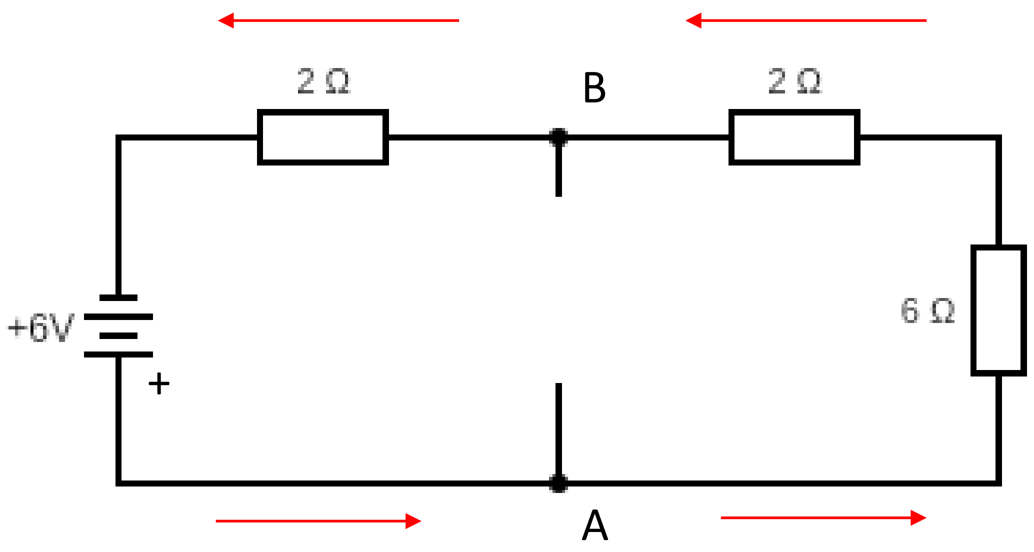
Example

- We will start by working out our (V_{th})
- To do this we must keep the voltage source and other components and just remove the load
- Then we will work out the voltage at both terminals



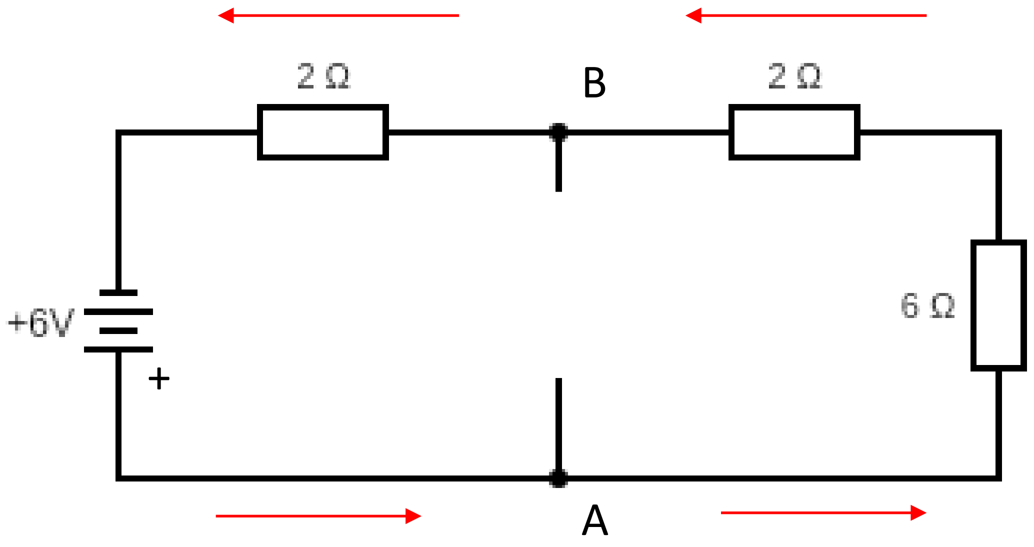
Example

- So we have first have to work out the current through the circuit
- We can do so by working out the total resistance (2+2+6)=10
- Then we can work out $I = \frac{V}{R}$
- $\frac{6}{10} = 0.6A$



