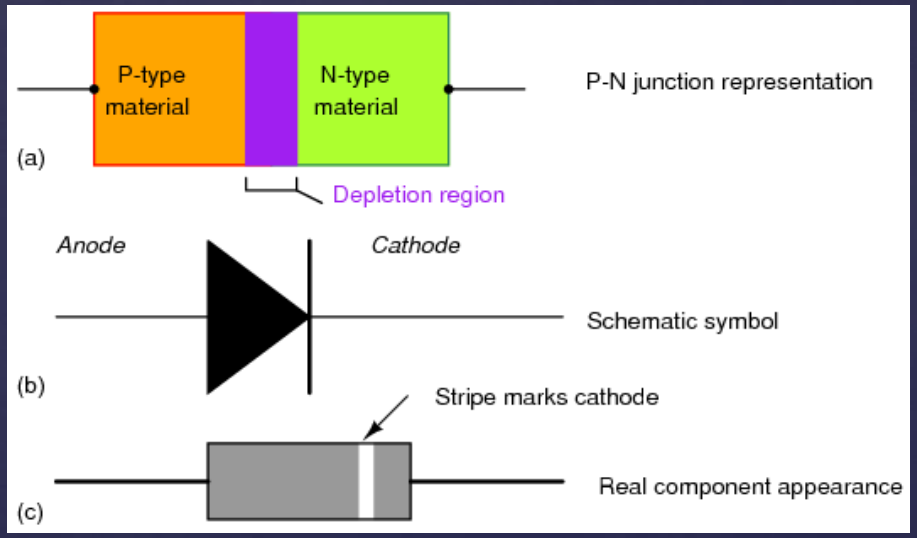
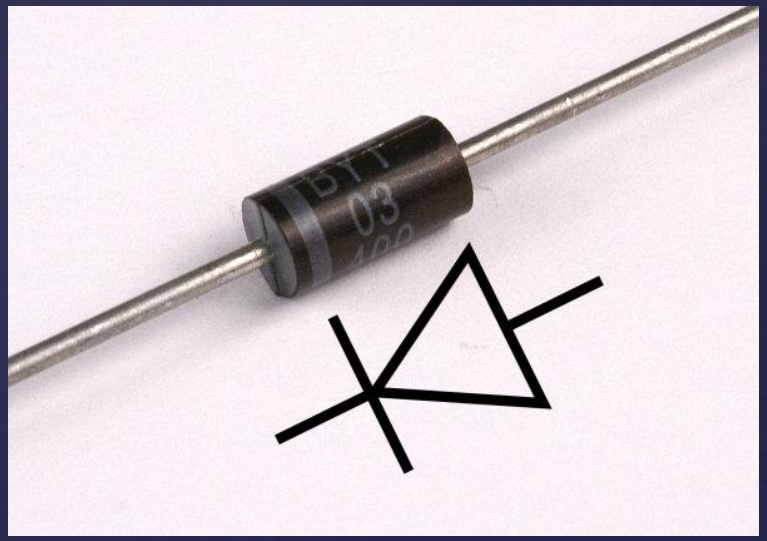
Diodes and Transistors

ELTN 130

Tom Thoen – Teacher / Student / Hobbyist / Inventor

Semiconductors are devices made with elements that can either allow current flow (a conductor) or block current flow (an insulator). The most basic semiconductor device is a diode.



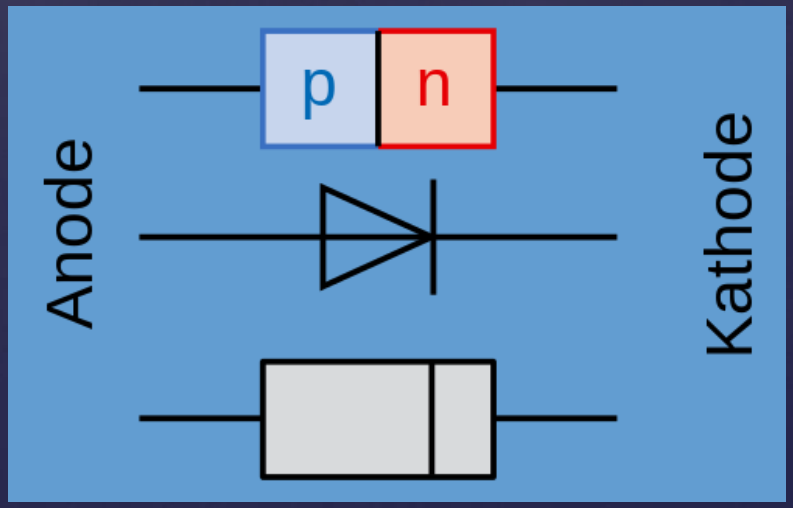


P and N materials:

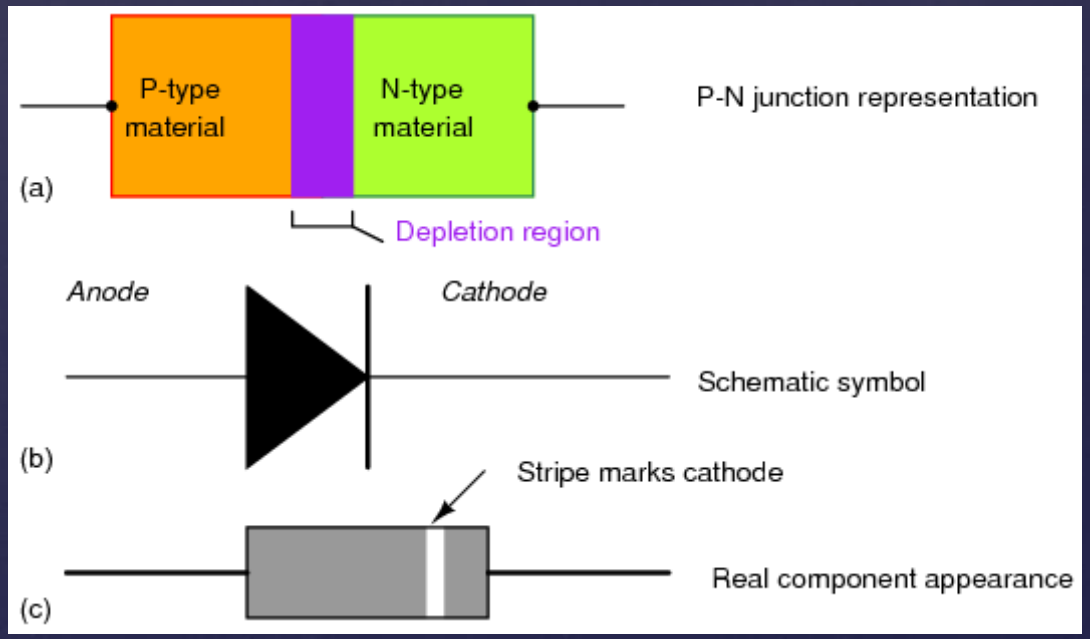
The most common type of semiconductor is *silicon*, which comes from sand.

Why Silicon? It is plentiful and cheap.

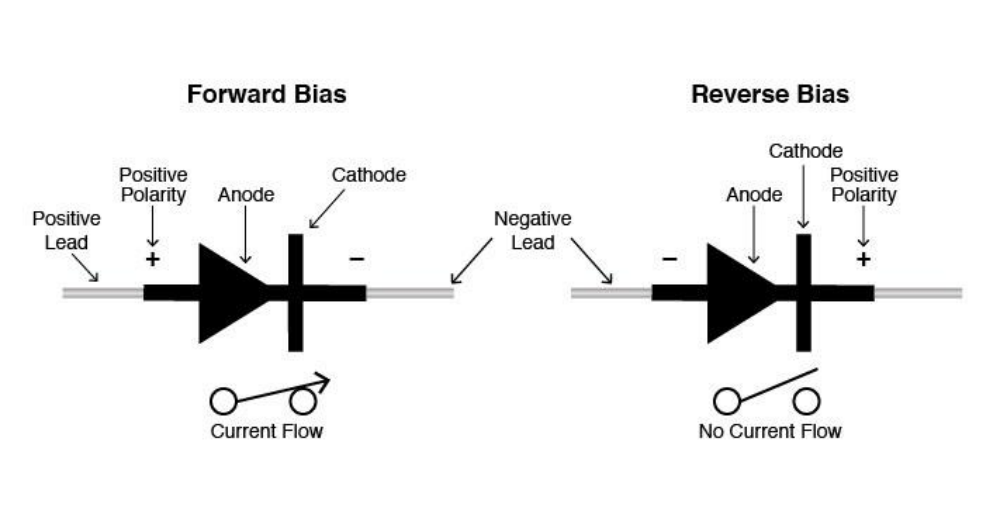
By processing the silicon in certain ways, it can be made more positive or negative. Combining the two materials creates a "P-N" junction.



