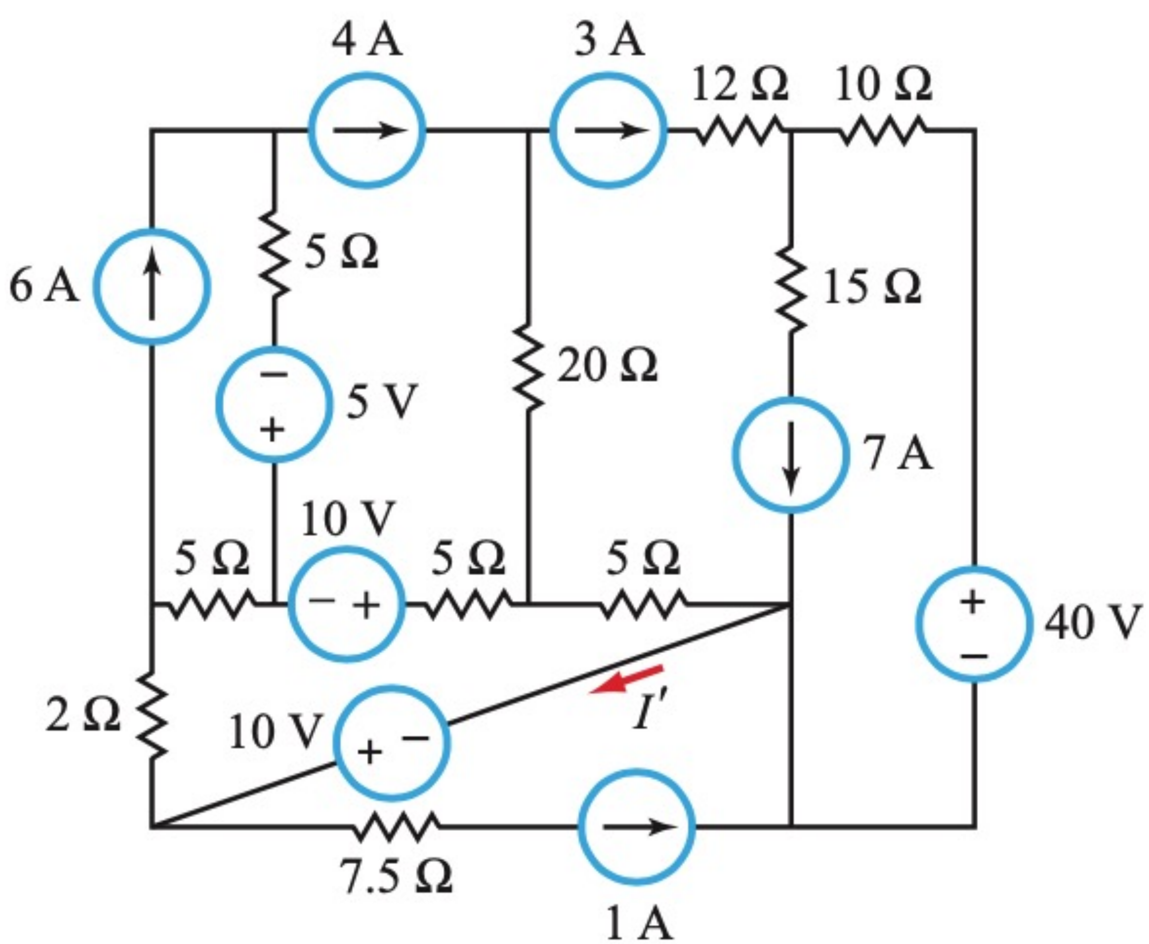
Last Class…

1. Identify the number of nodes and meshes in the circuit below.



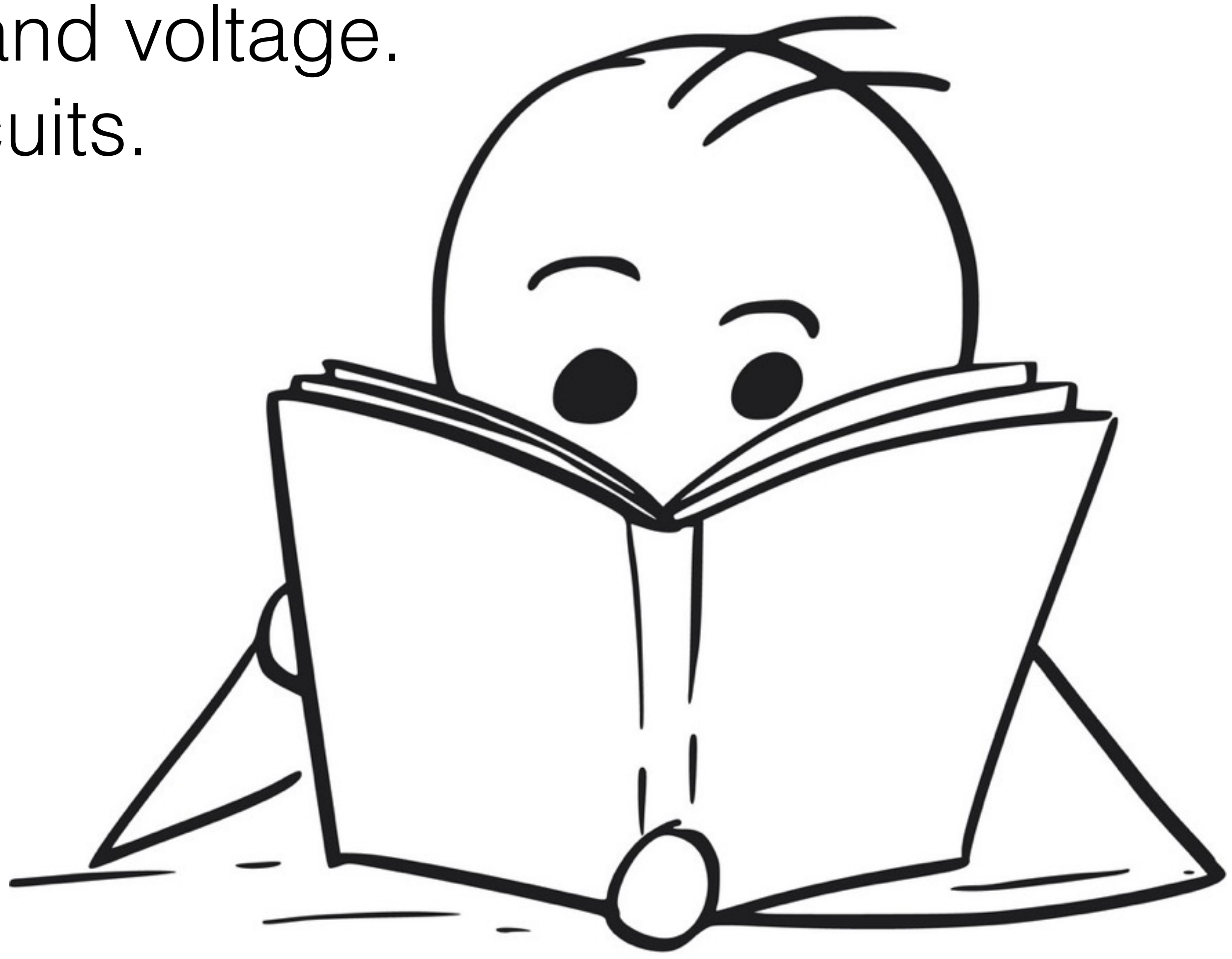
THE OHIO STATE UNIVERSITY

COLLEGE OF ENGINEERING

Resistors and Kirchhoff's Laws

Today…

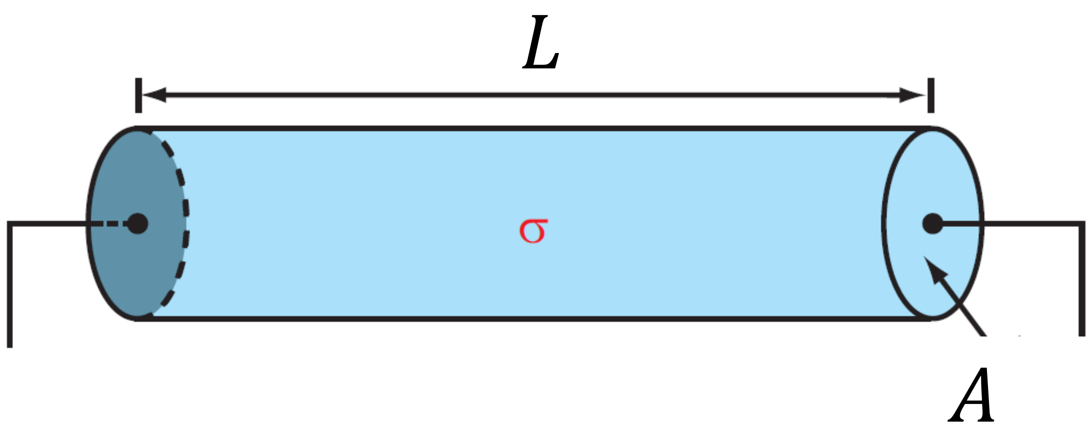
- Learning Objectives:
  - Understand the i–v characteristic across a resistor.
  - Apply Ohm's Law.
  - Apply Kirchhoff's current and voltage. laws to simple electric circuits.



Resistance

- Wires are typically made of metal (silver, copper, gold).
  - High conductivity (σ)
  - Low resistivity (ρ)

