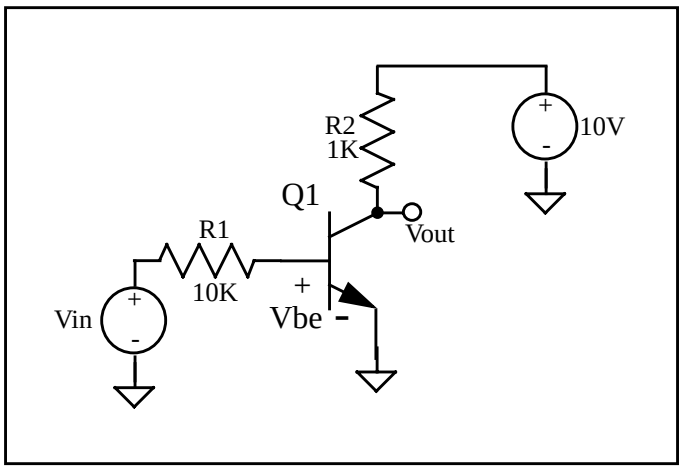
BJT Regions of Operation

To understand the three regions of operation of the transistor, consider the circuit below:



The first region is called “cutoff”. This is the case where the transistor is essentially inactive. In cutoff, the following behavior is noted:

* Ib = 0 (no base current)
* Ic = 0 (no collector current)
* Vbe < 0.7V(emitter-base junction is not forward biased)

Whenever we observe the terminals of a BJT and see that the emitter-base junction is not at least 0.6-0.7 volts, the transistor is in the cutoff region. In cutoff, the transistor appears as an open circuit between the collector and emitter terminals. In the circuit above, this implies Vout is equal to 10 volts.

The second region is called “saturation”. This is where the base current has increased well beyond the point that the emitter-base junction is forward biased. In fact, the base current has increased beyond the point where it can cause the collector current flow to increase. In saturation, the transistor appears as a near short circuit between the collector and emitter terminals. In the circuit above, this implies Vout is almost 0 volts, but actually about 0.2 volts.

In saturation, the following behavior is noted:

* Vce <= 0.2V. This is known as the saturation voltage, or $Vce_{(sat)}$
* Ib > 0, and Ic > 0
* Vbe >= 0.7V

Using the two states of cutoff and saturation, the transistor may be used as a switch. The collector and emitter form the switch terminals and the base is the switch handle. In other words, the small base current can be made to control a much larger current between the collector and emitter. For example, the circuit above can be modified to control an electric motor. The motor would replace the collector resistor and transistor would act as a switch. See the drawing below.