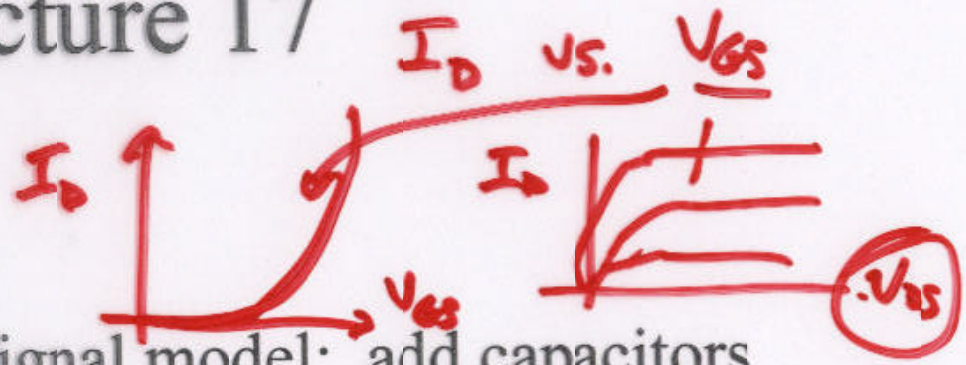
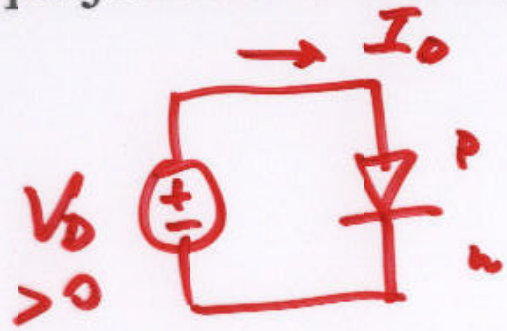
Lecture 17



- Last time:
  - Complete small-signal model: add capacitors
  - P-channel MOSFET
- Today :
  - pn junctions under *forward* bias (Chapter 6), 7.



