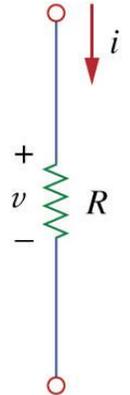


Lesson 2: Ohm's Law, KCL, and KVL

Ohm's law

Georg Simon Ohm (1787-1854) investigated the relation between voltage and current in materials of different lengths and thicknesses.

Ohm discovered that the _____ across a resistor is _____ to the _____ flowing through the resistor.



Ohm defined the constant of proportionality to be the _____ R .
Thus, Ohm's law is given

$$v =$$

The resistance (R) of an element denotes its ability to _____ the flow of electric current. It is measured in _____ (_____).

$$R =$$

Passive sign convention

Recall that resistors are _____ elements, not capable of supplying power.

Resistors must comply with the passive sign convention, thus current must flow from _____ to _____ potential..

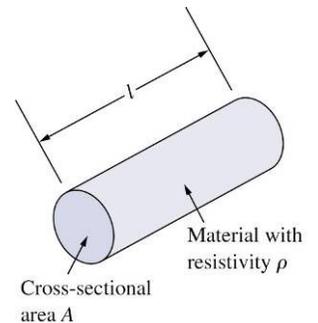
Resistivity

For a resistor with cross-sectional area A and length ℓ , the resistance R is given

$$R =$$

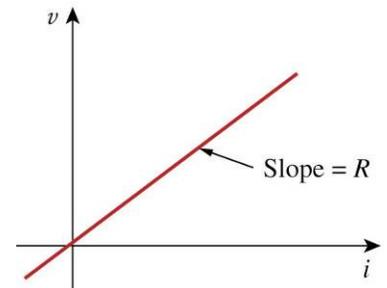
where ρ is the resistivity in ohm-meters.

Resistivity is a material property and a function of _____.



Visualizing resistance

Graphically, resistance is simply the slope of the plot of voltage vs. current.

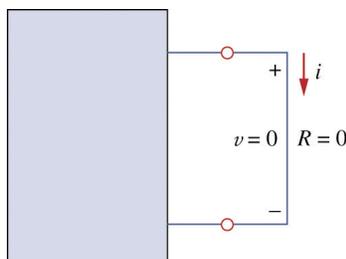


Short circuit

If $R = ___ \Omega$, then $v = iR = 0$.

A _____ circuit is a circuit element with resistance approaching zero.

In practice we consider connecting wires to be perfect conductors or short circuits.

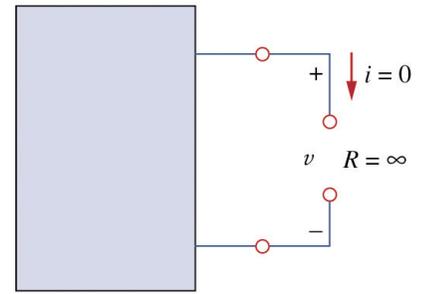


Open circuit

If $R = \infty$, then $i =$

An _____ circuit is a circuit element with resistance approaching infinity.

The current through any open circuit is zero but the voltage could be _____.



Types of resistors

Two main categories of resistors are _____ and _____.

Fixed resistors have an essentially constant value of resistance.

Types

- Molded carbon composition – cheap, large variations
- Metal film, metal oxide – precision
- Wire-wound – high _____ dissipation
- Integrated circuit - miniature



Variable resistors

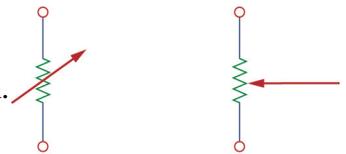
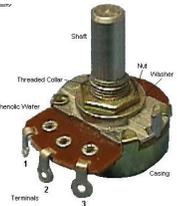
Variable resistors have an adjustable value of resistance and have two principle functions

- _____ (pots) are used to adjust voltage.
- Rheostats are used to adjust current.

Variable resistors have three terminals.

Resistance between outer terminals is _____.

Resistance between center and outer terminals _____ with wiper position.



