Phosphorous donor atoms with a concentration of $10^{16}$ cm$^{-3}$ are added to a piece of silicon. Assume that the phosphorous atoms are distributed homogeneously throughout the silicon. The atomic weight of phosphorous is 31.

a) What is the sample resistivity at 300 K?

b) What proportion by weight does the donor impurity comprise? The density of silicon is 2.33 gram/cm$^3$.

c) If $10^{17}$ atoms cm$^{-3}$ of boron are included in addition to phosphorous, and distributed uniformly, what is the resulting resistivity and type (i.e., p- or n-type material)?

d) Sketch the energy-band diagram under the condition of part c) and show the position of the Fermi energy relative to the valence band edge.