5.20. the total current

$$I = qA\left(\frac{D_p}{L_p} p_n + \frac{D_n}{L_n} n_p\right)\left(e^{qV/kT} - 1\right) \quad \cdots\cdots \textcircled{1}$$

For from the junction in p-side, no electron current, no diffusion hole current, only the drift hole current.

Thus,

$$I_{total} = I_{drift}^{hole}$$

i.e.

$$qA\left(\frac{D_p}{L_p} p_n + \frac{D_n}{L_n} n_p\right)\left(e^{qV/kT} - 1\right) = qA\,\mu_p\, p\, \mathcal{E}(x)$$

For n^+-p junction, $\frac{D_p}{L_p} p_n \ll \frac{D_n}{L_n} n_p$

And $p \simeq N_a$

So,

$$\mathcal{E}(x \gg x_{po}) = \frac{D_n n_p}{\mu_p N_a L_n}\left(e^{qV/kT} - 1\right)$$

$\because$ $\mu_p = \frac{q}{kT} D_p$ $\quad D_n = \frac{kT}{q}\mu_n$ $\quad L_n = \sqrt{D_n \tau_n} = \sqrt{\frac{kT}{q}\mu_n \tau_n}$

$$n_p = \frac{n_i^2}{N_a}$$

$$\therefore \mathcal{E}(x \gg x_{po}) = \frac{\frac{kT}{q}\mu_n \cdot \frac{n_i^2}{N_a}}{\frac{q}{kT} D_p \cdot N_a \cdot \sqrt{\frac{kT}{q}\mu_n \tau_n}}\left(e^{qV/kT} - 1\right)$$

$$= \frac{(0.0258)^2 V^2 \times 1000\ cm^2/(V\cdot s) \times (1.45\times 10^{10})^2\ cm^{-6}}{13\ cm^2/s \times (10^{16})^2\ cm^{-6} \times (0.0258\,V \times 1000\ cm^2/V\!\cdot\! s \times 2\times 10^{-6}\,s)^{1/2}}\left(e^{0.7/0.0258} - 1\right)$$

$$\boxed{\mathcal{E}(x \gg x_{po}) = 9.10\ V/cm}$$

5.35. (a) $\delta p(x_n) = c_1 e^{x_n/L_p} + c_2 e^{-x_n/L_p}$ ...... ①

Use B.C. $\begin{cases} \delta p(x_n=0) = c_1 + c_2 = \Delta p_n \\ \delta p(x_n=l) = c_1 e^{l/L_p} + c_2 e^{-l/L_p} = 0 \end{cases}$

Get $\begin{cases} c_1 = \dfrac{-\Delta p_n e^{-l/L_p}}{e^{l/L_p} - e^{-l/L_p}} \\ c_2 = \dfrac{\Delta p_n e^{l/L_p}}{e^{l/L_p} - e^{-l/L_p}} \end{cases}$

So, $\delta p(x_n) = \dfrac{\Delta p_n [e^{(l-x_n)/L_p} - e^{(x_n-l)/L_p}]}{e^{l/L_p} - e^{-l/L_p}}$ ...... ②

(b). $I \simeq -qAD_p \dfrac{d\delta p(x_n)}{dx_n} = qAD_p \cdot \dfrac{\Delta p_n}{L_p} \dfrac{e^{(l-x_n)/L_p} + e^{(x_n-l)/L_p}}{e^{l/L_p} - e^{-l/L_p}}$

At $x_n = 0$.

$I = qAD_p \dfrac{\Delta p_n}{L_p} \cdot \dfrac{e^{l/L_p} + e^{-l/L_p}}{e^{l/L_p} - e^{-l/L_p}} = qAD_p \dfrac{\Delta p_n}{L_p} \cot h(\dfrac{l}{L_p})$

$\because \Delta p_n = p_n (e^{qV/kT} - 1)$

$\therefore I = \dfrac{qAD_p p_n}{L_p} \coth(\dfrac{l}{L_p}) (e^{qV/kT} - 1)$

5.41. $p = N_v \exp\left[-\frac{E_F - E_v}{kT}\right] \Rightarrow E_F - E_v = kT \ln \frac{N_v}{p}$