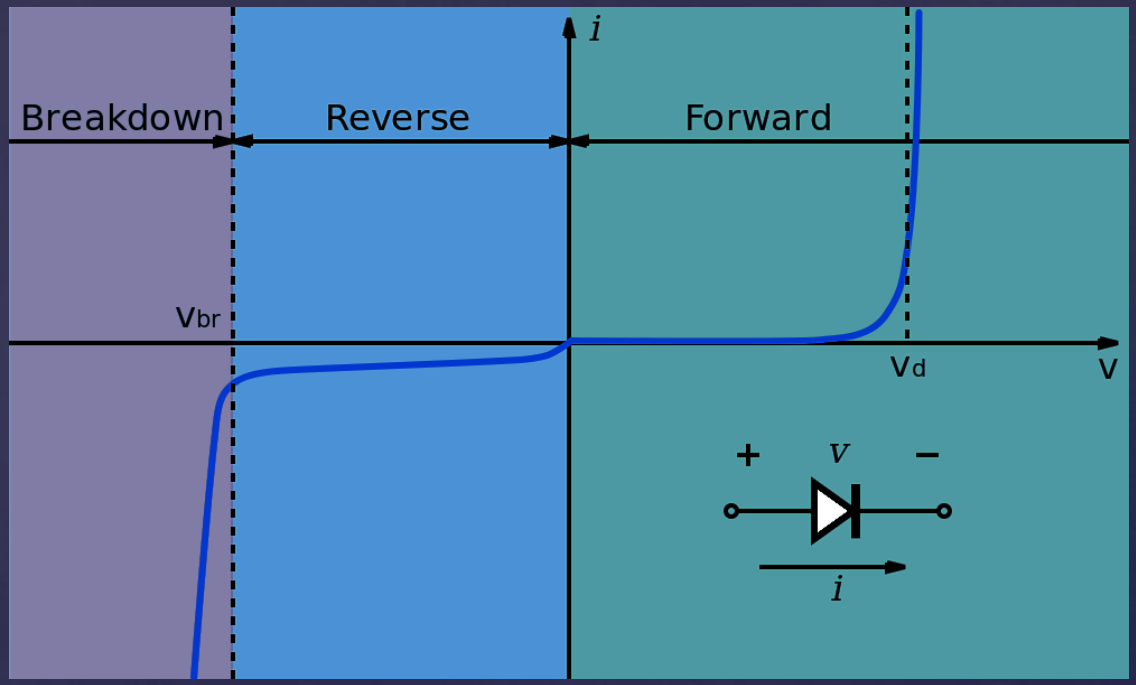
A gap called the *depletion region* determines the Vf, or forward voltage drop of the diode. When the diode conducts, it drops a small amount of voltage.