Non-ideal resistance

A nonlinear resistance does not obey Ohm's law. (Ex: _____ and diodes.)

In this book we assume all elements designated as resistors are linear.

Conductance

Conductance (G) is the ability of an element to _____ electrical current.

Conductance is the reciprocal of resistance and given by

$G =$

The unit of conductance is the _____ (_____)

Previously, the unit of conductance was the _____ (ohm spelled backwards). $1 S =$

Power in resistors

The power dissipated by a resistor is given by $p =$

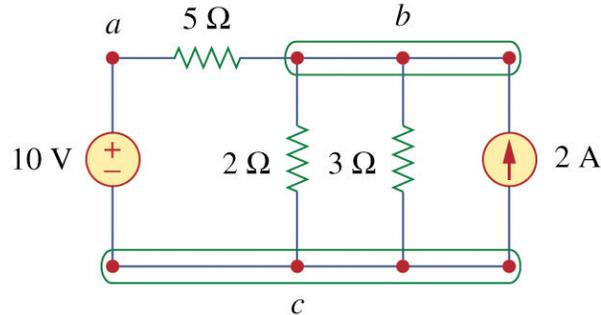
Note that

- Power dissipated by a resistor is a non-linear function of either voltage or current.
- Power dissipated by a resistor is always positive, consistent with the idea that a resistor is a passive element, incapable of generating energy.

Network topology

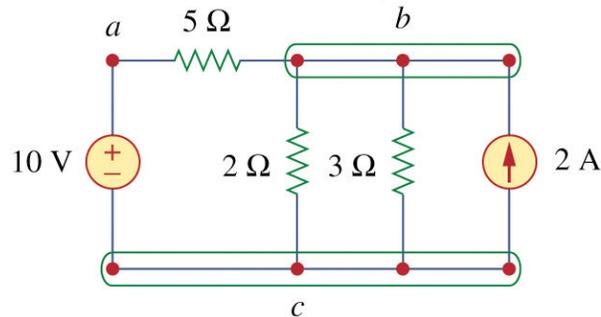
Network topology refers placement of elements in the network (circuit) and the _____ configuration of the network.

- Consider the equivalent circuits drawn below.



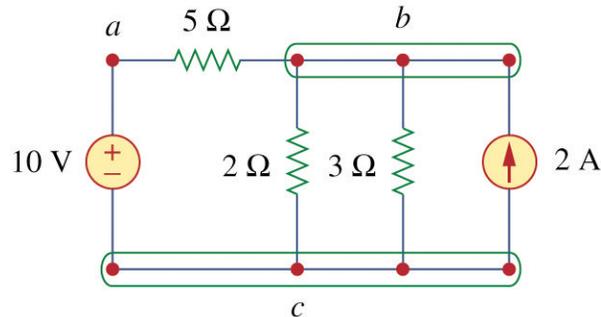
A _____ represents a single element such as a voltage source or a resistor.

A _____ is the point of connection between two or more branches.



A _____ is any closed path in a circuit.

A loop is said to be _____ if it contains at least one branch which is not part of any other independent loop.

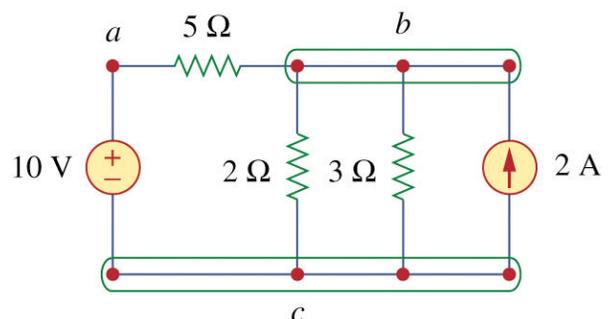


Series

Two or more elements are in series if they exclusively share a _____ and consequently carry the same _____.