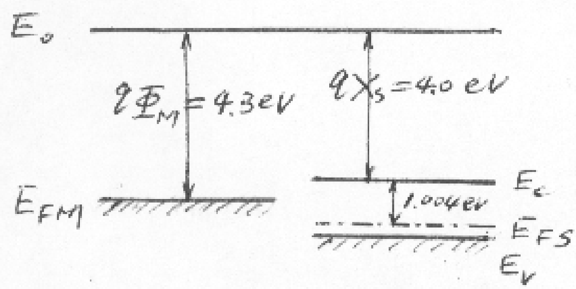
$E_F - E_v = 0.0258 \ln \frac{1.04 \times 10^{19}}{10^{17}} = 0.12 \text{ eV}$

$E_g - (E_F - E_v) = E_c - E_F = 1.124 - 0.12 = 1.004 \text{ eV}$

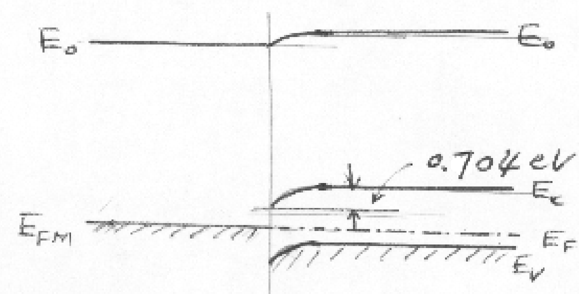
$q\Phi_s = q\chi_s + (E_c - E_F) = 4.0 + 1.004 = 5.004 \text{ eV}$

$\boxed{q\phi_i = qV_o = q\Phi_s - q\Phi_M = 5.004 - 4.3 = 0.704 \text{ eV}}$

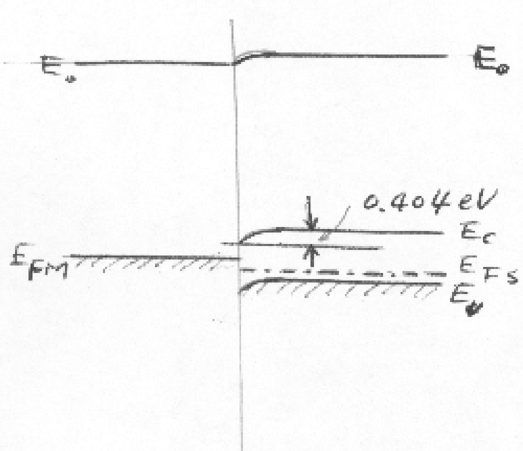
Forward bias	$V_a = 0.3$ V	$q\phi_i = 0.704 - 0.3 = 0.404$ eV
Reverse bias	$V_a = -2.0$ V	$q\phi_i = 0.704 + 2.0 = 2.704$ eV



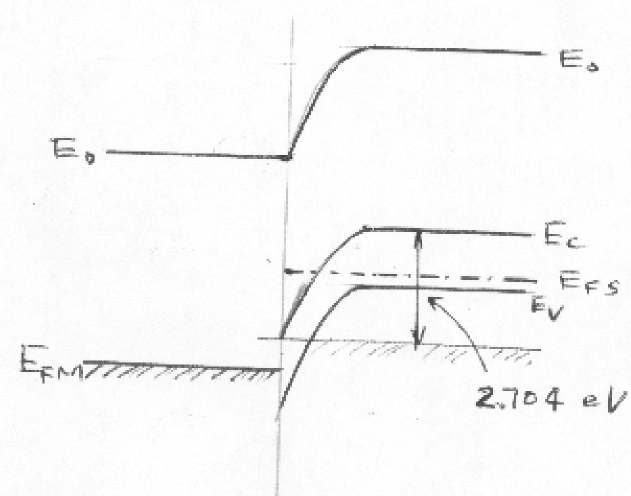
(a)



(b) at equilibrium



(c) Forward bia 0.3 V



(d) Reverse bias 2.0 V