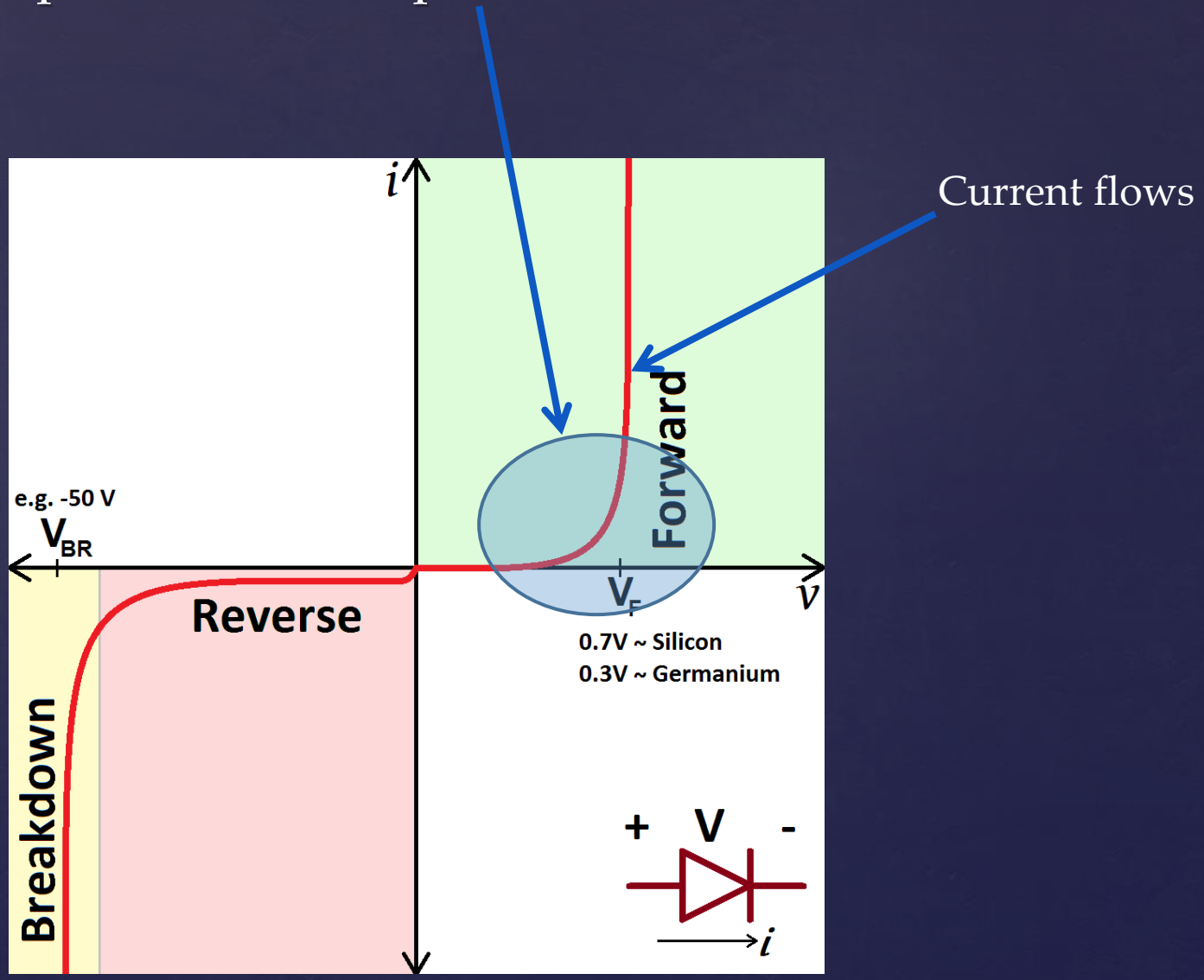
A diode can be used to allow or block current flow, similar to a water check valve:



Diodes have three “regions” of operation – forward, reverse, and breakdown:

