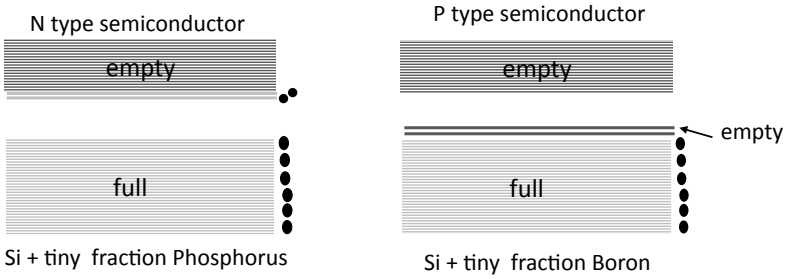
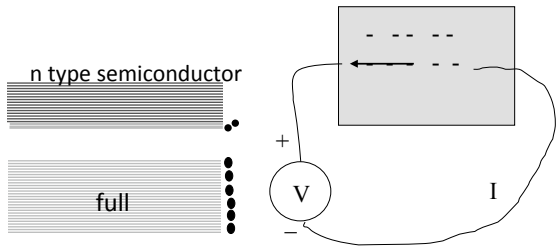
6.1 Ideal *pn* junction

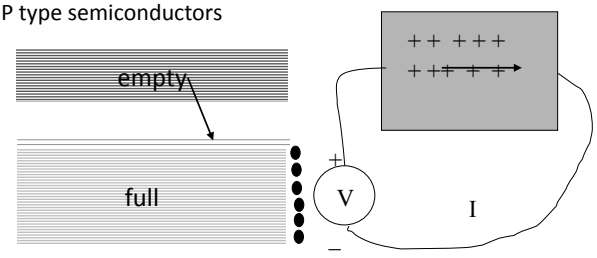


Extra or missing free/moveable electros are NOT(!) EXTRA TOTAL CHARGE.
There are also extra or missing protons!
Typically books (and these pictures) just show moveable electrons.

N type- atoms with extra free electrons



P type semiconductors



"holes", leave room to move

This is standard representation showing only moveable charges, not actual electric charge. +s are unfilled electron levels!

When semiconductors get really useful:

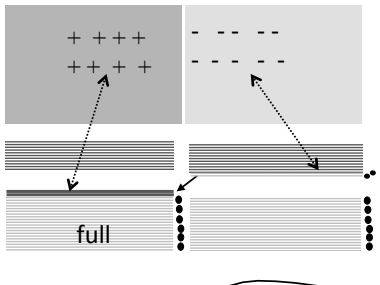
Diodes (& LEDS) - PN junctions.

Transistors- PNP or NPN junctions

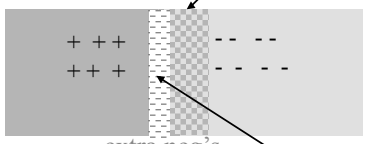
PN junction

P type N type

P- N junction



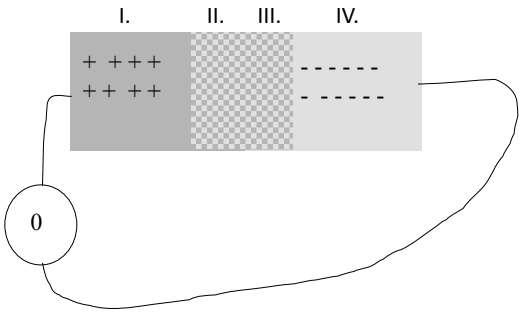
electrons diffuse to left (lower energy), fill up holes to annihilate moveables at border



"depletion layer"- no moveable charges

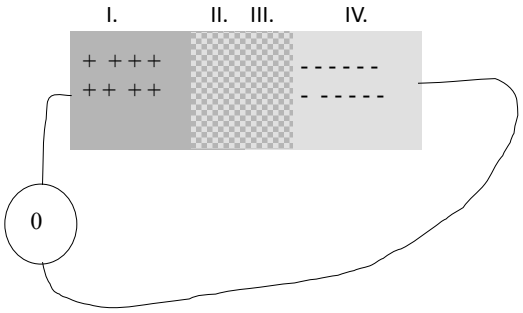
show sim

true charge buildup--keeps rest of moveable -'s on right side. Balances energy they get going down.