electrons can move easily between conduction bands



$$R = \rho \frac{L}{A}$$

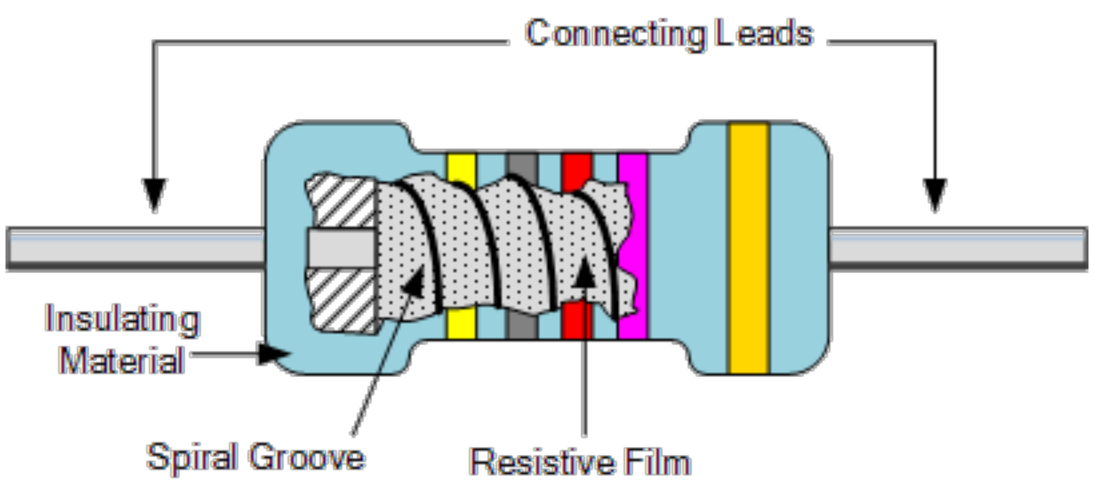
length

cross-sectional area

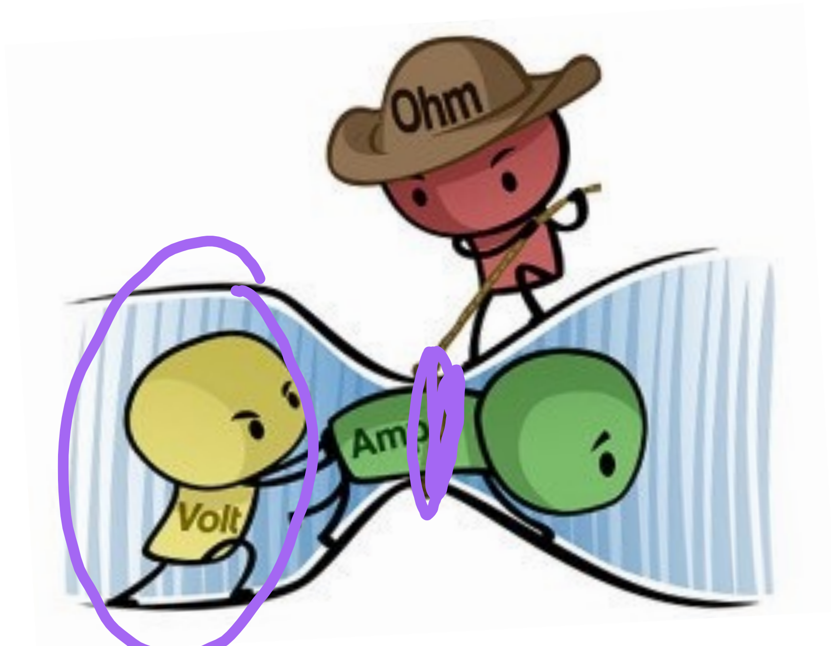
wider shorter wires have less resistance

- In circuits: resistance is the ability to resist flow of electric current.