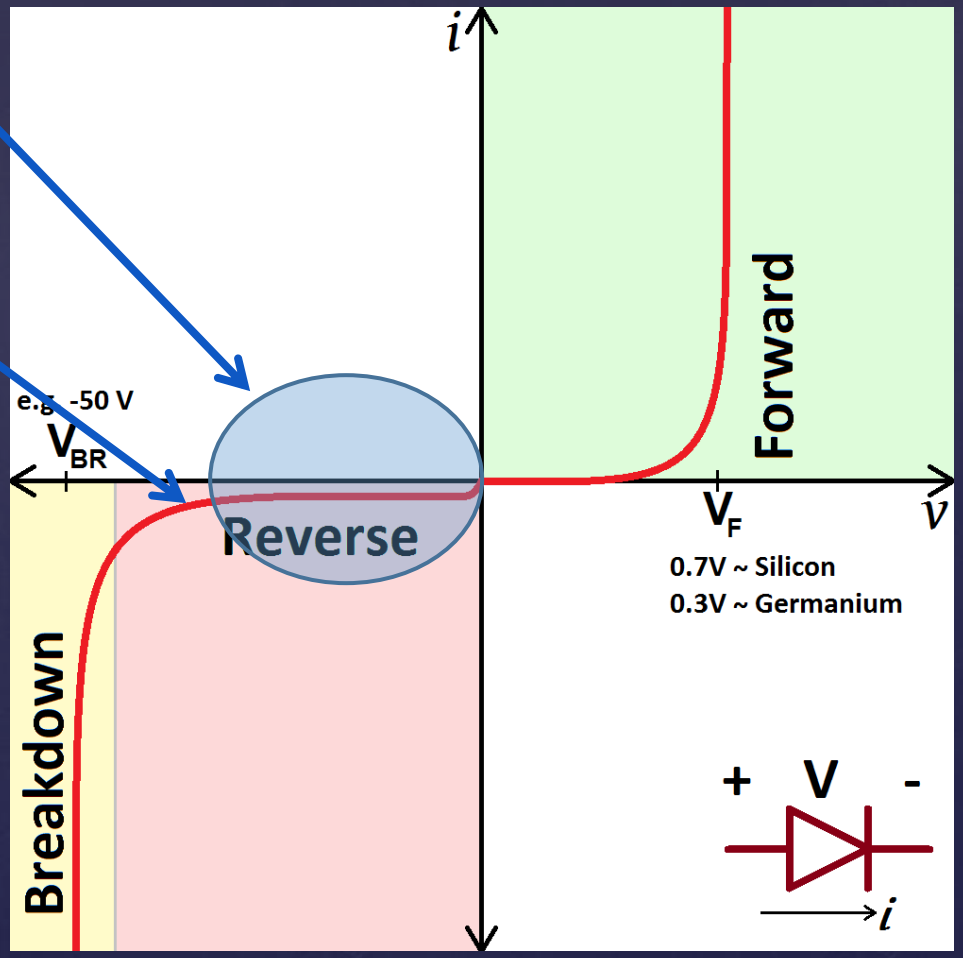


The forward region is the normal operation, much like a valve that opens at a small pressure:

