Chapter 10 50, 57, 64, 66

10-25

Figure 25

At the top of $n=2$ band, each cell contains a whole wavelength. Thus $a=\lambda$.
At the top of the $n=1$ band, each cell contains one half wavelength, or $a=\lambda/2$

The Energy is $E = \dfrac{\hbar^2 k^2}{2m}$

The energy at the top of the $n=2$ $\quad k = \dfrac{n\pi}{a}$

$$E_{\text{top of }2} = \frac{\hbar^2}{2m}\left(\frac{2\pi}{a}\right)^2$$

$$E_{\text{top of }1} = \frac{\hbar^2}{2m}\left(\frac{2\pi}{2a}\right)$$

$$\Delta E = E_{\text{top of }2} - E_{\text{top of }1} = \frac{\hbar^2(2\pi/a)}{2m} - \frac{\hbar^2(2\pi/2a)}{2m}$$

$$= \frac{3\hbar^2\pi^2}{2ma^2}$$

$$\Delta E = \frac{3(1.055\ 10^{-34}\,\text{Js})^2\pi^2}{2(9.11\times10^{-31}\,\text{kg})(0.15\ 10^{-9}\,\text{m})^2}$$

$\boxed{\Delta E \cong 50\,\text{eV}}$

57

Semi conductor

Gap 1eV

$\Delta T \uparrow = 4K$ ~~$\sigma \uparrow$ by~~

show that $\sigma \uparrow$ by 30%

Conductivity is dominated by a factor of $e^{-E_{Gap}/2k_B T}$

$$\frac{\sigma_f}{\sigma_i} = \exp\left[\frac{-E_{Gap}}{2k_B}\left[\frac{1}{T_f} - \frac{1}{T_i}\right]\right]$$

$$= \exp\left[\frac{E_{gap}\,(T_f - T_i)}{2k_B\, T_f T_i} \right]$$

$$= \exp\left[\frac{(1.6\ 10^{-19}\,J)(4\,K)}{2(1.38\ 10^{-23}\,J/K)(295)(299)} \right]$$

$= 1.3 \sim 30\%$ rise

64

$$E = \frac{hc}{\lambda} = \frac{1240\ eV \cdot nm}{700\ nm}$$

$$\boxed{E = 1.77\ eV}$$

66

$$E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E} = \frac{1240\ \cancel{eV} \cdot nm}{2.25\ \cancel{eV}}$$

$$\boxed{\lambda = 551\ nm}$$