

Semiconductors

What is a semiconductor?

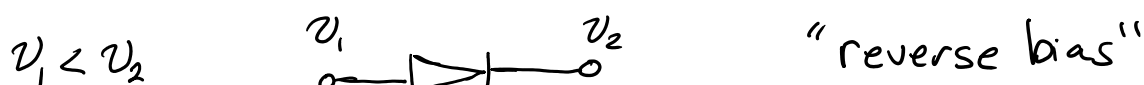
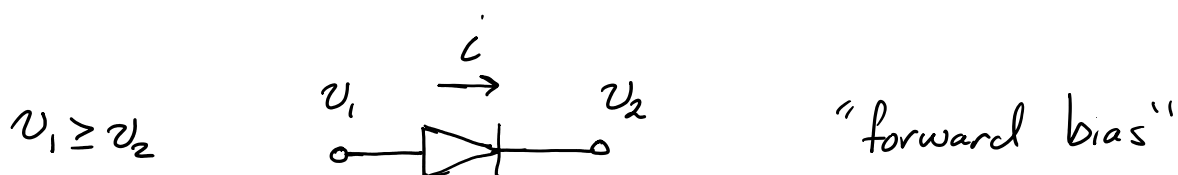
- A circuit component whose behavior sits somewhere between a conductor & an insulator
- Typically made from (doped) silicon
- Development began in early 20th century by Thomas Edison. First practical semiconductor invented by John Fleming in 1904.

Simplest example of a semiconductor is the diode. Applications

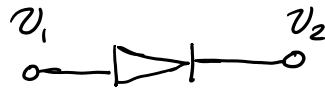
- Light Emitting Diode (LED) used for displays & illumination
- Voltage regulation
- Waveform clipping
- Power supplies
- Logic circuits: AND and OR gates

Solid state diodes

- Silicon devices
- Nonlinear behavior
- Allows current flow in only one direction



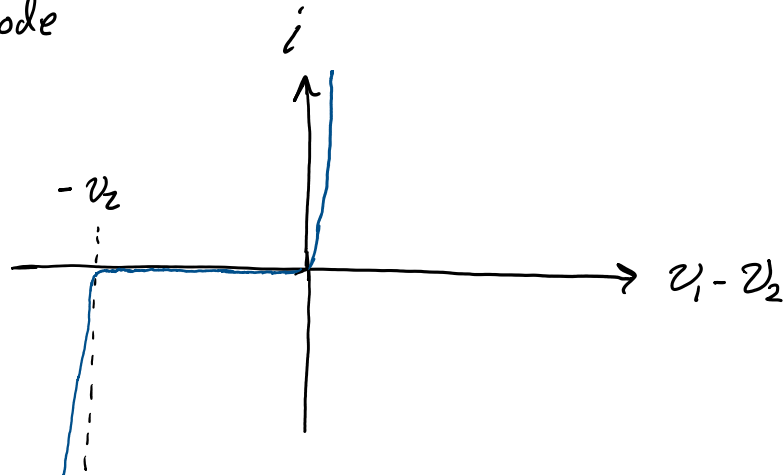
$$v_1 < v_2$$



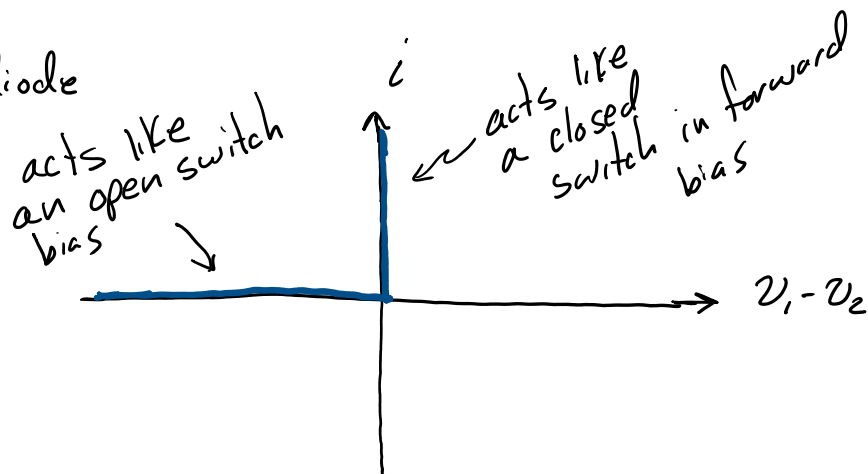
"reverse bias"

