1. $T = 300K$, $k = 8.625 \times 10^{-5}\ eV/K$

$E_g = 5.6\ eV$

$E_C - E_F = \frac{E_g}{2} = 2.8\ eV$

$$f(E_C) = \frac{1}{1 + e^{\frac{(E_C - E_F)}{kT}}} = 1.09 \times 10^{-47}$$

2. $E_C - E_F = 0.4\ eV$.

Assume, $T = 300K$

$$n_e = N_C\, e^{-(E_C - E_F)/kT} \quad \ldots\ldots (1)$$

$$2n_e = N_C\, e^{-(E_C - E_F)/kT} \quad \ldots\ldots (2)$$

$$(2) \div (1) \qquad 2 = e^{\frac{-(E_C - E_{F_2}) + (E_C - E_{F_1})}{kT}}$$

$$\Rightarrow kT \ln 2 = -(E_C - E_{F_2}) + 0.4$$

$$\Rightarrow E_C - E_{F_2} = 0.4 - kT \ln 2$$

$$= 0.382\ eV.$$

3. $E_F - E_i = kT \ln\left(\frac{n_0}{n_i}\right)$

$n_0 \approx N_D$

$n_i = 1.5 \times 10^{10}\ cm^3$ at $T = 300K$

$E_F - E_i = 0.424\ eV$.

$\Rightarrow E_F = E_i + 0.424$

4. $E_F - E_V = kT \ln\left(\frac{N_V}{P_0}\right)$

$P_0 \approx N_A = 5 \times 10^{16} / cm^3$

$N_V = 4.82 \times 10^{15} \times \left(\frac{m_p}{m}\right)^{3/2} \cdot T^{3/2}$

$= 0.0259$

	Si	Ge	GaAs
N_c	2.8×10^{19}	1.04×10^{19}	4.7×10^{17}
N_V	1.04×10^{19}	6×10^{18}	7×10^{18}
$\frac{m_n}{m}$	1.08	0.57	0.067
$\frac{m_p}{m}$	0.56	0.37	0.48

$E_F - E_V = kT \ln\left(\frac{7 \times 10^{18}}{5 \times 10^{16}}\right)$

$= 0.127 \text{ eV}$

5. $E_F - E_V = 0.22 eV = kT \ln\left(\frac{N_V}{P_0}\right)$

$= kT \ln\left(\frac{N}{N_A}\right)$

$N_V = 1.04 \times 10^{19} / cm^3$

$\therefore \frac{N_V}{N_A} = e^{\frac{0.22}{0.0259}} = 4914.77$

$\Rightarrow N_A = P_0 = \frac{1.04 \times 10^{19}}{4914.77} = 2.12 \times 10^{15} / cm^3$ Ans

$np = n_i^2$

$\Rightarrow n_0 = \frac{n_i^2}{P_0}$

$= \frac{(1.5 \times 10^{10})^2}{2.12 \times 10^{15}}$

$= 1.02 \times 10^5 / cm^3$

Ans