1. Yes; www.chu.berkeley.edu/modern-semiconductor-devices-for-integrated-circuits-chenming-calvin-hu-2010/

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3. At 0 Kelvin, molecules and electrons have no energy. Since no electrons in Si have energy to jump from the valence band to the conduction band at 0 K, the valence band is full of electrons and the conduction band has no electrons. Electrons are not able to move in the valence band because there is no place for electrons to move to; electrons are not able to move in the conduction band because there are no electrons. Therefore, since no electrons can move, Si at 0 K cannot conduct any electric current.

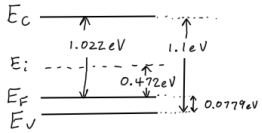
2)

a) p-type, $N_A=5\times10^{23}\ \mathrm{m}^{-3}$

$$p = N_A = 5\times10^{23}/m^3$$

$$E_F - E_V = -kT\cdot\ln\left(\frac{N_A}{N_V}\right) = 0.026\cdot\ln\left(\frac{5\times10^{23}}{10^{25}}\right) = 0.0779\,eV$$

$$n = \frac{n_i^2}{N_A} = \frac{(1.5\times10^{16})^2}{5\times10^{23}} = 4.5\times10^{8}/m^3$$

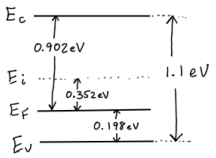


b) p-type, $N_A=5\times10^{21}\ \mathrm{m}^{-3}$

$$p = N_A = 5\times10^{21}/m^3$$

$$E_F - E_V = -kT\cdot\ln\left(\frac{N_A}{N_V}\right) = 0.026\cdot\ln\left(\frac{5\times10^{21}}{10^{25}}\right) = 0.198\,eV$$

$$n = \frac{n_i^2}{N_A} = \frac{(1.5\times10^{16})^2}{5\times10^{21}} = 4.5\times10^{10}/m^3$$

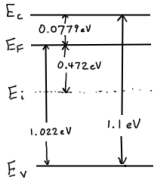


c) n-type, $N_D=5\times10^{23}\ \mathrm{m}^{-3}$

$$n = N_D = 5\times10^{23}/m$$

$$E_c - E_F = -kT\cdot\ln\left(\frac{N_D}{N_c}\right) = -0.026\cdot\ln\left(\frac{5\times10^{23}}{10^{25}}\right) = 0.0779\,eV$$

$$p = \frac{n_i^2}{N_D} = \frac{(1.5\times10^{16})^2}{5\times10^{23}} = 4.5\times10^{8}/m^3$$



d) n-type, $N_D=5\times10^{21}\ \mathrm{m}^{-3}$

$$n = N_D = 5\times10^{21}/m$$

$$E_c - E_F = -kT\cdot\ln\left(\frac{N_D}{N_c}\right) = -0.026\cdot\ln\left(\frac{5\times10^{21}}{10^{25}}\right) = 0.198\,eV$$

$$p = \frac{n_i^2}{N_D} = \frac{(1.5\times10^{16})^2}{5\times10^{21}} = 4.5\times10^{10}/m^3$$