Answer on Question #50965 – Physics - Other

The HCl molecule consists of a hydrogen atom (mass $m_H = 1\text{u}$) and a chlorine atom (mass $m_{\text{Cl}} = 35\text{u}$). The centres of the two atoms are separated by $l = 127\text{pm}$ (=1.27x10-10m). What is the moment of inertia, I, about an axis perpendicular to the line joining the two atoms which passes through the centre of mass of the HCl molecule?

Solution:

The centre of mass of HCl molecule locates at a distance of $\frac{l}{36}$ from the chlorine atom and at a distance of $\frac{35}{36}l$ from the hydrogen atom due to its masses. The moment of inertia of a point particle with mass m located at a distance r from the axis is given by

$$I = mr^2$$

So the moment of inertia of the HCl molecule is given by

$$I_{\text{HCl}} = m_{\text{H}}\left(\frac{35}{36}l\right)^2 + m_{\text{Cl}}\left(\frac{l}{36}\right)^2 = \frac{35^2 \cdot 1\text{u} + 35\text{u}}{36^2}l^2 = \frac{35}{36}\text{u}l^2 =$$
$$= \frac{35}{36}1.66 \cdot 10^{-27}\text{kg} \cdot (1.27 \cdot 10^{-10})^2\text{m}^2 = 2.6 \cdot 10^{-47}\text{kg} \cdot \text{m}^2$$

Answer: $I_{\text{HCl}} = m_{\text{H}}\left(\frac{35}{36}l\right)^2 + m_{\text{Cl}}\left(\frac{l}{36}\right)^2 2.6 \cdot 10^{-47}\text{kg} \cdot \text{m}^2$.