Answer on question #62345, Chemistry / Inorganic Chemistry

The transition from J = 0 to J'=1 for HCl takes place at 21.18 cm^{-1}.Calculate the bond length for 1H35Cl.

Solution:

The dependence of the rotational constant on bond length, R_o:

$$\tilde{B}_0 = \frac{\hbar}{4\pi cI}$$

Where the moment of inertia $I = \mu R^2$ o for a diatomic molecule.

$$\tilde{B}_0 = \frac{\hbar}{4\pi\mu c{R_0}^2}$$

Where μ = m1m2/ m1+m2

m_1(H)=1.008 amu
m_2(Cl)=35.453 amu

$$\mu = \frac{1.008\ amu \times 35.453\ amu}{1.008\ amu + 35.453\ amu} = 0.980\ amu$$

Then

$$R_0 = \sqrt{\frac{\hbar}{4\pi\mu c\tilde{B}_0}}$$

You need the units in kg, so you multiply by the constant, $1.66 \cdot 10^{-27}$ kg/amu.

Finally

$$R_0 = \sqrt{\frac{1.0546 \cdot 10^{-34}\ Js}{4\pi \times 0.980\ amu\ \times\ 1.66 \cdot 10^{-27}\frac{kg}{amu} \times 3 \cdot 10^8 \frac{m}{s} \times 2118\mathrm{m}^{-1}}} = 9.01 \cdot 10^{-11} m$$

$$R_0 = 90.1\ pm$$

Answer: 90.1 pm