Resistors



A



B

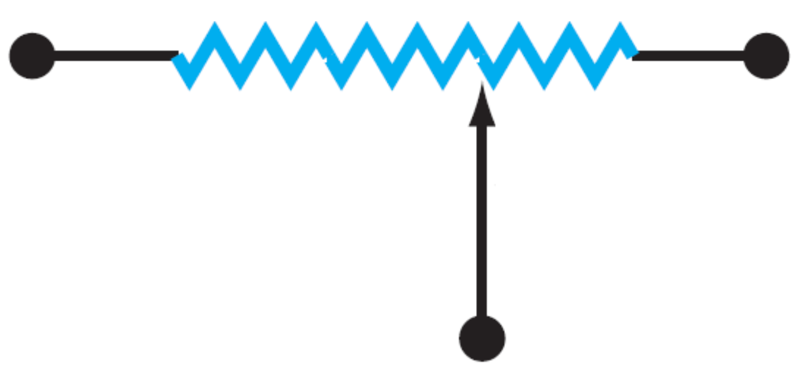
circuit symbol

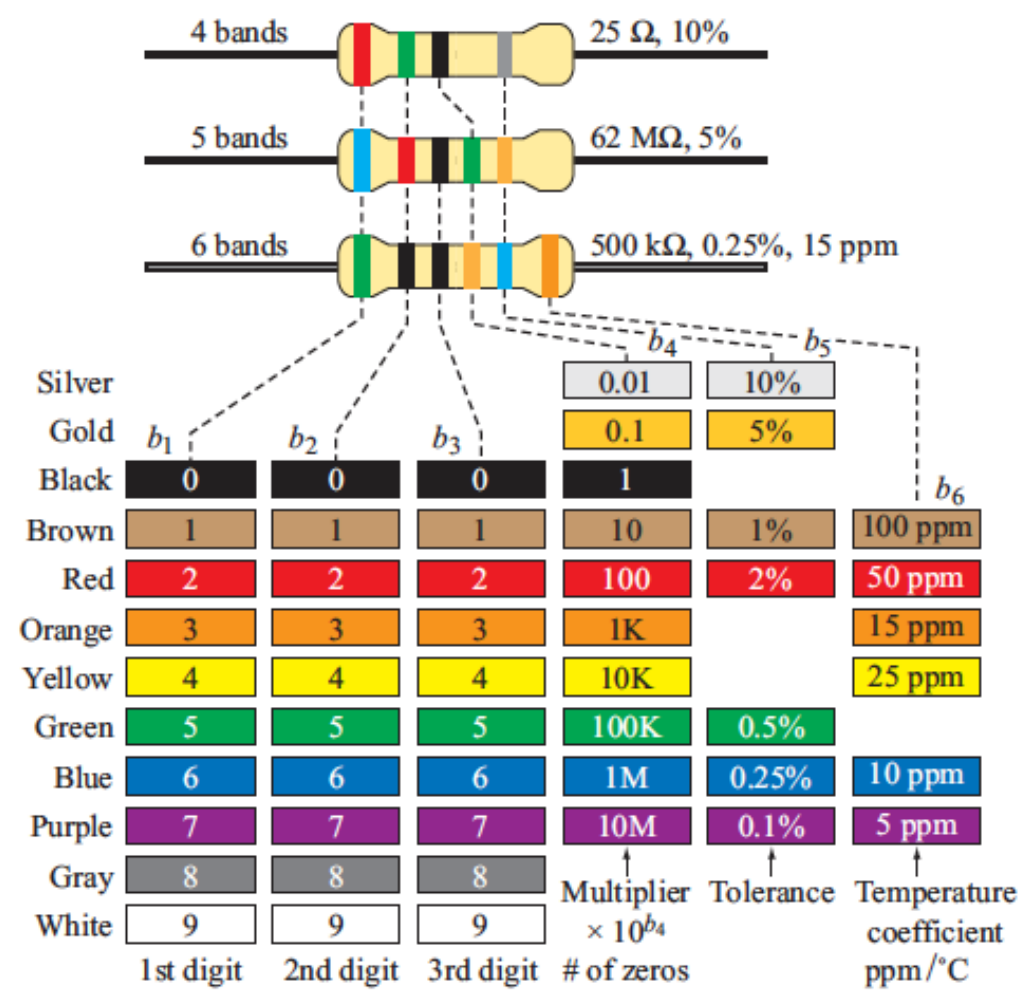
complicated path for electrons flow

Resistors

- Typical Resistor: “wire-wound”
  - wire wrapped around ceramic core.
  - more wraps = more length = higher resistance

- Variable Resistor: potentiometer or rheostat
  - turn a knob and changes the effective length



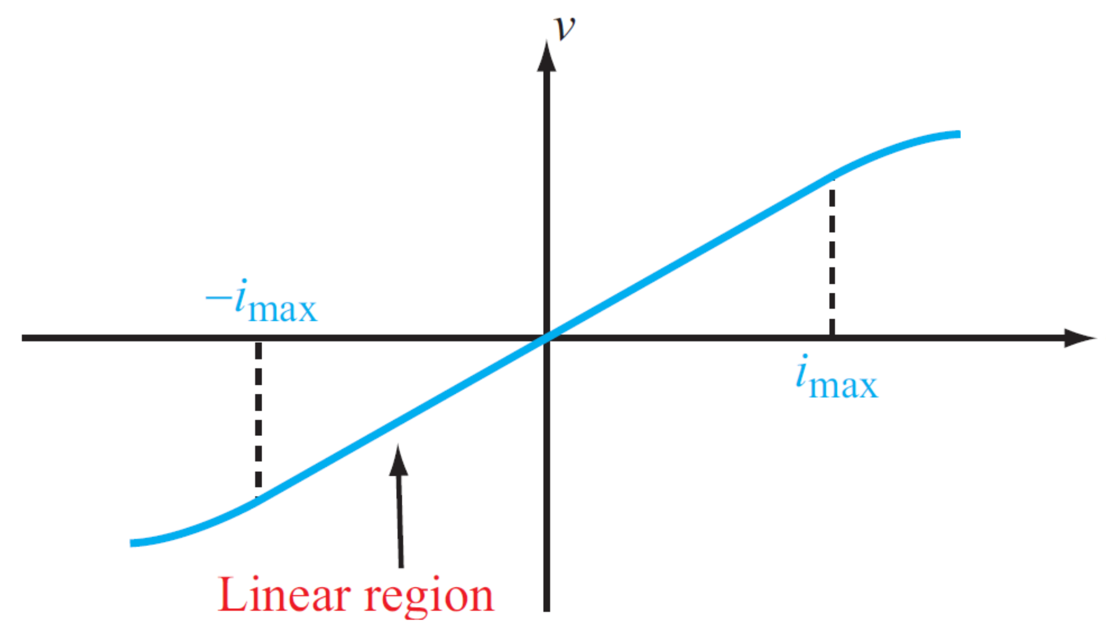


4-, 5-, and 6-band color code system

Resistors

Ohm's Law:

- Linear relationship does not apply over large ranges of voltage or current.



- Empirical relationship given by:

$$v = iR$$

- Recall that:

$$R = \frac{v}{i} = \left[\frac{V}{A}\right] = [\Omega]$$

ohm's

Kirchhoff's Current Law (KCL)

- The sum of the currents at a node must equal zero.

$$\sum_{\ell=1}^{N} i_\ell = 0$$

- Principle: charge cannot be created but must be conserved.

