

SSP Exercise 5

To be handed in by 4pm, Thursday 16th February.

1. Explain why phosphorus and boron atoms function as donors and acceptors in silicon. Which one acts as a donor? [5]

2. A detailed calculation shows that at low temperature in an n-type material, the density of ionised donors is given by:

$$n_D^+ = N_D \left[\frac{1}{\exp((\epsilon_D - \epsilon_F)/kT) + 1} \right]$$

Use this and the graphs below to **estimate**:

(i) the donor ionisation energy relative to the Fermi energy for n-type silicon [5]. **Hint:** Freeze-out range corresponds to the behaviour of donors (see lecture on extrinsic semiconductors).

(ii) the band gap energy of gallium arsenide (GaAs) [5]

(iii) the band gap energy of germanium (Ge) [5].

