810.

Problem 53.38 (RHK)

A sample of pure germanium has one impurity atom to 1.3×10^{9} *atoms of germanium. We have to calculate the distance between impurity atoms.*

Solution:

From the physical data of germanium we calculate the number of germanium atoms per cubic meter. The physical data for germanium are:

molar mass of germanium, $M_{\text{Ge}} = 72.61 \text{ g mol}^{-1}$,

density of germanium, $\rho_{\text{Ge}} = 5.323 \text{ g cm}^{-3}$.

Therefore, the number of germanium atoms per cubic meter is given by

$$n_{\text{Ge}} = \frac{N_A \rho_{\text{Ge}}}{M_{\text{Ge}}} = \frac{6.02\times10^{23} \text{ mol}^{-1} \times 5.323\times10^{3} \text{ kg m}^{-3}}{72.61\times10^{-3} \text{ kg mol}^{-1}}$$

$$= 4.41\times10^{28} \text{ m}^{-3}.$$

It is given that a sample of pure germanium has one impurity atom to 1.3×10^{9} atoms of germanium. Therefore, the number of impurity atoms per cubic meter in that sample of germanium will be

$$\frac{4.41\times10^{28}}{1.3\times10^{9}} = 3.39\times10^{19} \ .$$

Therefore, the average distance between impurity atoms will be

$$a = \left(\frac{1}{3.39\times10^{19}} \right)^{1/3} \ \text{m} = 3.09\times10^{-7} \ \text{m} = 309 \ \text{nm}.$$