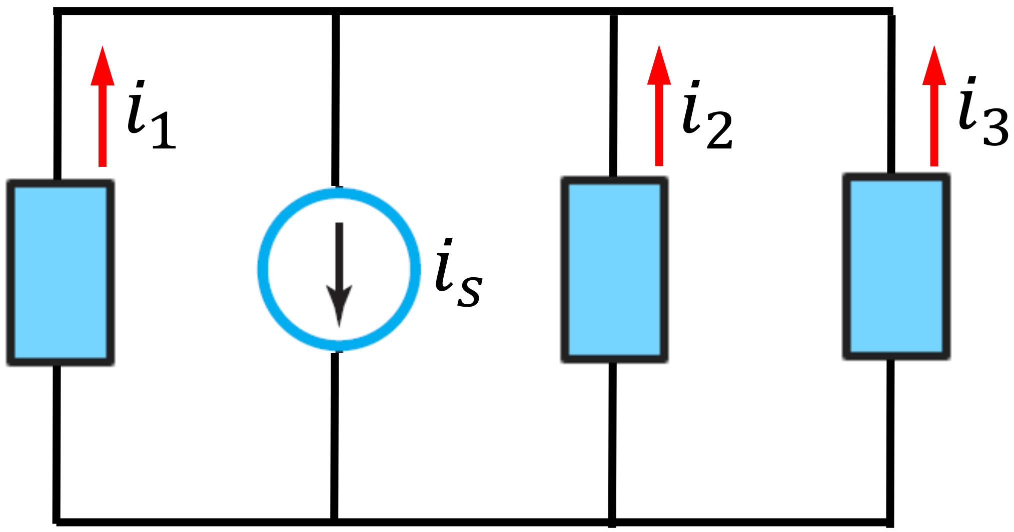
Pick a convention:

- in = positive and out = negative.

or

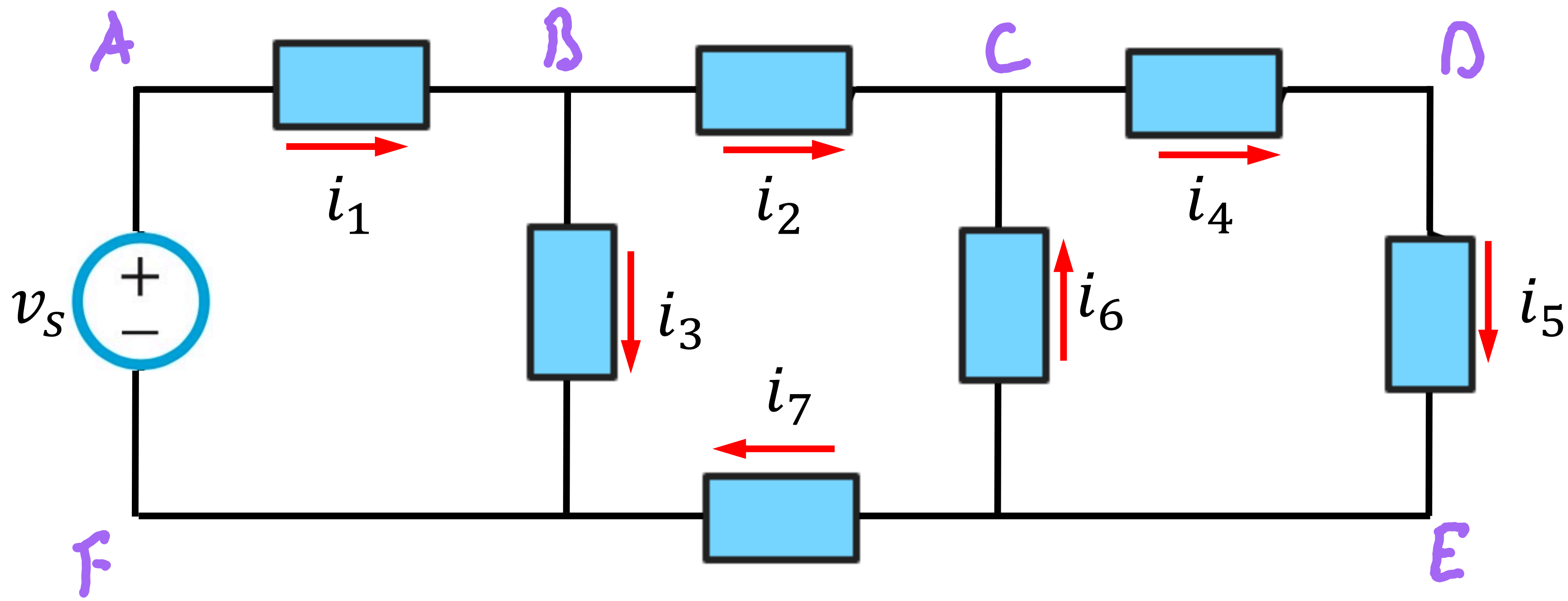
- in = negative and out = positive.

$$\sum i_{in} = \sum i_{out}$$



Test Your Knowledge

How many nodes can you identify in the circuit below?
KCL on node 3?



