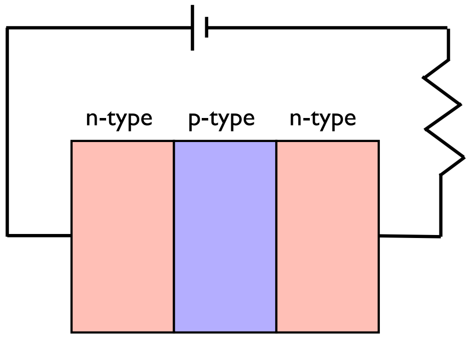
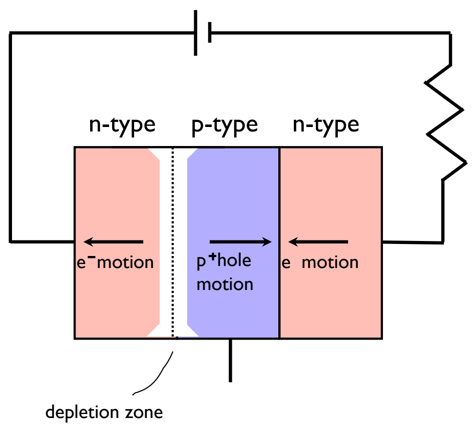
TRANSISTORS

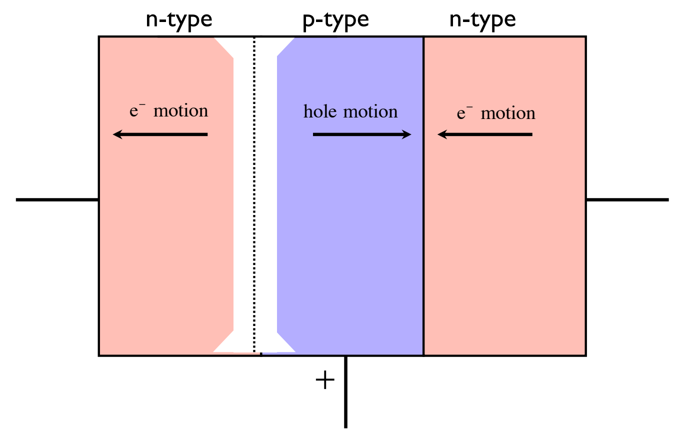
What's going to happen in this circuit?

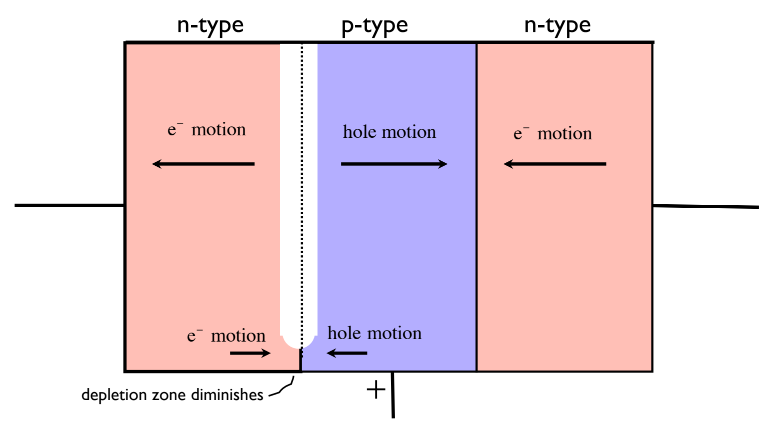


A depletion zone is going to form along the left p-n junction, and no current will pass through the load resistor.



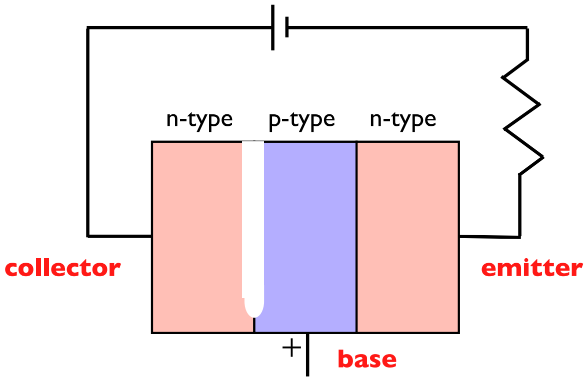
But what if we were clever? What if we made the connector to the central section electrically positive? What then?





