**Answer on Question #44197-Physics-Mechanics-Kinematics-Dynamics**

For hydrogen iodide, 1 H^127 I, force constant is 314 N m-1. Calculate the fundamental frequency in cm^-1 unit for

i) 1H127I

ii) 2H127I

Hint: Assume that force constant does not change with isotopic substitution.

**Solution**

In the harmonic approximation, the stationary vibrational energy levels for a diatomic molecule A–B are given by

$$E_{\mathrm{v}} = (\mathrm{v}+½)\hbar\omega = (\mathrm{v}+½)\hbar\sqrt{\frac{k}{\mu}}, \qquad \mathrm{v} = 0, 1, 2, \cdots$$

where k is the "force constant" for the chemical bond between the atoms A and B, $\mu$ is the reduced mass, $\mu = m_A m_B/(m_A + m_B)$ .

i)

$$\omega_1 = \frac{1}{2\pi c}\sqrt{\frac{k}{\mu_1}} = \frac{1}{2\pi \cdot 3 \cdot 10^8}\sqrt{\frac{314}{\frac{1.67 \cdot 10^{-27} \cdot 212 \cdot 10^{-27}}{1.67 \cdot 10^{-27} + 212 \cdot 10^{-27}}}} = 0.231 \cdot 10^6\ m^{-1} = 2310\ cm^{-1}.$$

ii)

$$\omega_2 = \frac{1}{2\pi c}\sqrt{\frac{k}{\mu_2}} = \frac{1}{2\pi \cdot 3 \cdot 10^8}\sqrt{\frac{314}{\frac{3.34 \cdot 10^{-27} \cdot 212 \cdot 10^{-27}}{3.34 \cdot 10^{-27} + 212 \cdot 10^{-27}}}} = 0.164 \cdot 10^6\ m^{-1} = 1640\ cm^{-1}.$$