Ge, \( E_g = 0.6 \text{ eV} \)

Gibbs' donor levels in gap 0.01eV below bottom of conduction band at \( T = 300 \text{K} \), probability \( e^{-E/RT} \). Draw energy-level diagram at bottom of conduction band. Where is Fermi level?

See Ex. 42.9, p. 165 and Ex. 42.17, p. 161

\[
\frac{E}{kT} = \frac{1}{e^{E/E_F/kT} - 1}
\]

Solve for \( E_F \):

\[
E - E_F = kT \ln \left( \frac{1}{e^{-E/RT} - 1} \right)
\]

\[
E_F = E - kT \ln \left( \frac{1}{e^{-E/RT} - 1} \right)
\]

\[
E_F = E - (1.38 \times 10^{-23}) \left( \frac{1}{1200} \right) \ln \left[ \frac{1}{4.16 \times 10^{-4}} - 1 \right]
\]

\[
E_F = E - 3.26 \times 10^{-20} = E - 0.20 \text{ eV}
\]

So Fermi level is 0.20 eV below conduction band. This means at room temp there is a good percentage of chance for e- to get into conduction band.