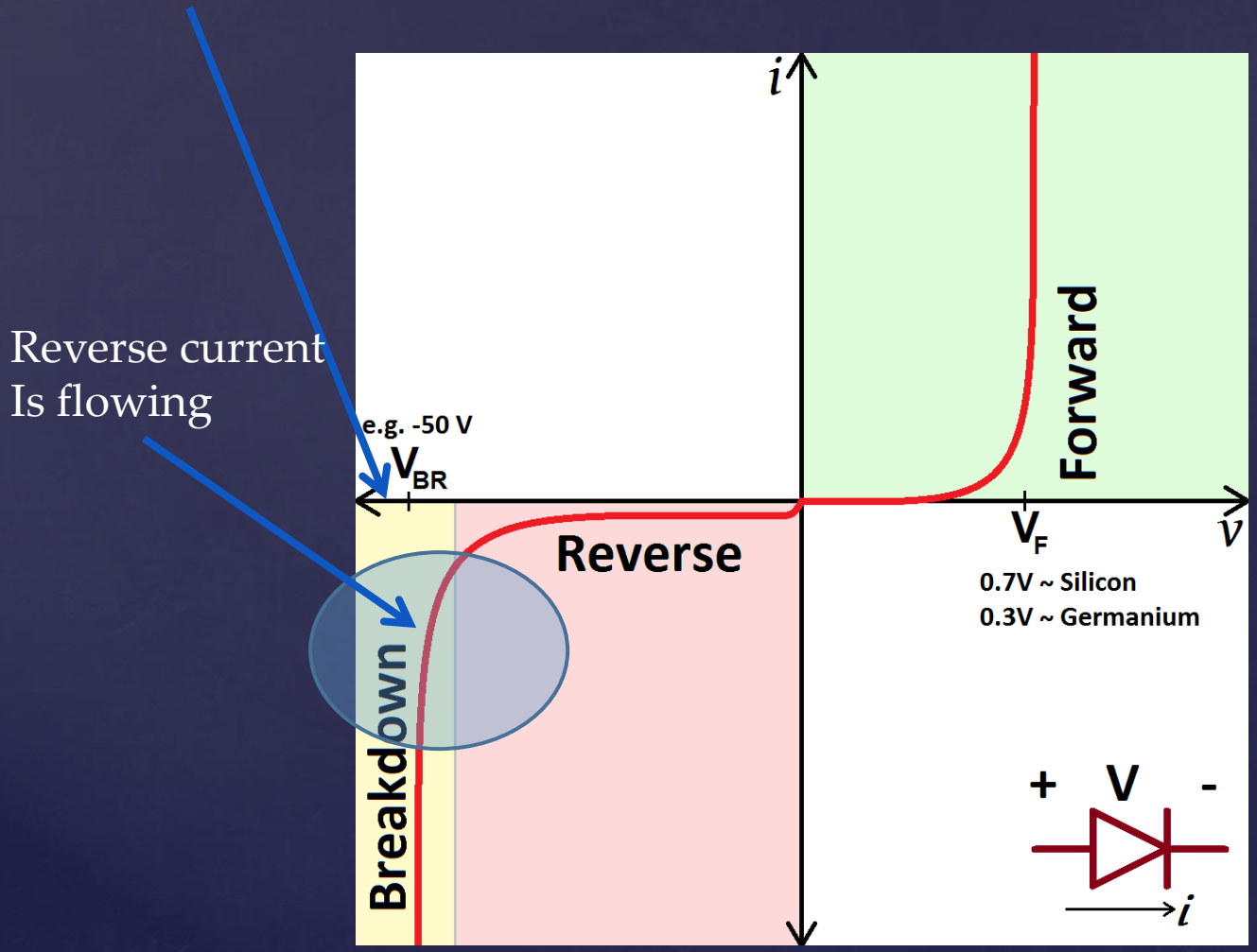


The reverse region is when the diode blocks reverse voltage, much like a valve that blocks the backflow of water:

Current is blocked



The breakdown region is when the reverse voltage gets too large, and the diode allows the current to flow backwards - much like a valve that breaks with too much back pressure:



Important terms:

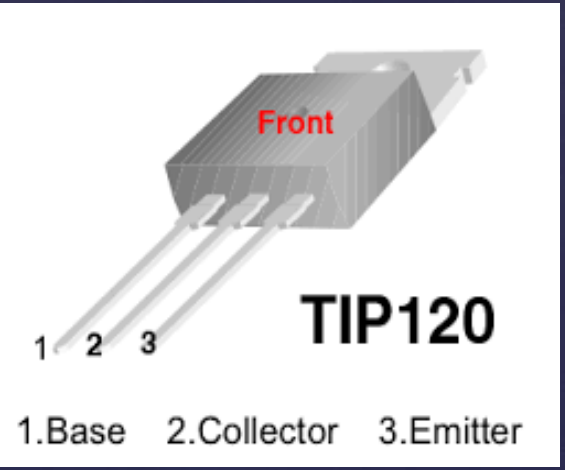
- Vf = forward voltage drop
- Imax = maximum current the diode can conduct
- PIV = ***P***eak ***I***nverse ***V***oltage – the point where it breaks down with a reverse voltage

Diode applications:

(Note – this is in the video lecture)

Transistors:

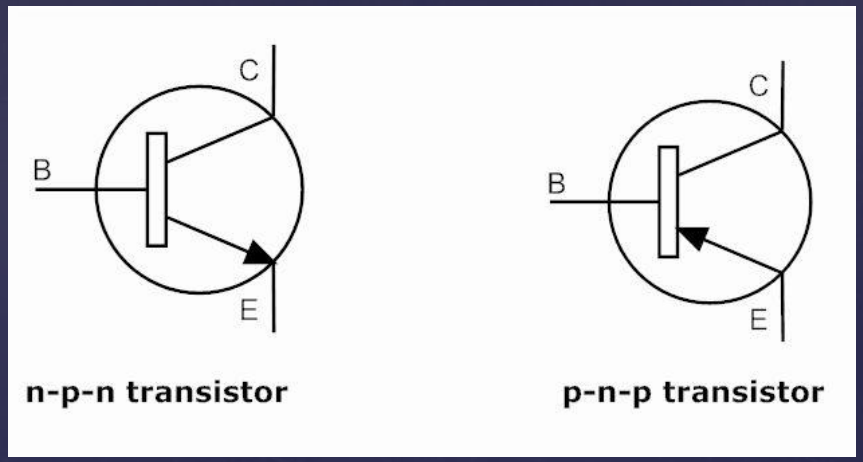
Transistors are three pin semiconductor devices that can switch large output currents with a small input current. They are similar to relays in concept, except have no moving parts.