KCL @ C

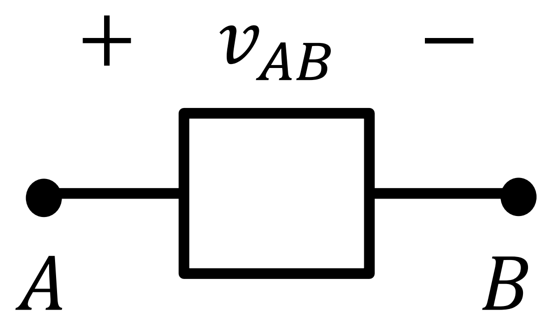
$i_2 + i_6 = i_4$

KCL @ F

$i_3 + i_7 = i_5$

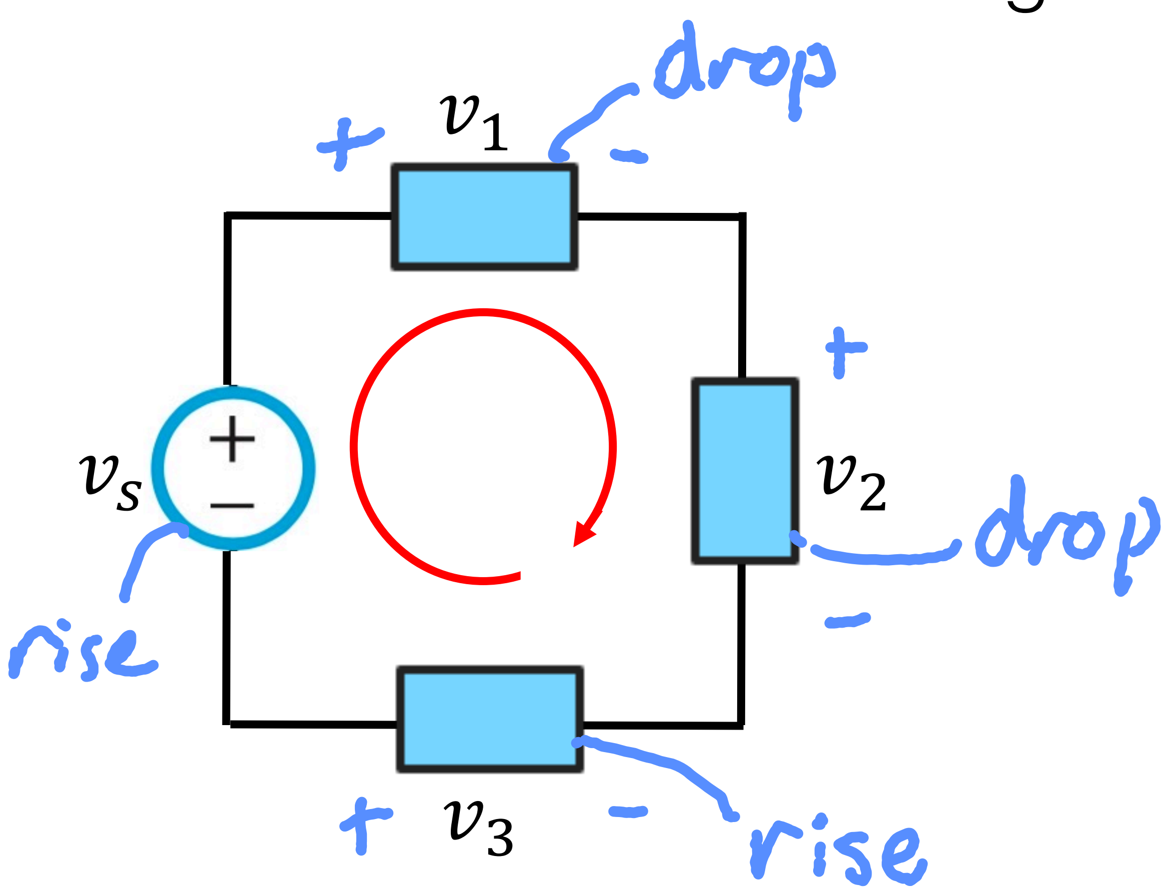
Voltage Rise and Voltage Drop

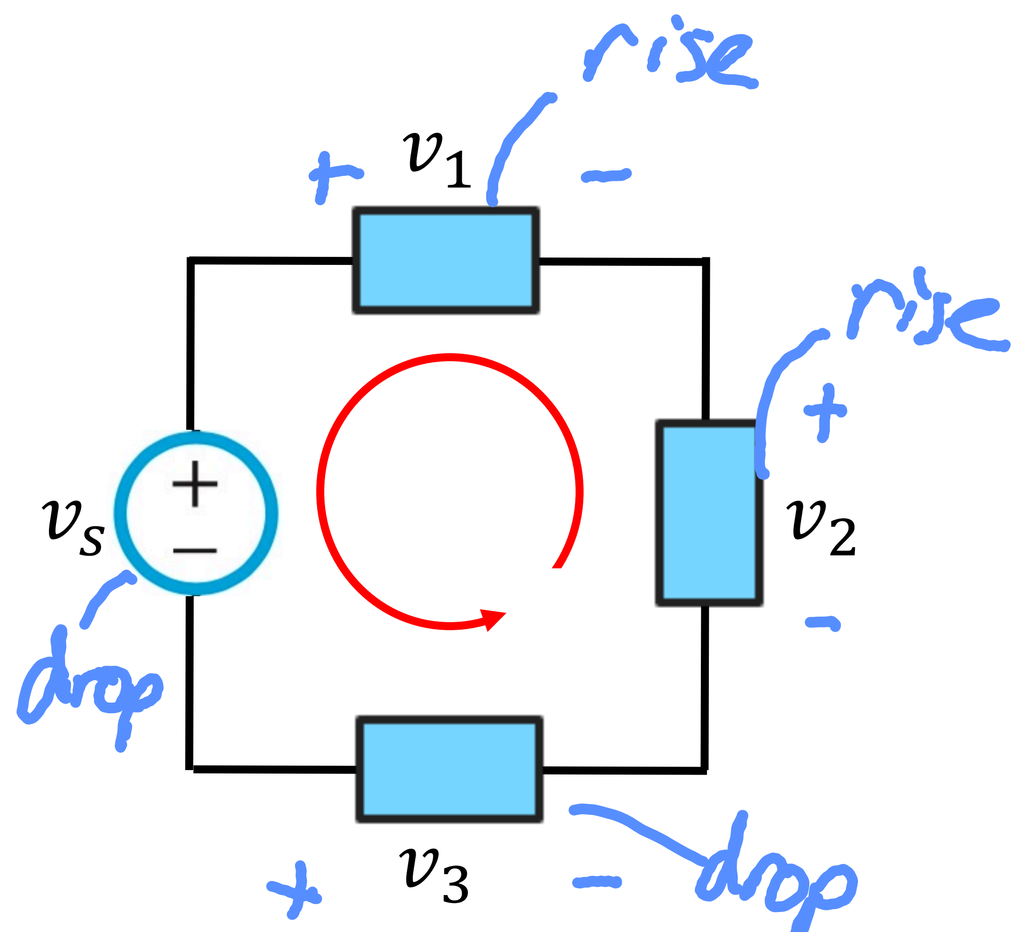
Assume that $v_A > v_B$



- Moving: $A \rightarrow B$ is a voltage drop

  $B \rightarrow A$ is a voltage rise