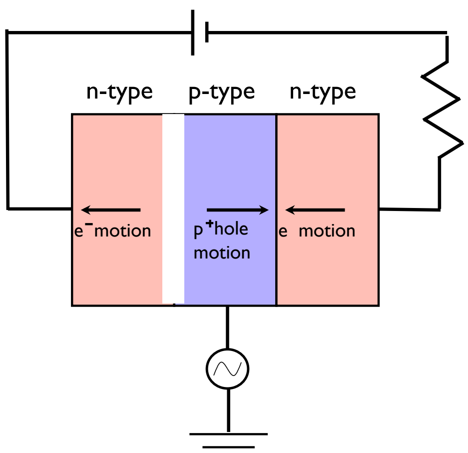
Electrons at the bottom of the left n-type semiconductor will be attracted rightward toward the positive central lead, and similar holes in the p-type semiconductor will be repulsed leftward away from the positive central lead, and the depletion zone at the bottom of the p-n junction will diminish effectively allowing "current" to flow through the circuit and, as a consequence, the load resistor.

This device is called an "npn" transistor. The left lead in this case is called "the collector," the right lead "the emitter" and the middle lead "the base."

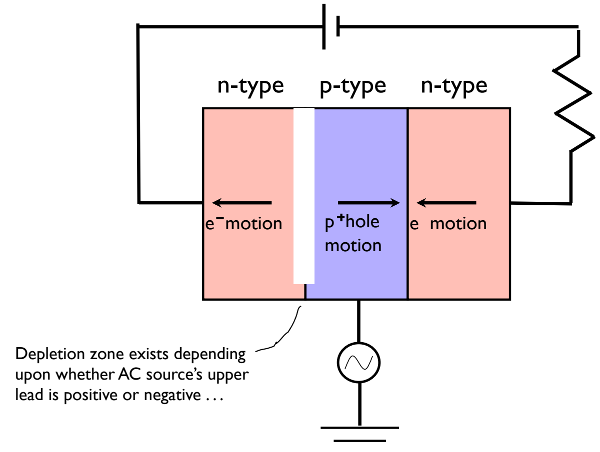


NOTICE: The depletion zone is and WILL ALWAYS BE found between what is called "the collector" and "the base."

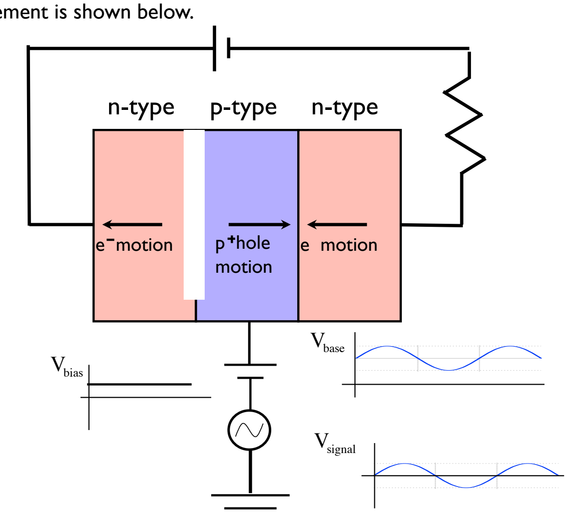
So back to the original circuit, with modification. Let's attach an AC source to the base and see what happens.



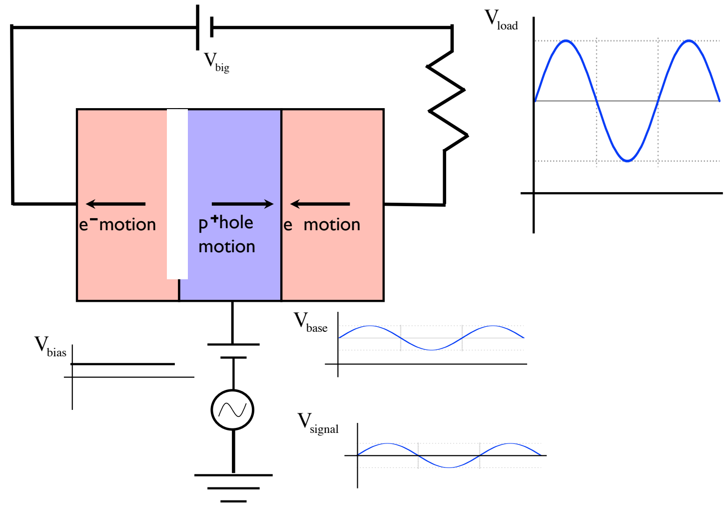
With this configuration, you would get current flow through the load resistor when the polarity of the AC source made the upper terminal and the base electrically positive, but you'd lose the effect when that terminal went negative. So how to fix that problem?



By putting in a bias voltage to keep the base terminal always positive, though, we can get current to flow in the upper circuit non-stop. The voltages produced by each element is shown below.