Transistors have three pins – the Base (input) the Collector (output) and the Emitter (connects to ground)*.

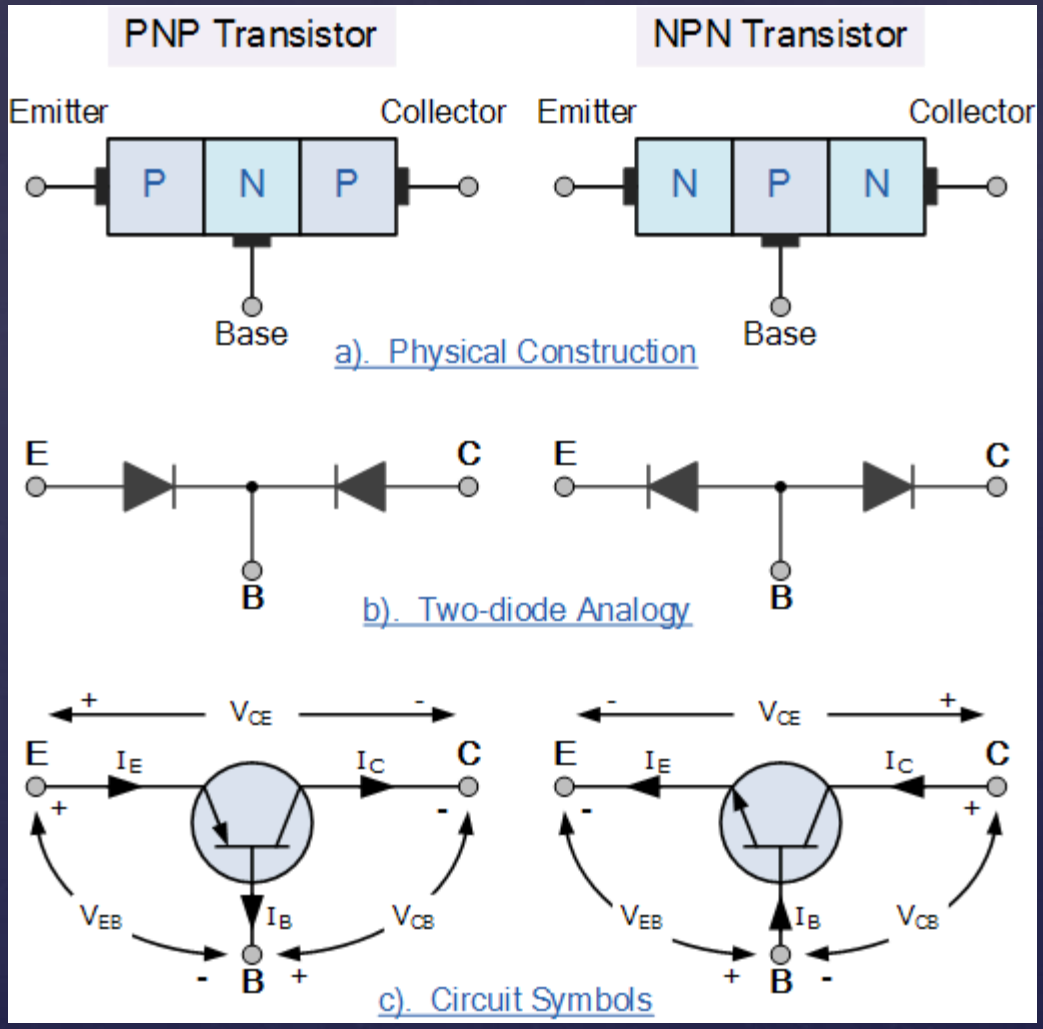
* *Note, these are generally the way the pins are used as a switch*

The schematic symbol for a common transistor looks like this:

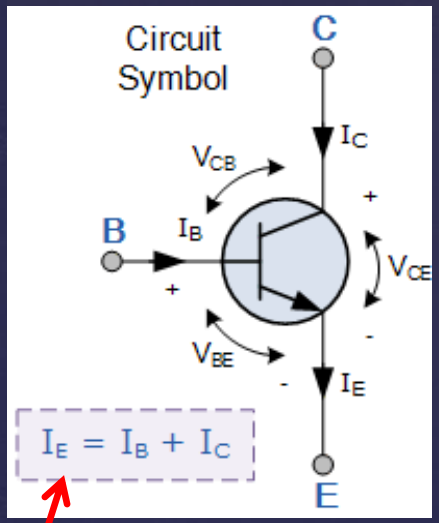


The transistor we will be working with is an NPN transistor. The **N** stands for a negative junction, and the **P** stands for a positive junction. Often the circle is left off the drawing.

