Question #81072, Physics / Astronomy | Astrophysics | Completed

Task: An energy of 5.35eV is stored by a molecule undergoing circulatory motion with an angular momentum of 0.5kgm^2s-1, determine its moment of inertia.

Solution: Rotational energy or angular kinetic energy is kinetic energy due to the rotation of an object and is part of its total kinetic energy. Looking at rotational energy separately around an object's axis of rotation, the following dependence on the object's moment of inertia is observed:

$$E_{rot} = \frac{1}{2} I\omega^2 (1)$$

where

ω is a angular velocity

I is the moment of inertia around the axis of rotation

$E_{rotational}$ is the kinetic energy

angular momentum L is proportional to moment of inertia I and angular speed ω

$$L = I\omega (2)$$

From (1) and (2) we have:

$$\begin{cases} E_{rot} = \frac{1}{2} I\omega^2 \\ L = I\omega \end{cases}$$

$$\omega = \frac{L}{I}$$

$$E_{rot} = \frac{1}{2} I \cdot \left(\frac{L}{I}\right)^2 = \frac{1}{2} I \cdot \frac{L^2}{I^2} = \frac{1}{2} \cdot \frac{L^2}{I}$$

$$I = \frac{L^2}{E_{rot}}$$

E_{rot}= 5.35eV=5.35$eV \cdot\ 1.6 \cdot\ 10^{-19}\ J$

$$I = \frac{L^2}{E_{rot}} = \frac{\left(0.5\ \mathrm{kg\ m^2/s}\right)^2}{5.35 \cdot 1.6 \cdot 10^{-19}\ \mathrm{J}} = \frac{0.5^2}{8.56 \cdot 10^{-19}}\ kg\ m^2 = 2.92 \cdot 10^{17}\ kg\ m^2$$

Answer: $I = \frac{L^2}{E_{rot}} = 2.92 \cdot 10^{17}\ kg\ m^2$