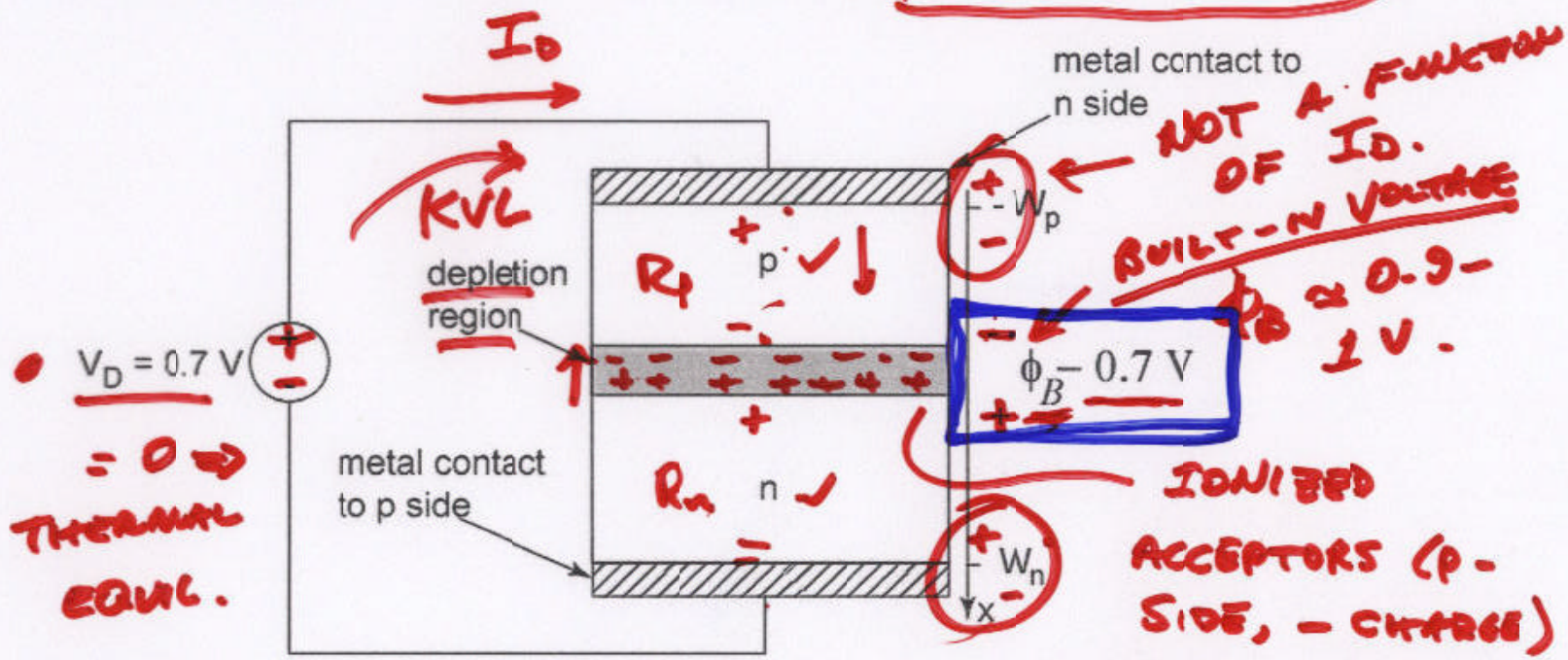
CONFLICT EXAM

4 → 5:30 ... PUSH EARLIER.

- MIDTERM I:
  - SIBLEY AUD. WED 3/6 (6 → 7:30) 80 min.
  - NO LEC. WED.
- MIDTERM I REVIEW.
  - 100 LEWIS TONIGHT 6 → 7:30 PM
  - → VIDEOTAPED. (205 McLAUGHLIN)
  - SOLNS TO PRACTICE EXAM TUES. MORNING 437 CORY.

OH
- RTH 10:30 - 12 MON
  10:30 - 12 + 2-3 TUES
- J.C. TUES 2 → 3:30
  WED 2-3
- K.O. WED 10-12, MON. 4 → 5:30.

Junction Diode with $V_D = 0.7$ V



- Barrier is reduced by forward bias (what about "ohmic contacts"?)

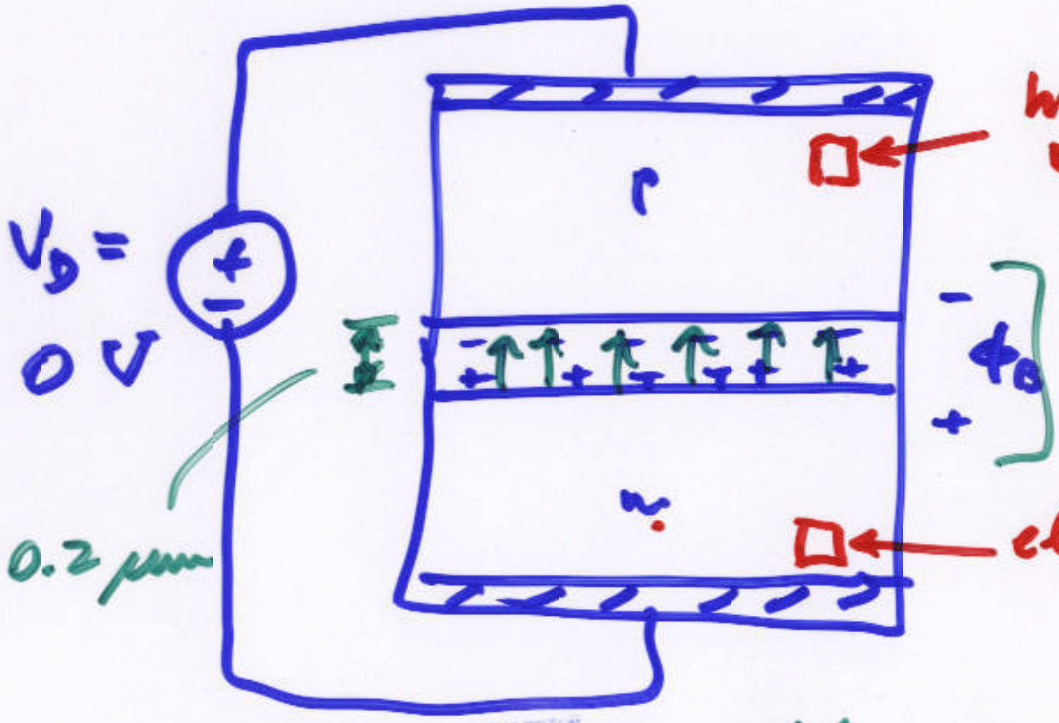
R_p, R_n SMALL! [POLARITY OF V_D ⇒ REDUCING THE BARRIER $\phi_j = \phi_B - V_D$

→ THERMAL EQUILIBRIUM .... NOT "DEAD"

→ 300K.