Current-voltage relationship

Real-world diode



Ideal diode



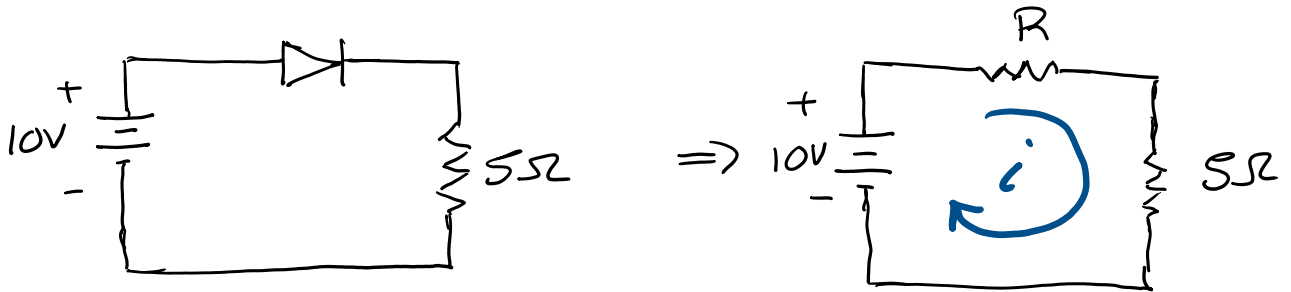
Circuit analysis: Nodal & mesh analysis may still be used, provided that the bias of the diodes is known.

How to determine bias?

1. Can sometimes determine bias by inspection.
2. Replace diodes) with a small resistor. Conduct circuit analysis to determine current flow directions. Identify diode bias. Replace forward bias diodes with closed switch, reverse bias with open switch. Repeat analysis to find voltages & current flow.

reverse bias with open switch. Repeat analysis to find voltage & current flow.

Example:



loop analysis:

$$10V - iR - i5\Omega = 0$$

$$\Rightarrow i = \frac{10V}{R + 5\Omega}$$

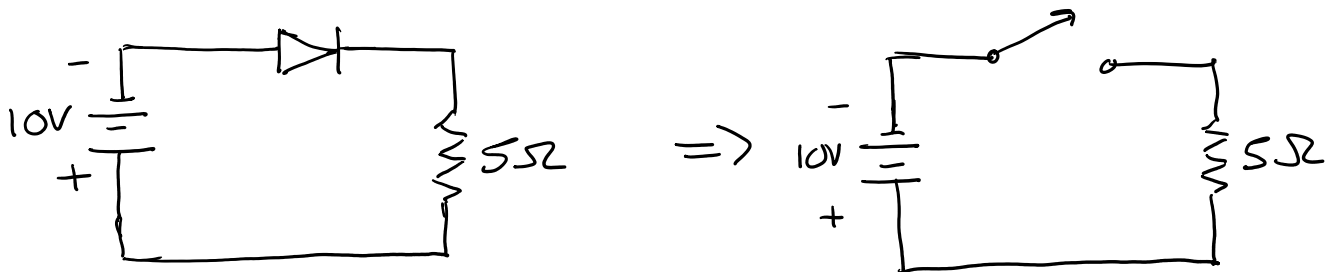
$\Rightarrow i > 0$ for any (small) R .

\Rightarrow Diode is in forward bias.

Actual current flow

$$R=0 \Rightarrow i = \frac{10V}{5\Omega} = 2A$$

What about?

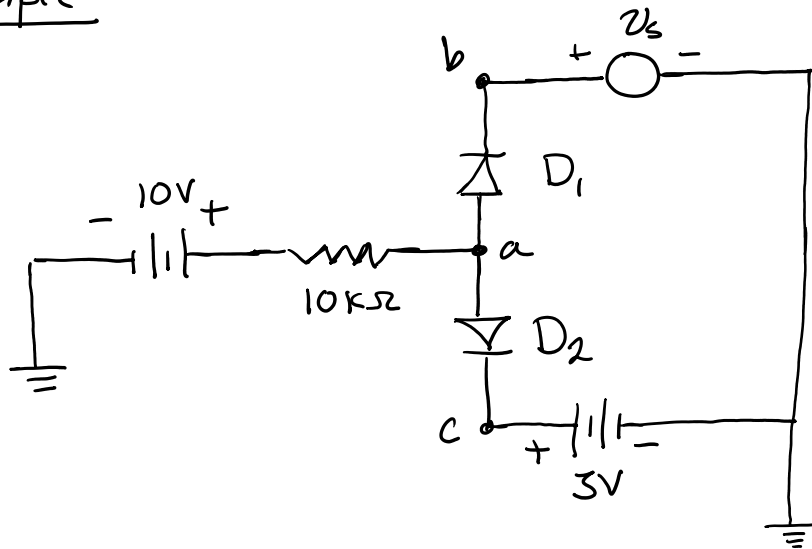


Diode is in reverse bias

\Rightarrow replace diode with open switch

\Rightarrow replace diode with open switch

Example



Assume ideal diodes.

Sketch a plot of nodal voltage at node a , v_a , as a function of v_s . ($v_s \geq 0$.)

