# SNS COLLEGE OF TECHNOLOGY

**An Autonomous Institution**

**Coimbatore-35**

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai


## DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

## 23ECB101-CIRCUIT ANALYSIS AND DEVICES

I YEAR/ II SEMESTER

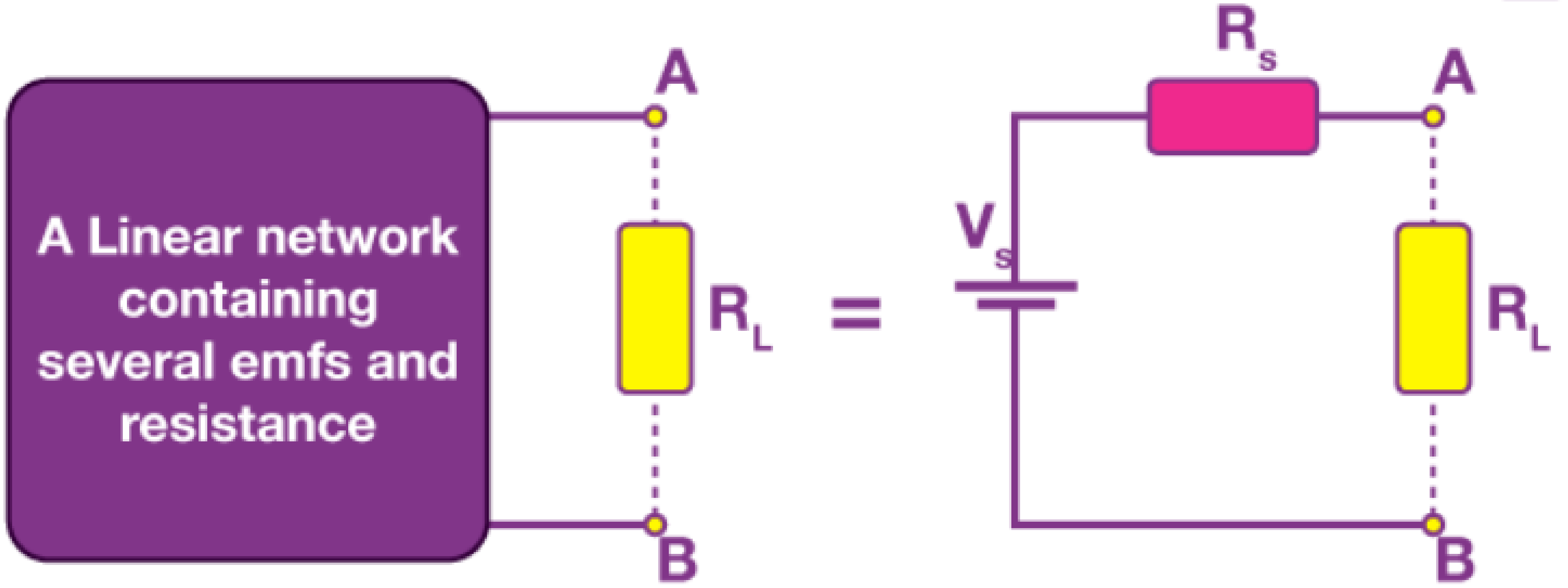
## UNIT 2 – NETWORK THEOREMS AND SOURCE TRANSFORMATION

TOPIC – THEVENIN THEOREM

# Thevenin theorem

- Most commonly, we use Ohm’s law, Kirchhoff’s law to solve complex electrical circuits, but we must also be aware that there are many circuit analysis theorems using which we can calculate the current and voltage at any given point in a circuit.
- Among the various circuit theorems, Thevenin’s theorem is most commonly used.
- Thevenin’s theorem states that it is possible to simplify any linear circuit, irrespective of how complex it is, to an equivalent circuit with a single voltage source and a series resistance.