- BALANCE
- BETWEEN HUGE "TRANSPORT PHENOMENA."

$I_D = 0\ A$



+ few electrons

holes moving

$v_{dr} = v_{sat} = 10^7\ ms^{-1}$

random

$v_{dr} = 0$

IS ELECTRIC FIELD

electrons. + few holes.

$v_{dr} = 0$

$v_{sat} = 10^7\ ms^{-1}$

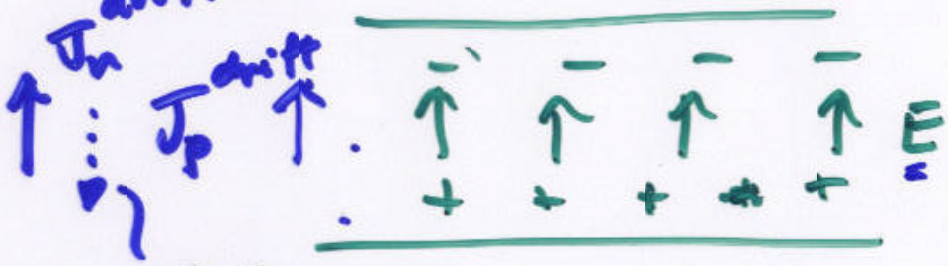
$\phi_B \sim 1V$ $\quad E \approx \frac{\Delta V}{\Delta x} = \frac{1V}{0.2\mu m}$ = HUGE!!!!

HUGE $E \Rightarrow$ HUGE J_n^{drift}, J_p^{drift}.

$$J_n = q n v_{dr.} = q n \mu_n E.$$

SIGNS:

$$J^{drift} = J_n^{drift} + J_p^{drift} = \text{UP}.$$



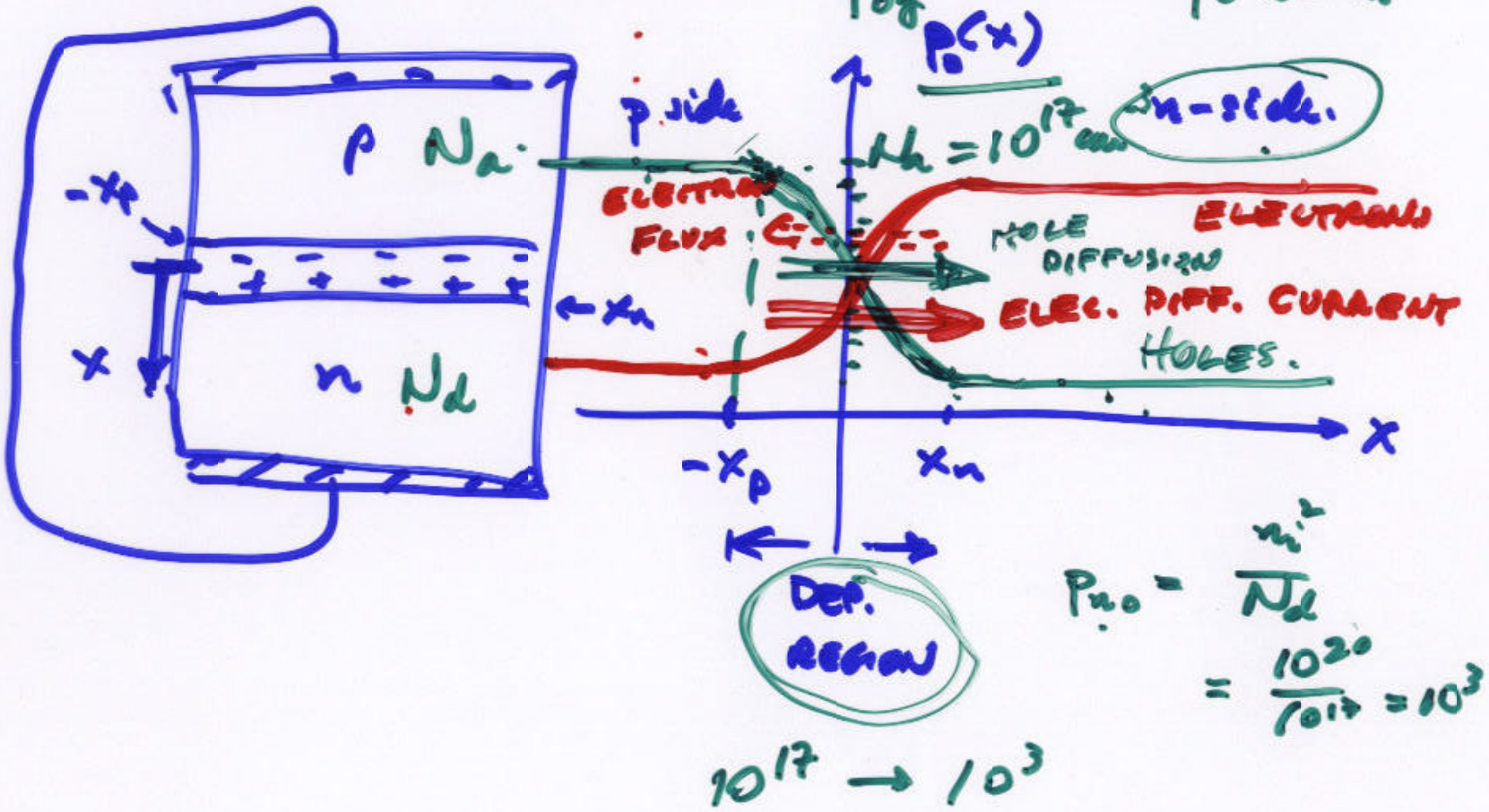
WHERE ARE THE BALANCING CURRENT DENSITIES ??

MEANS OF HOLE & ELECTRON

- ANOTHER TRANSPORT: DIFFUSION

or $\left[\frac{n(x)}{p(x)}\right]$ NOT HAVE $n(x,t) \Rightarrow$ STEADY-STATE $n(x)$.

DIFFUSION CURRENT DENSITIES.



$p_o n_o = n_i^2$

$p_{no} = \frac{n_i^2}{N_d}$

$= \frac{10^{20}}{10^{17}} = 10^3$

$10^{17} \rightarrow 10^3$

What Happens Inside the Junction?

LOWERED THE BARRIER $\phi_B - 0.7 \approx 0.2V$

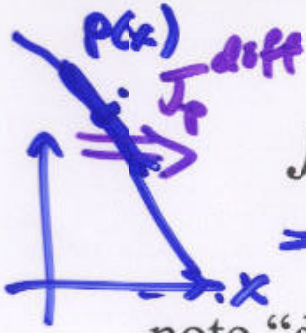
Electric field in the depletion region is reduced →

imbalance and net transport of holes from p side into n side and electrons in the other direction

→ DIFFUSION.

Physical process is called *diffusion* and results in a diffusion current density

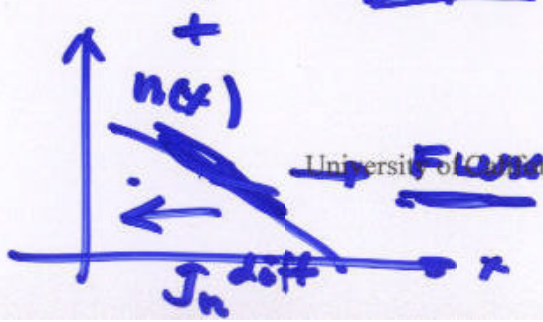
FICK'S LAW.