Net electrical charge in the regions above is

A. I. +, II. +, III. -, IV. -
B. I. +, II. 0, III. 0, IV. -
C. I. 0, II. -, III. +, IV. 0
D. I. 0, II. 0, III. 0, IV. 0
E. I. +, II. -, III. +, IV. -



Net electrical charge in the regions above is

A. I. +, II. +, III. -, IV. -
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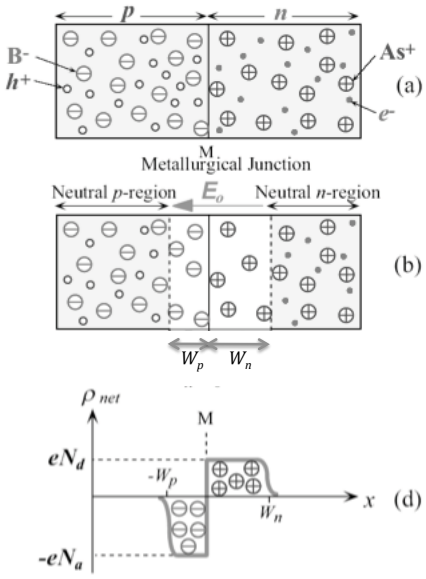
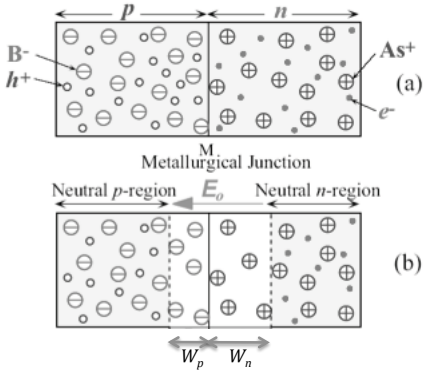
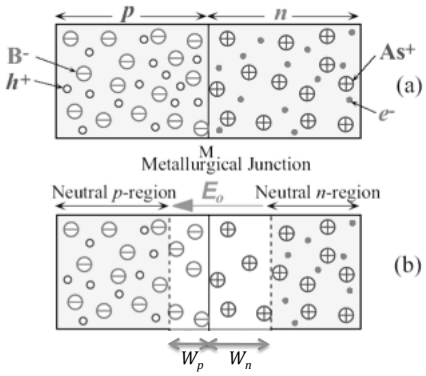


Properties of the PN junction



If $W_n > W_p$, as in the picture,

A) $N_a = N_d$
B) $N_a > N_d$
C) $N_a < N_d$



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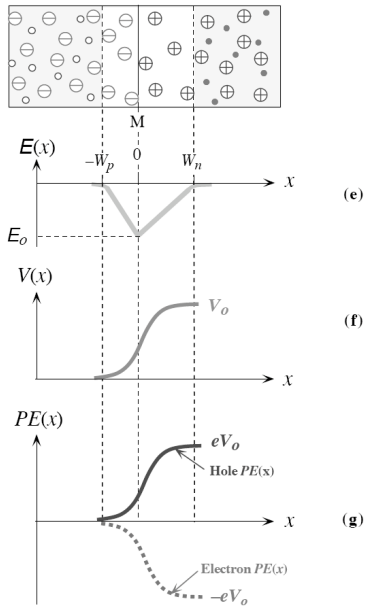
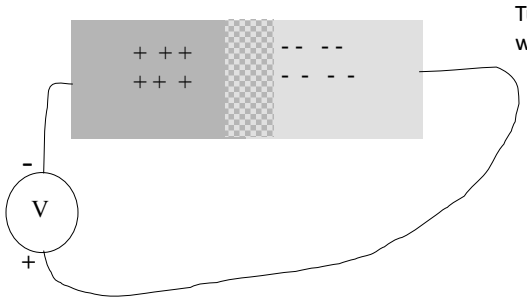
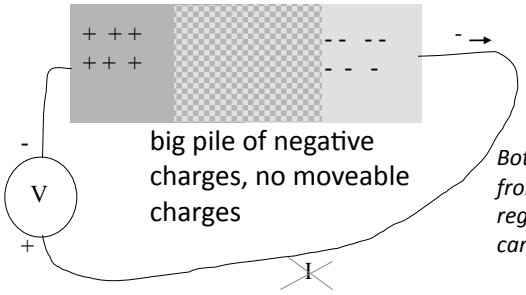




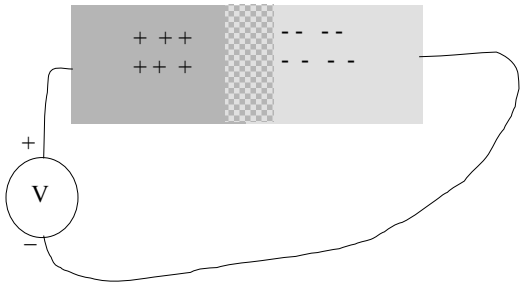
Turn on voltage, what happens? (why?)

a. electrons flow from left to right through junction.
b. electrons will not flow.
c. electrons will flow from right to left through junction.



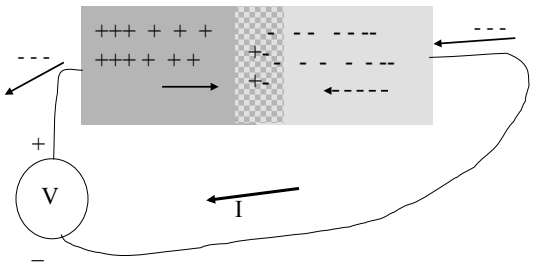
big pile of negative charges, no moveable charges

Both +s and -s pulled away from junction. Depletion region bigger. Current can't flow. ans. b.