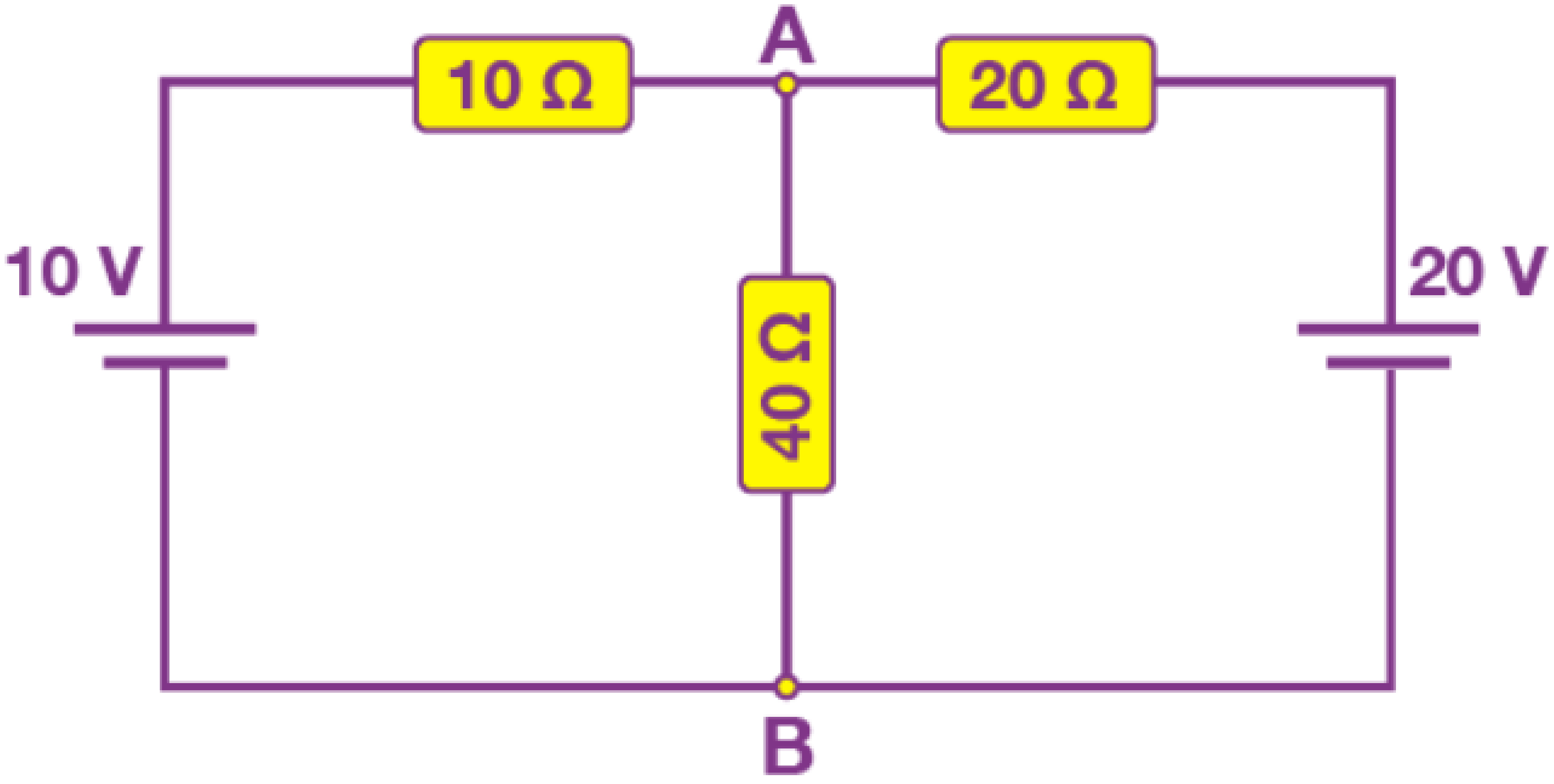
# Thevenin theorem




A Thevenin equivalent circuit is shown in the image. In the image, we see that multiple resistive circuit elements are replaced by a single equivalent resistance $R_s$ and multiple energy sources by an equivalent voltage source $V_s$.

# Thevenin theorem

Example:



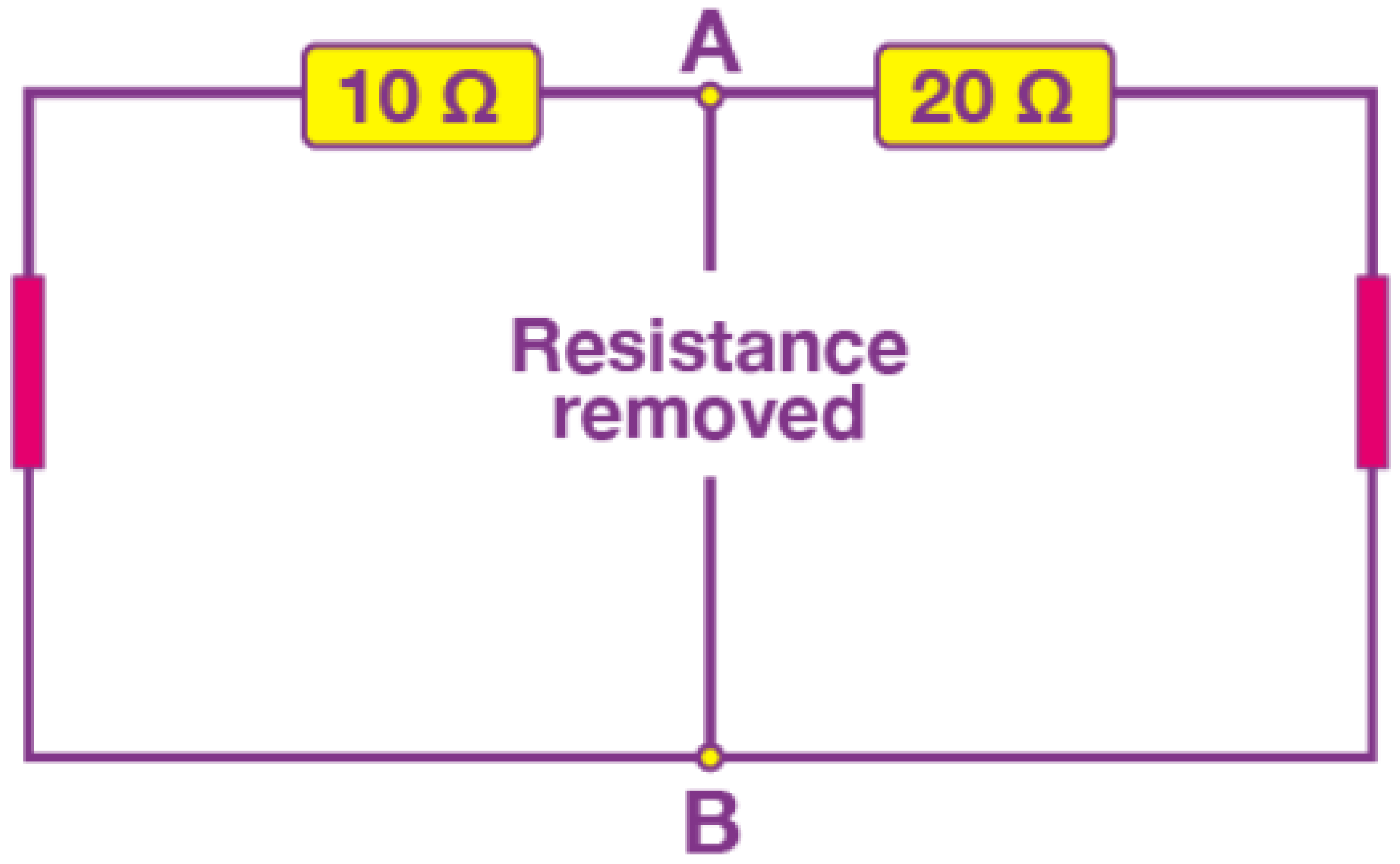
# Thevenin theorem

**Step 1:** For the analysis of the above circuit using Thevenin's theorem, firstly remove the load resistance at the centre, in this case, 40 Ω.

**Step 2:** Remove the voltage sources' internal resistance by shorting all the voltage sources connected to the circuit, i.e. v = 0. If current sources are present in the circuit, then remove the internal resistance by open circuiting the sources. This step is done to have an ideal voltage source or an ideal current source for the analysis.

# Thevenin theorem

**Step 3:** Find the equivalent resistance. In the example, the equivalent resistance of the circuit is calculated as follows:



# Thevenin theorem

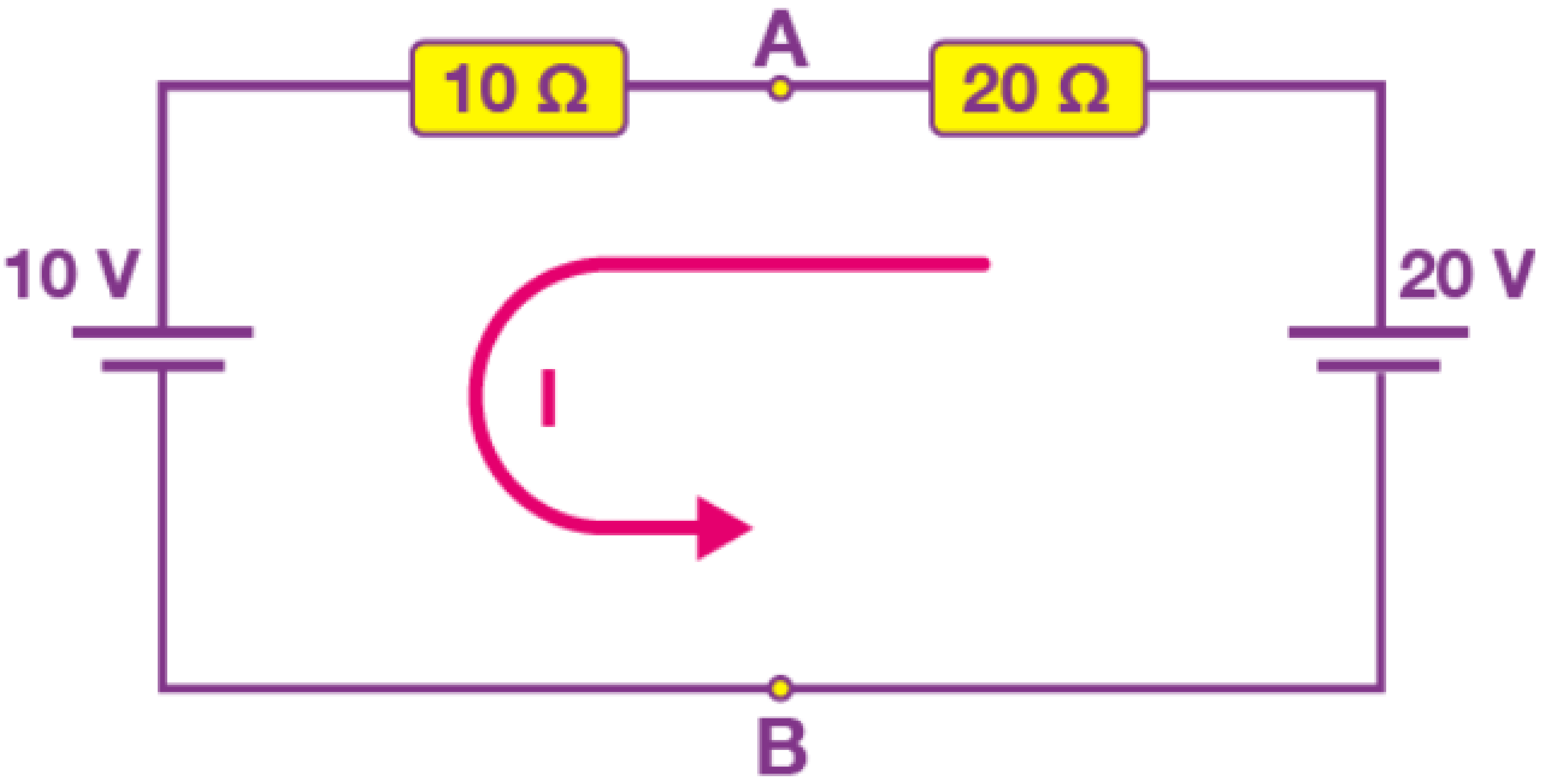
With the load resistance removed and the voltage sources shorted, the equivalent resistance of the circuit is calculated as follows:

The resistor 10 Ω is parallel to 20 Ω, therefore the equivalent resistance of the circuit is:

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{20 \times 10}{20 + 10} = 6.67\,\Omega$$

# Thevenin theorem

**Step 4:** Find the equivalent voltage.



# Thevenin theorem

To calculate the equivalent voltage, reconnect the voltage sources back into the circuit.

$V_s = V_{AB}$, therefore the current flowing around the loop is calculated as follows:

$$I = \frac{V}{R} = \frac{20\,V - 10\,V}{20\,\Omega + 10\,\Omega} = 0.33\,A$$

The calculated current is common to both resistors, so the voltage drop across the resistors can be calculated as follows:

$V_{AB} = 20 - (20\,\Omega \times 0.33\,A) = 13.33\,V$

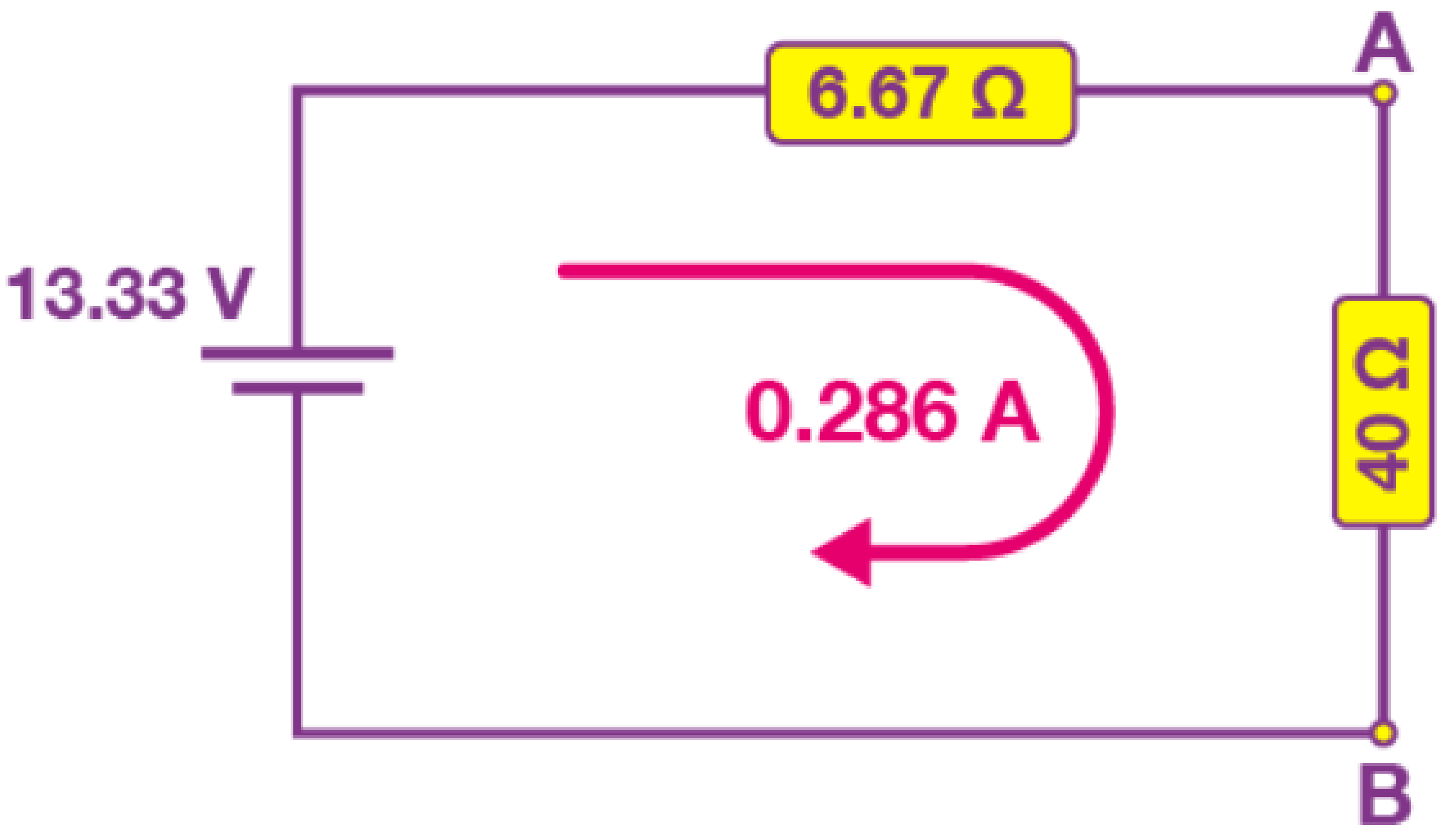
or,

$V_{AB} = 10 + (10\,\Omega \times 0.33\,A) = 13.33\,V$

The voltage drop across both resistors is the same.

# Thevenin theorem

**Step 5:** Draw the Thevenin's equivalent circuit. The Thevenin's equivalent circuit consists of a series resistance of 6.67 Ω and a voltage source of 13.33 V.



# Thevenin theorem

The current flowing in the circuit is calculated using the formula below:

$$I = \frac{V}{R} = \frac{13.33\ V}{6.67\ \Omega + 40\ \Omega} = 0.286\ A$$

Thevenin's theorem can be applied to both AC and DC circuits. But it should be noted that this method can only be applied to AC circuits consisting of linear elements like resistors, inductors, capacitors. Like Thevenin's equivalent resistance, Thevenin's equivalent impedance is obtained by replacing all voltage sources with their internal impedances.

# THANK YOU