Parallel

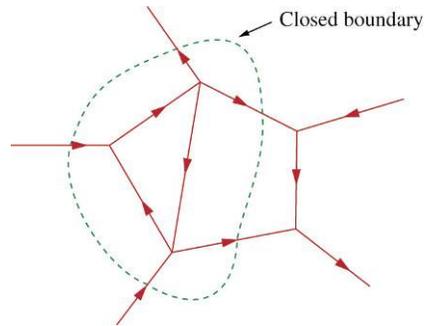
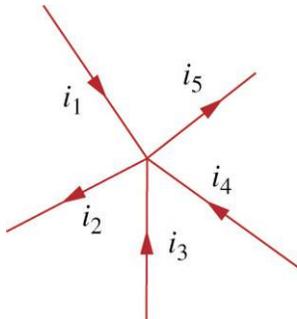
Two or more elements are in parallel if they are connected to the _____ and consequently have the same _____ across them.



Kirchhoff's current law

Kirchhoff's current law (KCL) states that the algebraic sum of currents entering a node (or a closed boundary) is _____.

Mathematically, KCL implies



Currents entering a node are _____ and those leaving a node are _____.

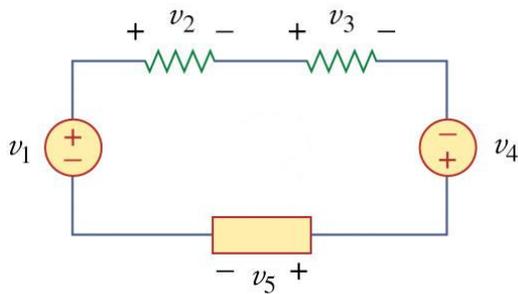
KCL can also be stated as “_____”

Kirchhoff's voltage law

Kirchhoff's voltage law (KVL) states that the algebraic sum of all voltages around a _____ (or _____) is zero.

Mathematically, KCL implies

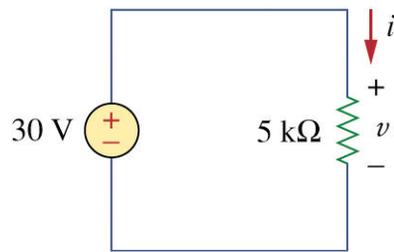
The sign on each voltage is the _____ of the terminal as we travel around the loop.



KVL can also be stated as “_____”

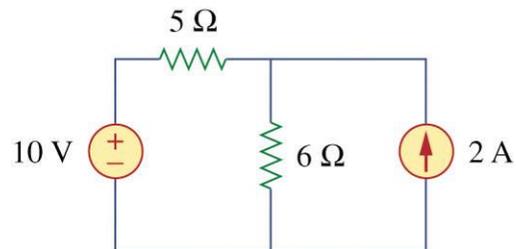
Example Problem 1

In the circuit below, calculate i , the conductance G , and the power p .



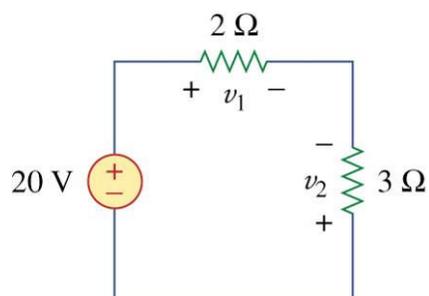
Example Problem 2

Determine the branches and nodes of the circuit below. Identify the elements in series and in parallel.



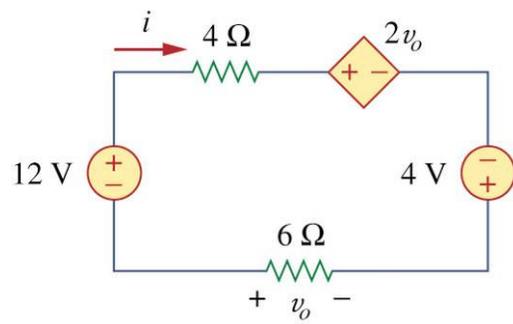
Example Problem 3

For the circuit below, find voltages v_1 and v_2 .



Example Problem 4

For the circuit below, find v_o and i .



Example Problem 5

Find the voltages and currents indicated below.