Example

- $\frac{6}{10} = 0.6A$
- So now we can work out our voltages
- At A we have 6v as there is no drop yet
- At B we have $6 - 6 * 0.6 - 2 * 0.6 = 1.2$v
- So the voltage between A and B is $6 - 1.2 = 4.8$

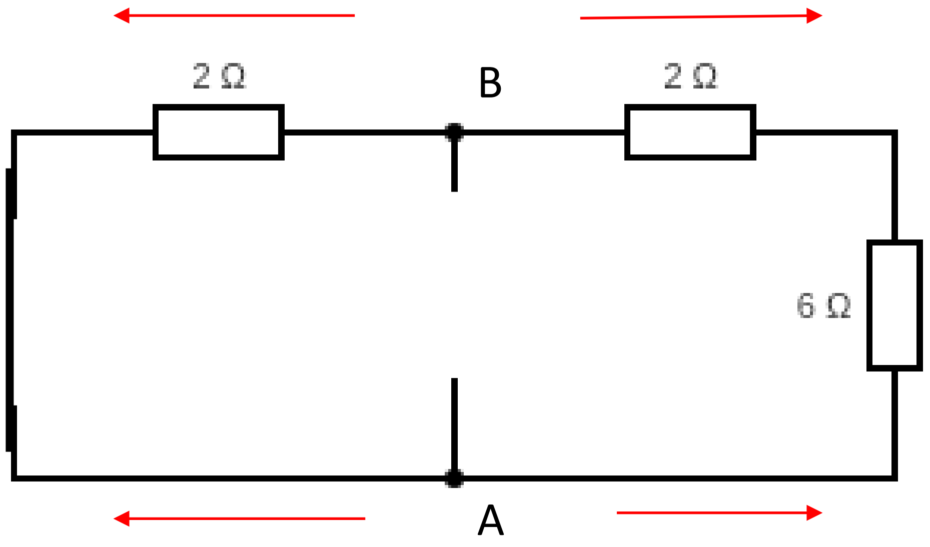


Example

- Next we need to work out the equivalent resistance, so we also treat the voltage source as a wire

- So for this circuit we have two parallel circuits

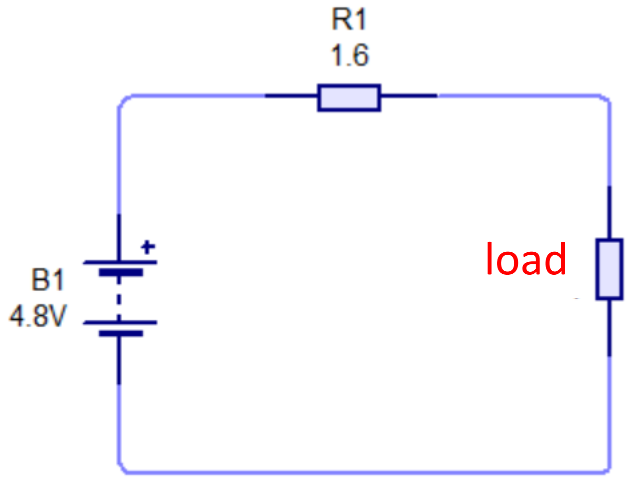
- $R_{th} = \frac{1}{\frac{1}{2}+\frac{1}{2+6}} = 1.6$