Kirchhoff's Voltage Law (KVL)

@ mesh or loop

- The net voltage around a close loop is zero.

$$\sum_{\ell=1}^{N} v_\ell = 0$$

- Principle: no energy is lost or created in an electric circuit.

Pick a convention:

$V_s - V_1 - V_2 - V_3 = 0$

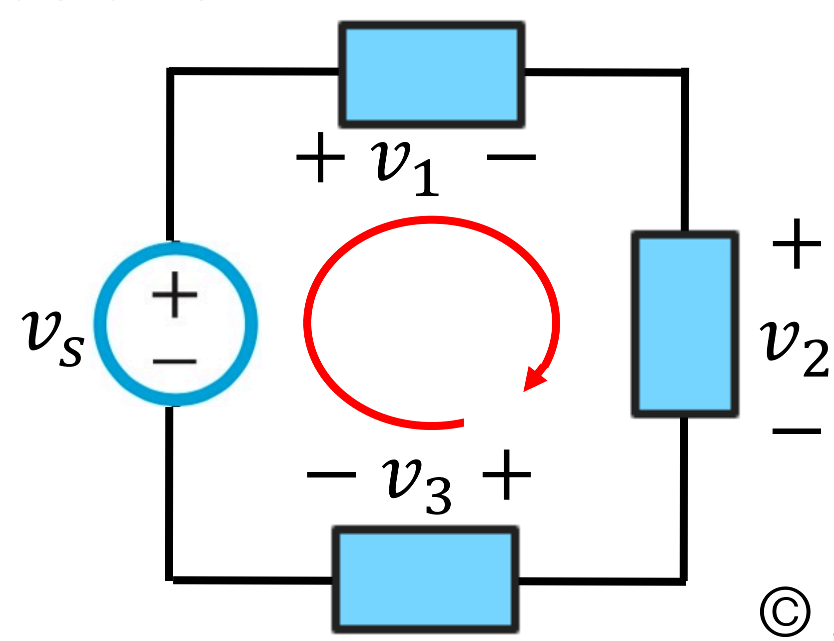
- $rise$ = positive and $drop$ = negative.