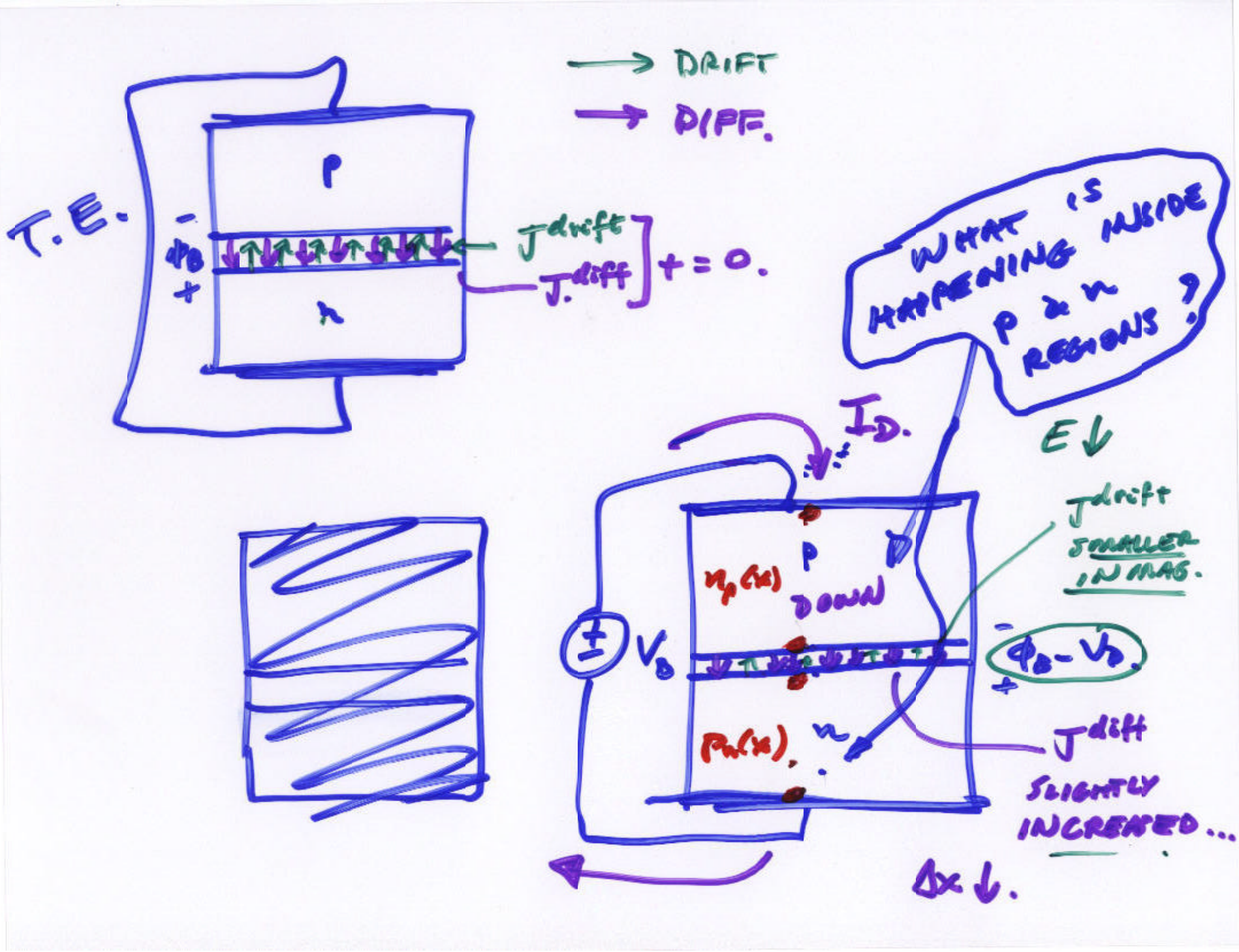


$$J_p^{diff} = -qD_p\frac{dp}{dx}$$

$$J_n^{diff} = qD_n\frac{dn}{dx}$$

note "downhill" = $-d(\ )/dx$




DRIFT
DIFF.
T.E.
P
n
ϕ_B
J^{drift}
J^{diff}
$t = 0$.
WHAT IS HAPPENING INSIDE P & n REGIONS ?
I_D.
E ↓
J^{drift} SMALLER IN MAG.
P
$n_p(x)$
DOWN
V_D
$\phi_B - V_D$
$P_n(x)$
n
J^{diff} SLIGHTLY INCREASED...
$\Delta x \downarrow$.