2.2. Refer to fig 1.14.

As we can see from this figure, GaAs has a direct bandgap and so the conduction minima is the \( \Gamma \) band. The electron concentration is maximum as the energy required for the electrons to move to the \( X \) and \( L \) bands is maximum. As the value of \( x \) is increased, the energy difference decreases and it becomes easier for electrons to jump to the \( X \) and \( L \) bands from the \( \Gamma \) band. As a result, the electron concentration in the conduction minima is decreased until the bands crossover. After this point, the energy difference starts to increase and now the \( X \) band is the conduction minima. Once again
the electron concentration in the $x$ band starts to increase, though it is never as much as the GaAs concentration because the energy difference between the $x$ and $L$ bands is less than the initial energy difference.
The pressure applied decreases the interatomic spacing, which results in an increase in the energy gap and hence alters the concentration of electron absorption. This is the principle of the pressure sensor.

Merits
- High sensitivity
- Good resolution
- Mobility & equilibrium carrier conc. can be determined.

Demerits
- Beyond a certain magnitude of pressure, GaAs becomes indirect bandgap.
- Change in bandgap causes change in dielectric constant. This alters ionization energies of impurity atoms.
- The intrinsic carrier conc. depends exponentially on the bandgap energy which alters the material properties.
\[ N_{D1} = 1 \times 10^{16} \text{ cm}^{-3} \]
\[ N_{D2} = 2 \times 10^{16} \text{ cm}^{-3} \]

According to charge neutrality

\[ n_0 + Na^- = p_0 + Nd^+ \]

\( Na^- \) is negligible

\[ \Rightarrow n_0 \approx p_0 + Nd^+ \]
\[ Nd^+ = N_{D1} + N_{D2} \]

\[ n_0 \approx p_0 + 3 \times 10^{16} \]

If acceptor atoms are added

\[ n_0 + Na^- \approx p_0 + 5 \times 10^{16} \]

\[ \Rightarrow n_0 = p_0 + 2.1 \times 10^{16} \]

Compensation of donor atoms changes the slope or the activation energy of the plot of \( \ln [n(p)] \) versus \( 1/T \) at low temperature.