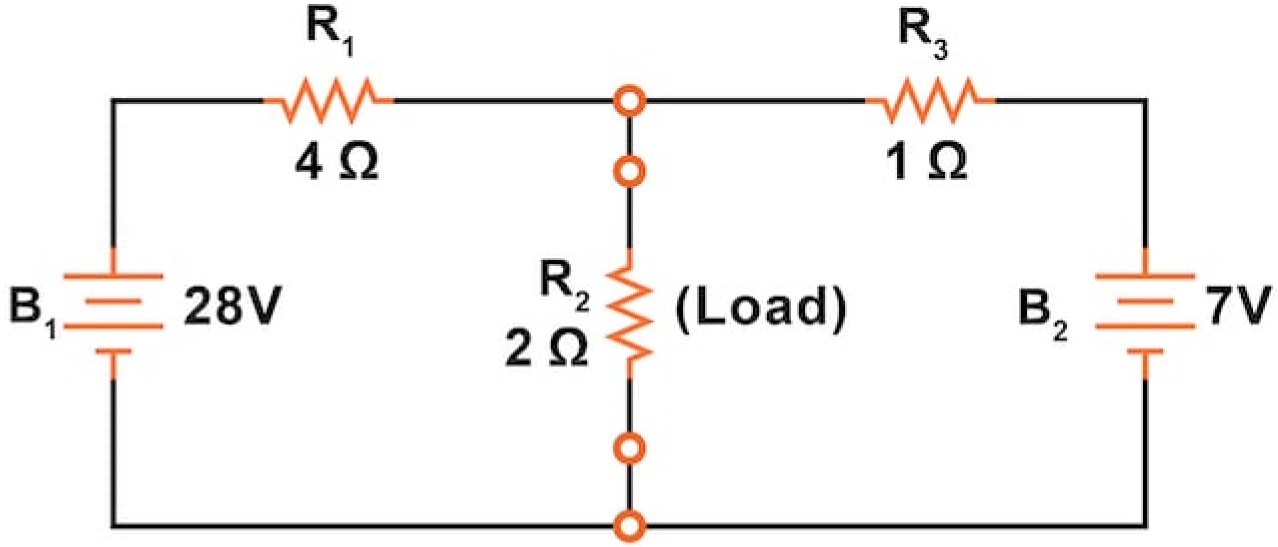


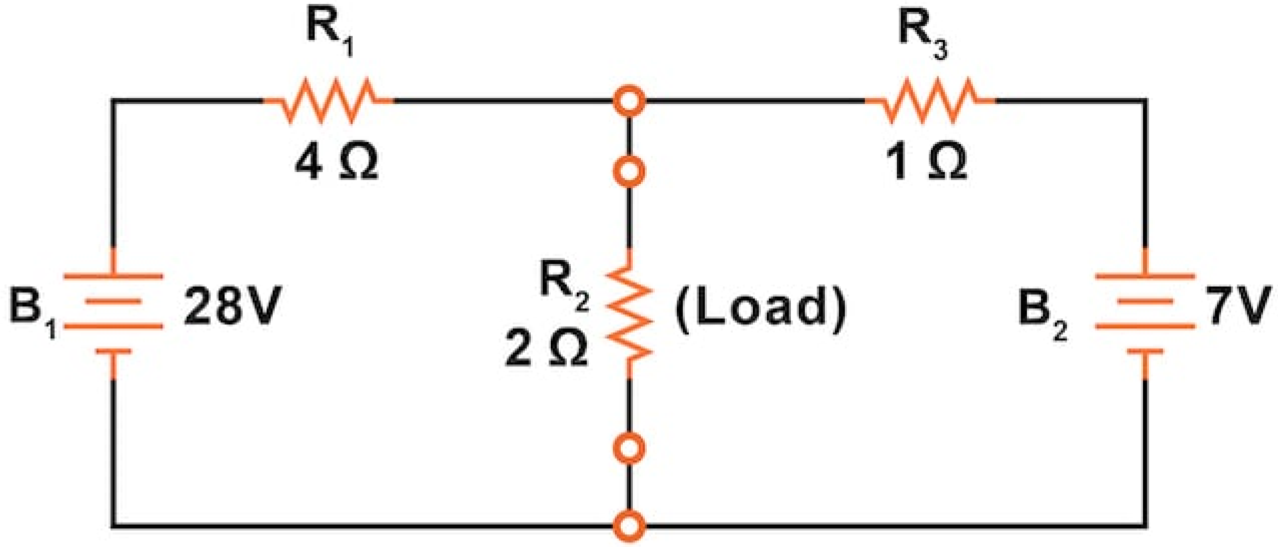
Example

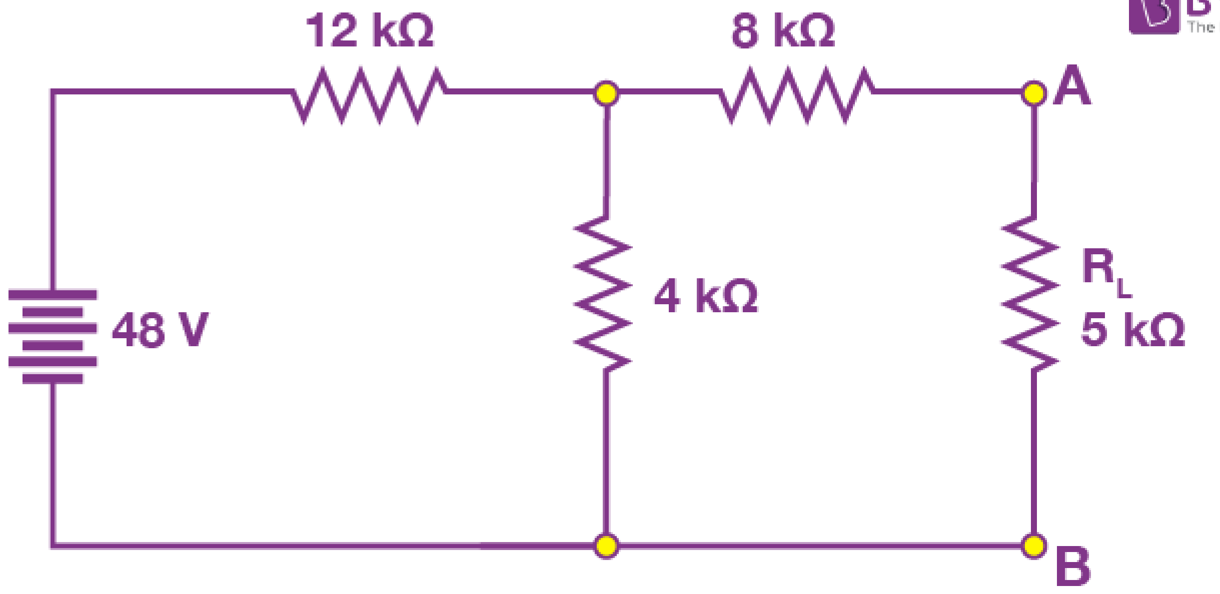
- Finally, we can draw our equivalent circuit

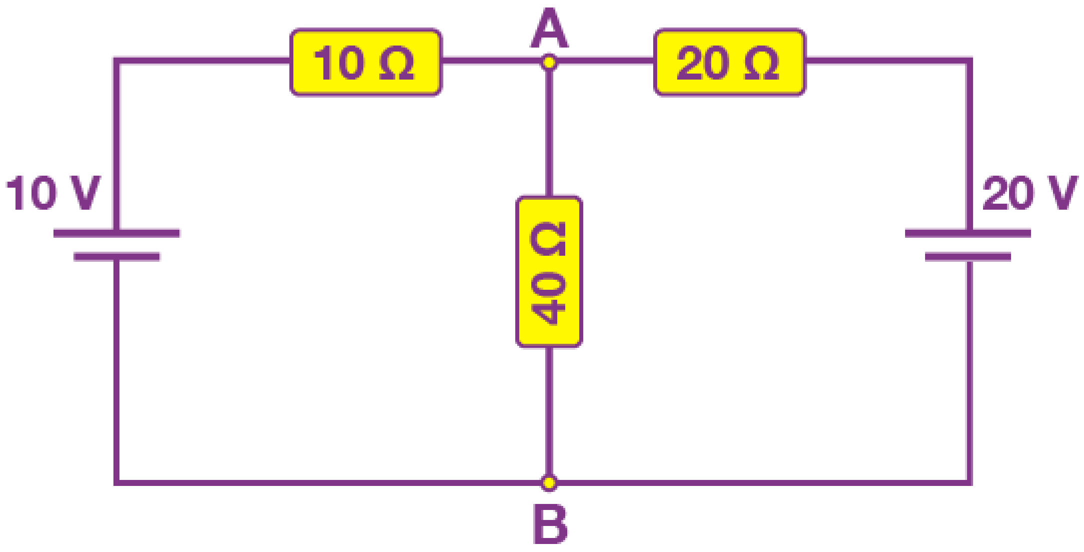
- With our values we just worked out




R1
4 Ω
R3
1 Ω
B1
28V
R2
2 Ω
(Load)
B2
7V


R1
4 Ω
R3
1 Ω
B1
28V
R2
2 Ω
(Load)
B2
7V


12 kΩ
8 kΩ
A
48 V
4 kΩ
R_L
5 kΩ
B



10 Ω
A
20 Ω
10 V
40 Ω
20 V
B