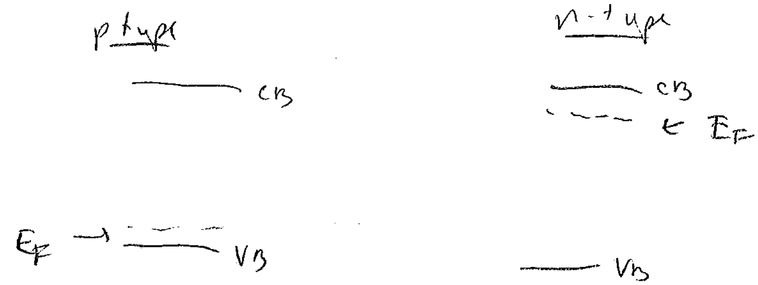
~~[Restate semester probably fewer qns, more concepts]~~

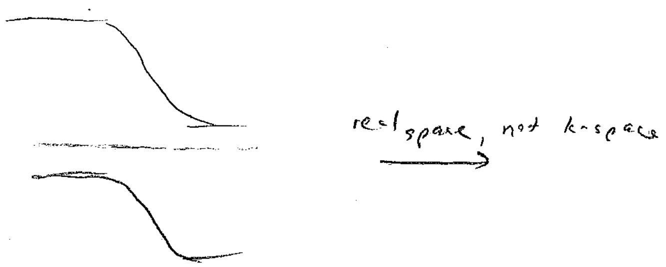
Ch 17: p-n junctions



What if you put them together?

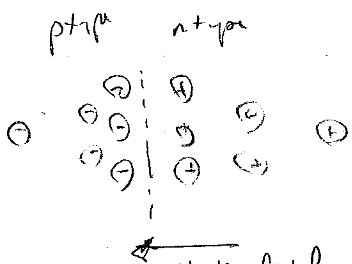
What happens to E_F?
like p-type?
like n-type?
in middle?
other? $\leftarrow$ *

Answer

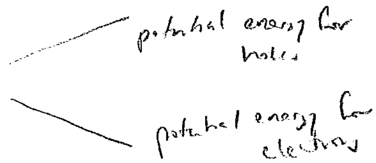


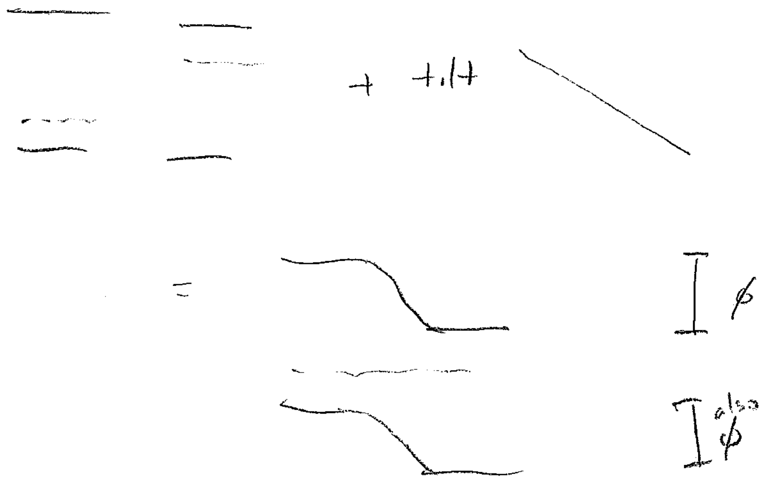
how does that work?

→ charge diffusion across barrier
p-type picks up some extra electrons
n-type " " " extra holes



electric field
tilts the band like so:





"depletion region", about 1μm long
lack of charges → holes get pushed left
+ electrons get pushed right

If any remain, then
electron-hole recombination

Also called "space charge" region,
because there will still be some
negative extra electrons on left + positive holes on right
(otherwise would have no electric field any more)

from acceptors who have given up holes

from donors who have given up electrons

Stokes: pg 128 Eqn 11.6

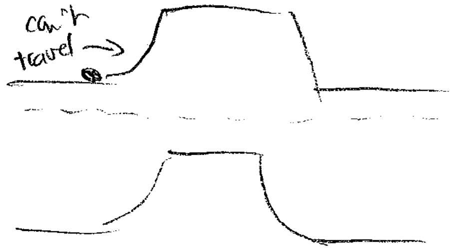
$$\phi = \frac{kT}{e} \ln \frac{N_d N_a}{n_i^2}$$

→ intrinsic concentration, as found a few lectures ago

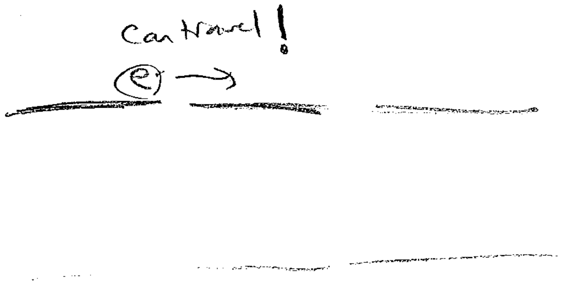
assumes same material is n and p type (same CB-VB on both sides of junction)

(Maybe make do for exam 3
Method: set μ left = μ right)

