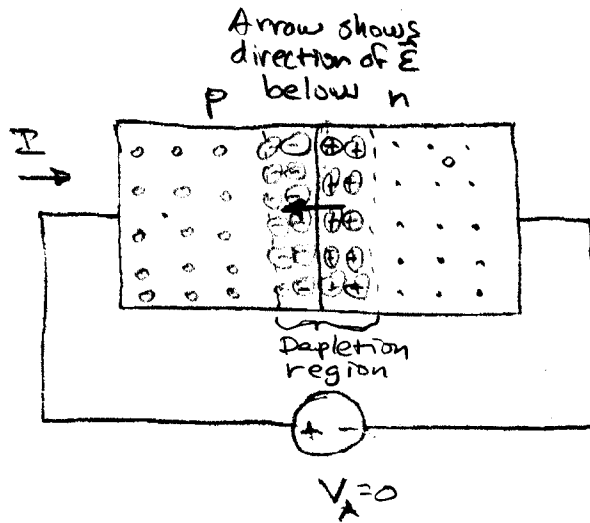


# Physics 116A Fall 2004: Diode Problem

11/15/2004

1)



- free electrons mainly in n material.
- free holes mainly in p material.
- (tiny number of holes in n-type, electrons in p-type)

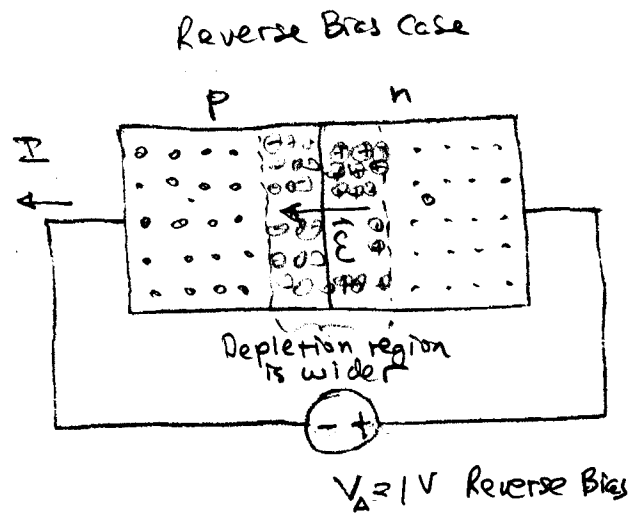
2.  $I = I_s (e^{V_A / \eta V_T} - 1)$ ,  $T = 300 \text{ K} \Rightarrow V_T = \frac{kT}{q} = \frac{300 \text{ K}}{11,586 \text{ K}} = 26 \text{ mV}$   
 $I = 10 \text{ nA} (e^{0.6 \text{ V} / 52 \text{ mV}} - 1) = 10 \text{ nA} \times 1.03 \times 10^5 = 10.3 \text{ mA}$

3.(a) The field due to  $V_A$  is opposite to the original  $\vec{E}$  so  $\vec{E}$  in the depletion region is reduced, but still in the original direction.

(b) The current is in the direction shown for  $I$  in the figure (forward bias). This means  $e$ 's move mainly from right to left across the junction, coming from the n-type material.

(c) These electrons flow primarily by diffusion. Note that they move in the direction of  $\vec{E}$ . For drift current, they would move in the opposite direction since their charge is negative. Reducing the potential diff. across the junction increases the diffusion current and reduces the drift current (since the original potential difference reduced the net current to zero).

4. (a)



(b), (c) The  $\vec{E}$  is increased due to the applied voltage. The reverse bias current is in the direction shown. The current is now due primarily to drift. Electrons making up this drift current move from left to right across the junction, from the p material into the n material. The density of such electrons is quite small, so the reverse current is small.

(In the p material,  $n_p = \frac{n_i^2}{N_A}$ )