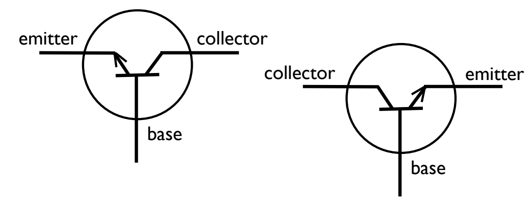
What's useful is that as the positiveness varies at the base, the current through the load resistor varies in exactly the same way, but (assuming V_{big} is, indeed, big) in a bigger way. In other words, what the transistor does is AMPLIFY the signal.



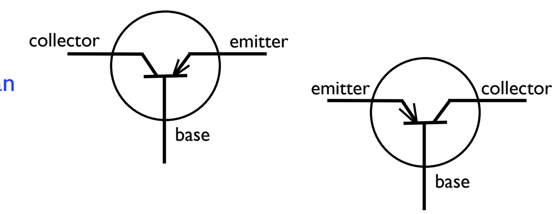
There are two kinds of transistor, npn transistors and pnp transistors. Each has it's particular characteristic, but each has the potential to do the same thing, amplify. Know the symbol for transistors, know that the terminals are called, know the main difference(s) between the two types of transistor, and knowing generally how they do what they do (i.e., about the depletion zone, etc.) is what you will be tested on come the next test.

Transistor Notation

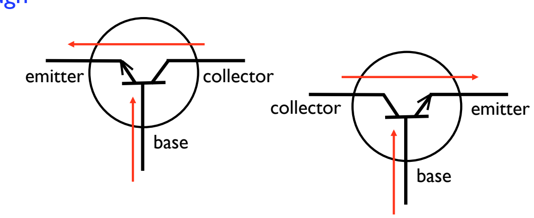
ways to symbolize an npn transistors



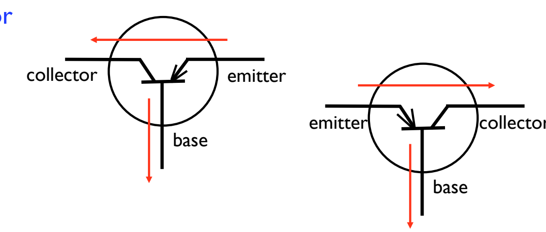
ways to symbolize an pnp transistors



current flows through npn transistor



current flows through pnp transistor



Generalizations

1.) The arrow always points:

a.) Away from the center for an "npn" transistor.

b.) Toward the center for an "pnp" transistor.

2.) The arrow always depicts the direction current will flow when current flows through the emitter/collector path (or the collector/emitter pathway).

3.) The arrow is always presented on the emitter side.

4.) The depletion zone is ALWAYS found along the collector/base *pn* junction.

5.) For an npn transistor, the base voltage must be positive (+), relative to the emitter, for the depletion zone to diminish allowing current to flow through the emitter/collector pathway. In that case, the base current will flow INTO the transistor.

6.) For a pnp transistor, the base voltage must be negative (-), relative to the emitter, for the depletion zone to diminish allowing current to flow through the collector/emitter pathway. In that case, the base current will flow AWAY FROM the transistor.

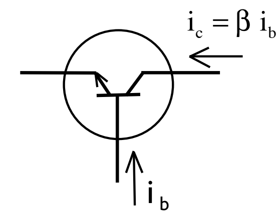
7.) More important than the polarity of the base, relative to the emitter, is the relationship between the various currents in the transistor.

8.) For an npn transistor, when the depletion zone is compromised and current flows into the collector, the base current is related linearly to the collector current.

a.) This relationship can be written as:

$$i_c = \beta\ i_b$$

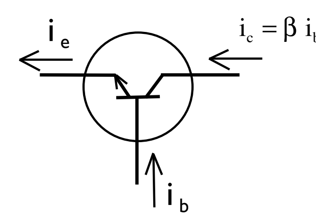
b.) This is schematically shown to the right.



9.) This means that when the depletion zone is thinned and current flows into the collector and out of the emitter, the total current out of the emitter will be the current through the collector added to the current into and through the base.

a.) That is:

$$\begin{aligned} i_e &= i_c + i_b \\ &= \beta\ i_b + i_b \\ &= i_b(1+\beta) \end{aligned}$$



10.) Effectively what is pointed out in the book is that the base current, hence the collector current (remember, the two are related linearly), will not become large enough to generate an appreciable emitter current until the base/emitter voltage is around .6 volts for a Silicon npn transistor.

11.) Put a little differently, the transistor will not turn "on" until the base/emitter voltage is .6 volts.