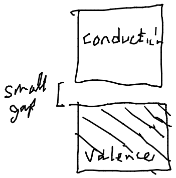
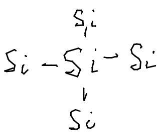
Semiconductors

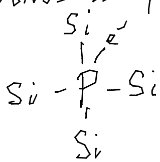


Doping -
adding impurities to semi conductor
replace one in every 100,000 atoms with a different atom

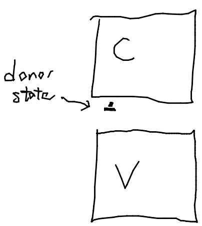
e.g. Si & Ge tetravalent: 4 outer electrons



Phosphorous is pentavalent (5)



extra electron doesn't fit into crystal
it doesn't jump all the way into conduction band

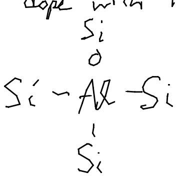


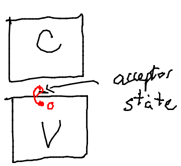
close enough to C that thermal energy can free it

n-type semiconductor

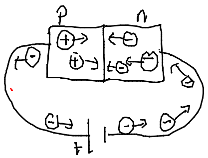
have ~~more~~ more electrons than usual
electrons: majority charge carrier

p-type semiconductor
dope with trivalent atom (Al, Ga)





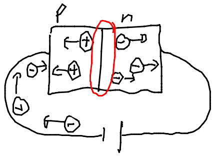
holes are majority charge carriers



pn-junction

forward bias

depletion zone — no more charge carriers

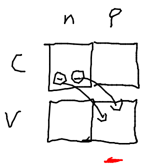


reverse bias

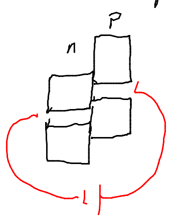
current dies quickly

From energy standpoint

no bias



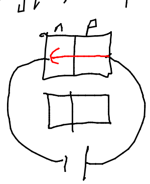
n electrons drop into p holes



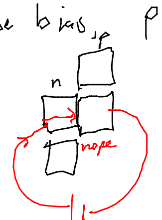
p rises due to repulsive PE due to excess electrons

If I apply a forward bias, negatively charged p-semiconductor is at a higher potential, $\Delta PE = q\Delta V$

then energy of p shifts down



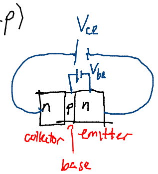
reverse bias, p-semiconductor increases in energy

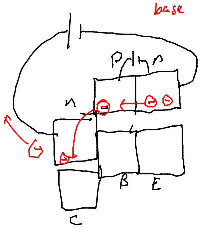


n conduction electrons can't flow through p

Bipolar Transistor
(npn or pnp)

npn





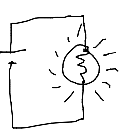
Forward bias btw base & emitter thanks to V_{be}.

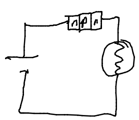
reverse bias btw C & B

- electrons flow from emitter to base due to V_{be}
- now base has more electrons than usual (minority)
- these electrons are happy to fall into collector (while holes cannot)

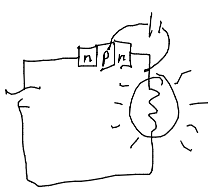
If I turn off V_{be}, no more minority charge carriers – current stops

V_{be} controls current of V_{ce}





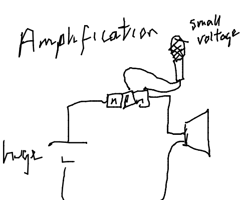
off



now light will go on.

Maybe this circuit will trigger other transistors, which trigger others, etc.

Amplification



as microphone input varies, its fluctuations show up in main circuit, but at a larger current level