Exercise 12-11

woensdag 20 mei 2020 20:47

Calculate the value of n_j in which an oxygen atom confined to a cubical box 1 cm on each side will have the same energy as the lowest energy available to a helium atom confined to a cubical box 2×10^{-10} m on each side.

$$\varepsilon_j = \frac{\pi^2\hbar^2}{2mL^2} n_j^2 = \frac{\pi^2\hbar^2}{2mV^{\frac{2}{3}}} n_j^2$$

ground state

$$\varepsilon_j\,(O_2) = \varepsilon_1(He)$$

$$n_1^2(He) = n_{1x}^2(He) + n_{1y}^2(He) + n_{1z}^2(He) = 1^2+1^2+1^2 = 3$$

$$n(O_2)^2 \frac{\pi^2\hbar^2}{2m\,(10^{-2})^2} = \frac{\pi^2\hbar^2}{2m\,(2\times10^{-10})^2}\,3$$

$$\frac{n(O_2)^2}{32u\times\ \ 10^{-4}} = \frac{3}{4u\times\ \ 4\times10^{-20}}$$

$$n_j(O_2)^2 = \frac{3\times32}{4\times4}\times10^{16}$$

$$= 6\times10^{16}$$

$$n_j(O_2) = \sqrt{6\times10^{16}} = 2{,}4\times10^{8}$$