Turn on opposite voltage, what happens? (why?)

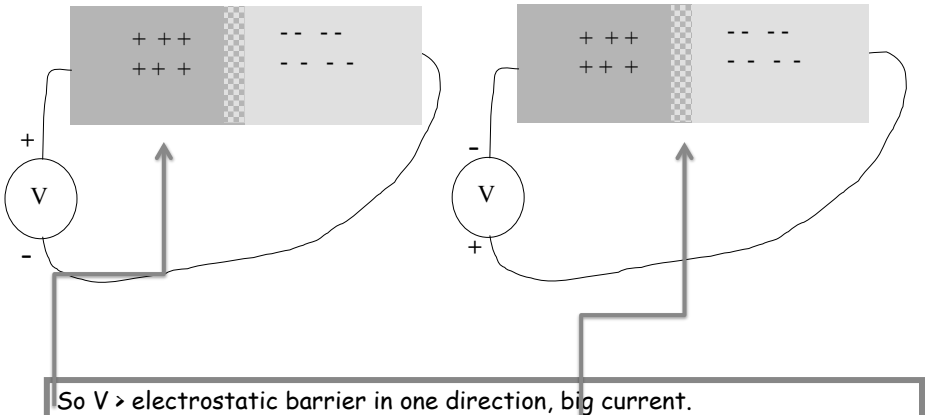
a. electrons flow from left to right.
b. electrons will not flow
c. electrons will flow from right to left



opposite voltage, what happens?

holes get shoved into depletion from left,
electrons get shoved into depletion from right,
= no more depletion region
⇒ moveable charges carry current.

V has to be bigger than the electrostatic barrier from charge.

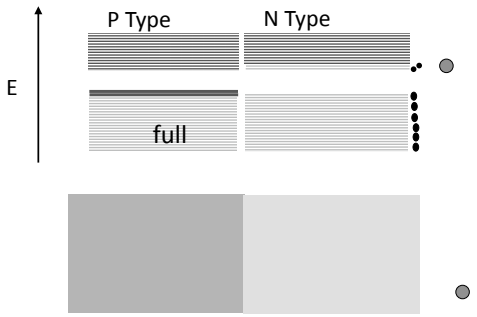


So V > electrostatic barrier in one direction, big current.

V in opposite direction, no current.

Diode is one-way street for current flow.

diode conducting



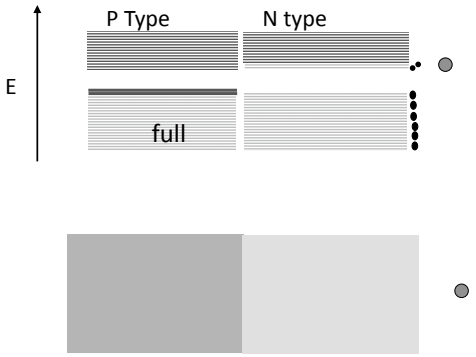
As electron moves across junction going from N type on right to P type on left

a. it stays at the same energy

b. it gains potential energy (if so from where?)

c. it loses potential energy (if so to where?)

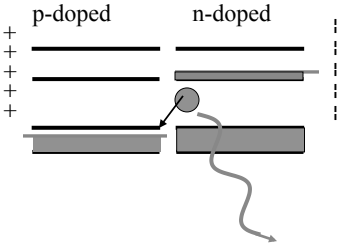
diode conducting

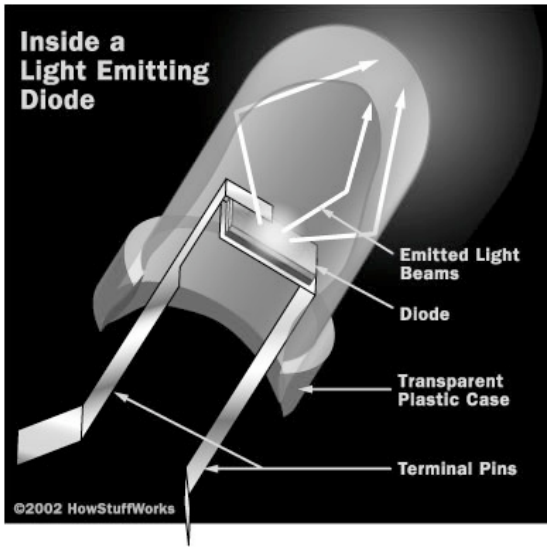


c. loses potential energy- goes into 1) heat (vibrating atoms)
or 2) if proper materials, light (light emitting diode)

LEDs -- don't burn out, high efficiency.

Really good LEDs reach
laser conditions--
diode lasers





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