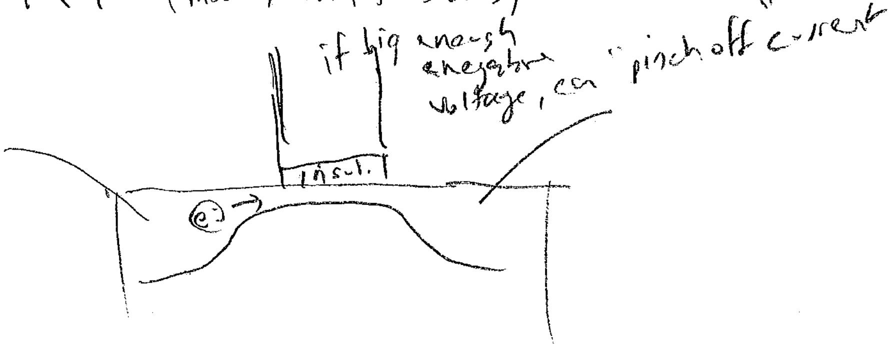
npn transistors ("early" transistors)



apply voltage (field) to middle gate

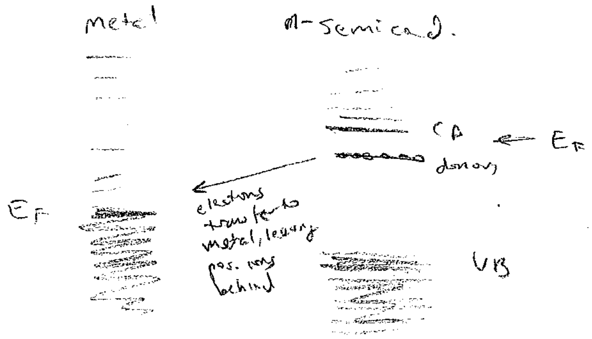


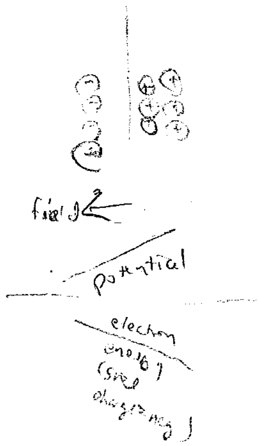
FET (most modern transistors)

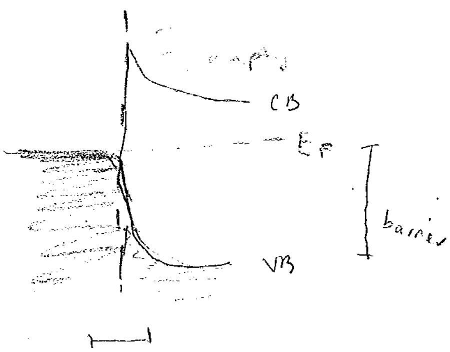


"Schottky barrier" → S.C. and metal

Case 1:





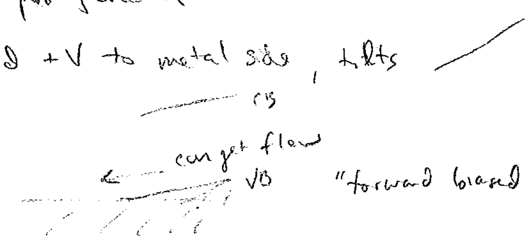


kittel pg 507 Fig 17.14

≃ .3μm , "simplified view" in fig 17.37 pg. 507

Acts like diode pn junction

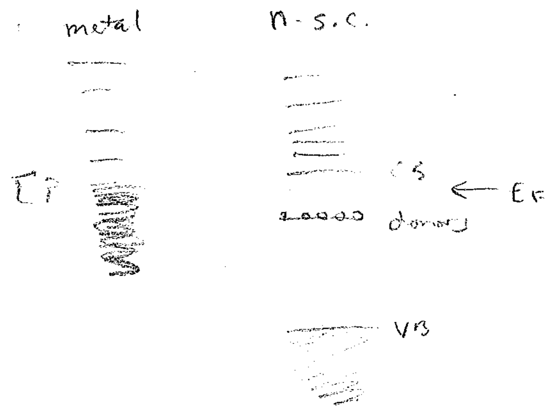
if you add +V to metal side, tilts



"forward biased"

if V added other way, don't get flow "reverse biased"

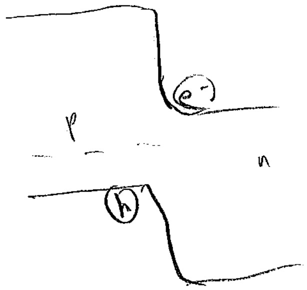
Case 2: (not discussed in Kittel)



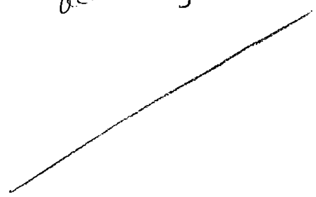
Applied voltage could cause
flow either way
as "tilt" is produced: electrons in metal to CB states if tilted
or electrons on donors to metal if tilted

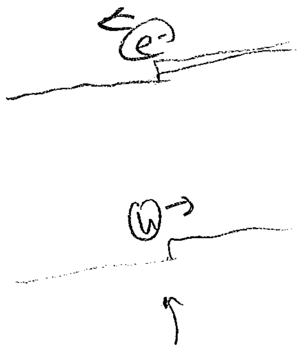
"ohmic contact"

LED ← diode = pn junction



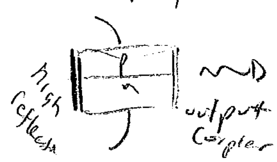
+





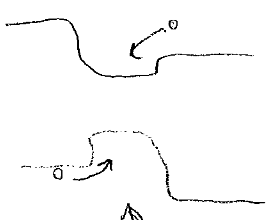
when at same spot, can "recombine" + emit light

Lasers in principle just LED with mirrored surfaces



electricity to keep upper state occupied

I think more common: thick QW



Need direct gaps!