Ch. 8-2.

1

$$J_x = |e|\mu_n n E_x - e\mu_n n C_n \frac{\partial T}{\partial x} - eD_n \frac{\partial n}{\partial x}$$

Problem. $J_x = 0$, $\frac{\partial T}{\partial x} = 0$

$$\Rightarrow \cancel{|e|}\mu_n n E_x = \cancel{e} D_n \frac{\partial n}{\partial x}$$

$$\mu_n n E_x = D_n \frac{\partial n}{\partial x} \quad \leftarrow n = n_i e^{(E_F - E_i)/kT}$$

$$E_x = \frac{D_n}{\mu_n} \frac{1}{n} \frac{\partial n}{\partial x}$$

$$= \frac{D_n}{\mu_n} \cdot \frac{1}{n} \cdot n \cdot \frac{1}{kT} \cdot \left(-\frac{dE_i}{dx}\right) \quad \leftarrow E_x = -\frac{1}{q}\frac{dE_i}{dx}$$

$$\cancel{-}\frac{1}{q}\cancel{\frac{dE_i}{dx}} = \frac{D_n}{\mu_n} \cdot \frac{1}{kT}\cancel{\left(-\frac{dE_i}{dx}\right)}$$

$$\boxed{\Rightarrow \frac{kT}{q} = \frac{D_n}{\mu_n}}$$

2

for metals $\langle \tau \rangle = \tau(\varepsilon_F) \leftarrow$ 근사 & $\frac{\partial(E_c - E_F)}{\partial T} = 0$.

$$\langle \tau \rangle = \frac{\int \tau \varepsilon^{3/2} \frac{df_0}{d\varepsilon} d\varepsilon}{\int \varepsilon^{3/2} \frac{df_0}{d\varepsilon} d\varepsilon} = \frac{\int \tau \varepsilon^{3/2} \delta(\varepsilon - \varepsilon_F) d\varepsilon}{\int \varepsilon^{3/2} \delta(\varepsilon - \varepsilon_F) d\varepsilon}$$

* for metals, $\frac{\partial f_0}{\partial \varepsilon} = -\delta(\varepsilon - \varepsilon_F)$

For a non-degenerate semiconductor with $\tau = A\varepsilon'^{-s}$

$$\langle \tau \varepsilon' \rangle = \frac{\int A \varepsilon^{-s+3/2} \frac{df_0}{d\varepsilon} d\varepsilon}{\int \varepsilon'^{3/2} \frac{df_0}{d\varepsilon} d\varepsilon} = A \frac{\varepsilon_F^{-s+3/2} + \frac{(\pi k_B T)^2}{6} \frac{d^2}{d\varepsilon'^2} \left(\varepsilon'^{-s+5/2}\right)\Big|_{\varepsilon'=\varepsilon_F}}{\varepsilon_F^{3/2} + \frac{(\pi k_B T)^2}{6} \frac{d^2}{d\varepsilon'^2} \left(\varepsilon'^{3/2}\right)\Big|_{\varepsilon'=\varepsilon_F}}$$

$$* \; I = -\int_0^\infty G(\varepsilon_0) \frac{\partial f_0}{\partial \varepsilon} d\varepsilon$$

$$\rightarrow I = G(\varepsilon_F - \varepsilon_c) + \frac{(\pi k_B T)^2}{6} G''(\varepsilon_F - \varepsilon_c)$$

metal.

$$\langle \tau \varepsilon' \rangle = \frac{\int \tau \varepsilon'^{+5/2} \frac{df_0}{d\varepsilon'} d\varepsilon'}{\int \varepsilon'^{3/2} \frac{df_0}{d\varepsilon'} d\varepsilon'} = \frac{\tau(\varepsilon_F)\varepsilon_F^{5/2} + \frac{(\pi k_B T)^2}{6} \frac{d^2}{d\varepsilon'^2} \left(\tau(\varepsilon)\varepsilon'^{5/2}\right)\Big|_{\varepsilon'=\varepsilon_F}}{\varepsilon_F^{3/2} + \underbrace{\frac{(\pi k_B T)^2}{6} \frac{d^2}{d\varepsilon'^2} \left(\varepsilon'^{3/2}\right)\Big|_{\varepsilon'=\varepsilon_F}}_{\rightarrow \text{ Ignore (: small)}}}$$

$$* \; \frac{d^2}{d\varepsilon^2}\left(\tau(\varepsilon)\, \varepsilon^{5/2}\right)\Big|_{\varepsilon=\varepsilon_F}$$

$$\hookrightarrow \frac{d}{d\varepsilon}\left(\varepsilon^{5/2}\frac{d\tau}{d\varepsilon} + 5/2\, \varepsilon^{3/2}\, \tau(\varepsilon)\right)\Big|_{\varepsilon=\varepsilon_F}$$

$$= 5/2\, \varepsilon^{3/2} \frac{d\tau}{d\varepsilon} + \varepsilon^{5/2} \frac{d^2\tau}{d\varepsilon^2} + 5/2 \cdot 3/2\, \varepsilon^{1/2}\tau(\varepsilon) + 5/2\, \varepsilon^{3/2} \frac{d\tau}{d\varepsilon}\Big|_{\varepsilon=\varepsilon_F}$$

$$= 5\, \varepsilon^{3/2} \frac{d\tau}{d\varepsilon} + \underbrace{\varepsilon^{3/2} \frac{d^2\tau}{d\varepsilon^2}}_{\text{small}} + \frac{15}{4} \varepsilon^{1/2}\tau(\varepsilon)\Big|_{\varepsilon=\varepsilon_F}$$

for metal
$\langle \tau \rangle \simeq \tau(\varepsilon_F)$

$$\simeq \frac{15}{4} \varepsilon_F^{1/2} \tau(\varepsilon_F) + 5\, \varepsilon_F^{3/2} \frac{d\tau}{d\varepsilon}\Big|_{\varepsilon=\varepsilon_F}$$