Basic transistor construction:



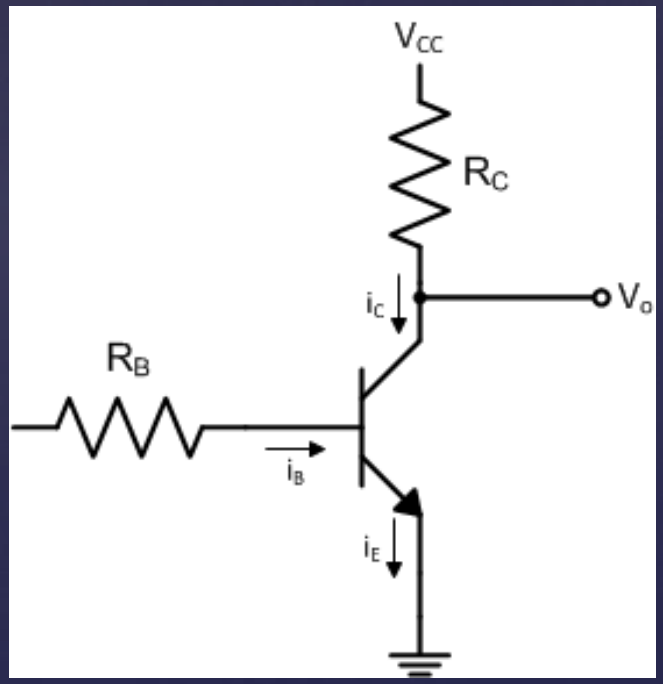
The voltages and currents associated with a transistor are related to each pin:



Notice that Kirchoff's current law works with the input currents I_B and I_C.

A Common transistor circuit:

R_B limits the input current going into base, R_C is the "load" or what is being turned on or off.



A transistor can amplify current from the base (I_B) to the collector (I_C). This amplification is called *gain* and is represented by the greek symbol beta β:

$$\beta = I_C/Ib$$

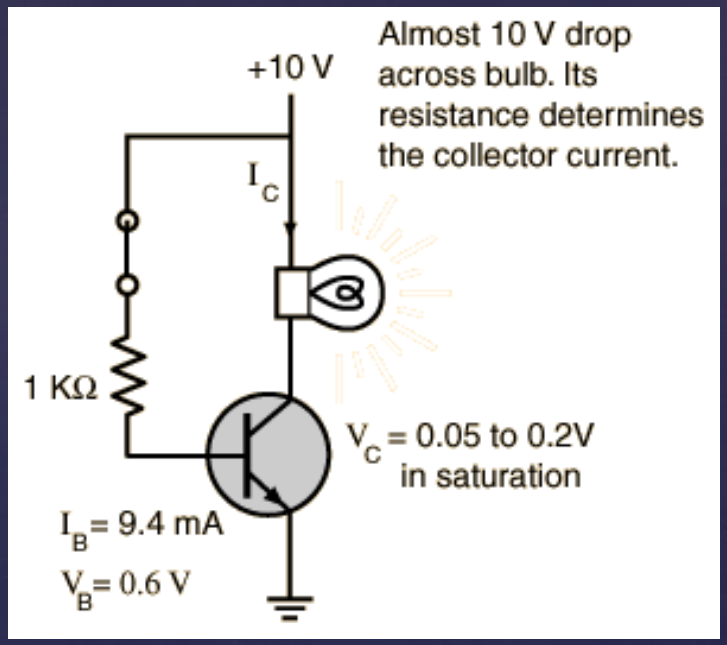
This is basically the output current divided by the input current.

The value for gain is usually between 50 and 200 for small transistors. Example:

I_B = 1mA I_C = 100mA

What is Beta in this example?

Basic transistor application:



References

- www.allaboutcircuits.com
- en-us.fluke.com
- www.build-electronic-circuits.com
- www.sparkfun.com