$V_1 + V_2 + V_3 - V_s = 0$

or

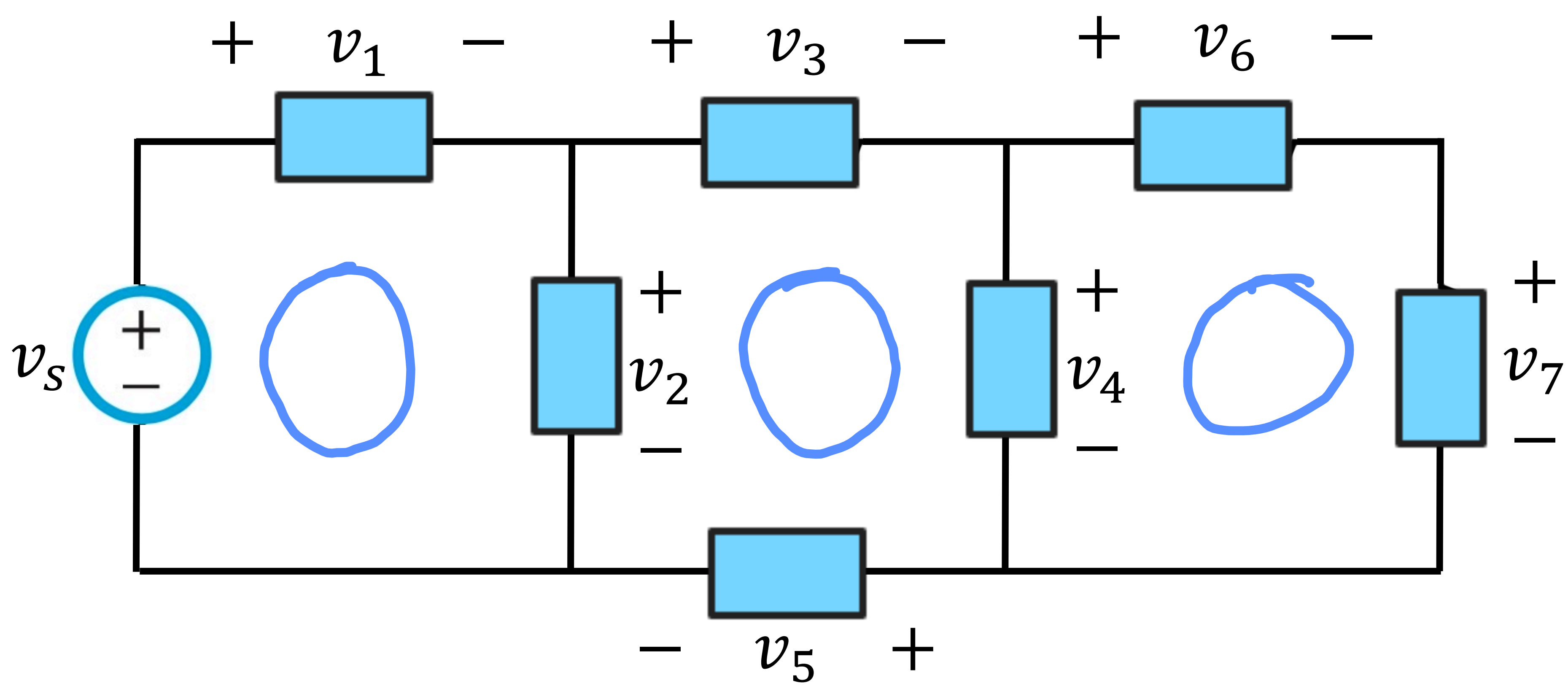
- $rise$ = negative and $drop$ = positive.

$$\sum v_{rise} = \sum v_{drop}$$



Test Your Knowledge

How many meshes can you identify in the circuit below?
KVL on mesh 2?

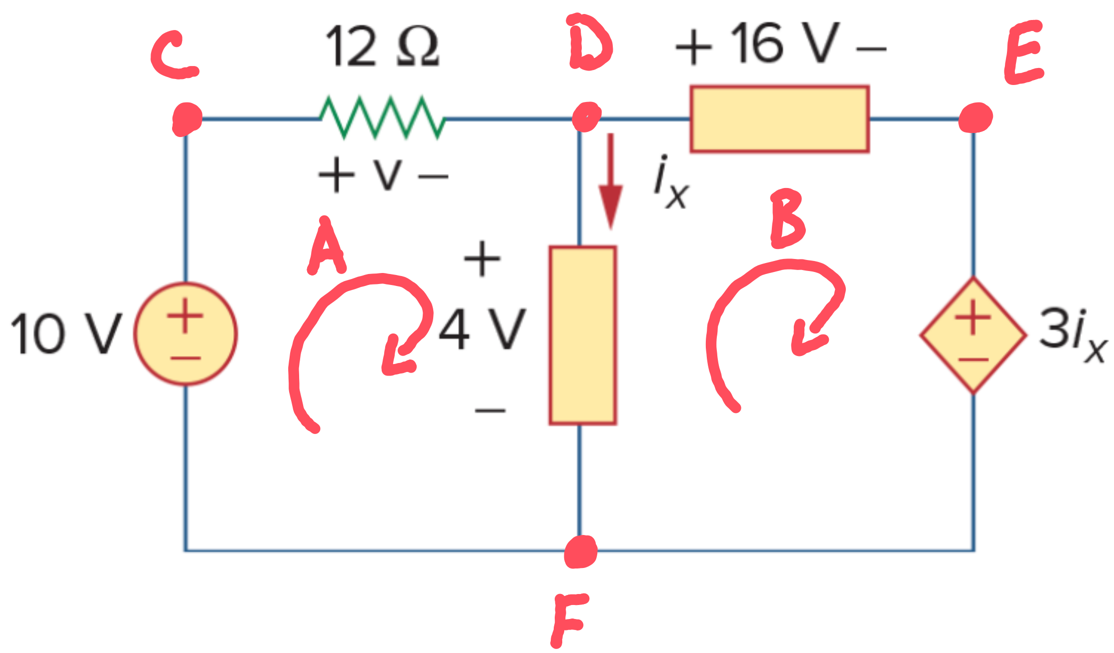


KVL 2

$V_3 + V_4 + V_5 - V_2 = 0$

Example

Calculate v and i_x in the circuit below



KVL@B:

$16 + 3i_x - 4 = 0$

$i_x = -4A$

KVL@A:

$4 - 10 + V = 0$

$V = 6V$

$i_{12} = \frac{6}{12} = 0.5A$