1. Calculate the lowest possible energy for an electron ($m=9.11 \times 10^{-31}$kg) confined to a cube of sides equal to 10^{-10} m.

Lowest energy or $n_1 = n_2 = n_3 = 1$; $a = 10^{-10}\,m$

$$E = \frac{h^2}{8m_1 a^2}(n_1^2 + n_2^2 + n_3^2)$$

$$= \frac{3 \cdot [6.626 \times 10^{-34}\,J \cdot s]^2}{8 \cdot 9.11 \times 10^{-31} \cdot (10^{-10} m)^2} = 1.81 \times 10^{-17}\,J$$

2. An electron is confined to a one-dimensional box 1 nm long. How many energy levels are there with energy less than 1.6×10^{-18} J?

$1\,nm = 10^{-9}\,m$

$$E_n = \frac{n^2 h^2}{8ma^2} = n^2 \cdot \frac{(6.626 \times 10^{-34})^2}{8.9.11 \times 10^{-31} \cdot (10^{-9})^2}$$

$$= n^2 \cdot 6.024 \times 10^{-20}\,J$$

$$\Rightarrow \frac{1.6 \times 10^{-18}}{6.024 \times 10^{-20}} > n^2 \Rightarrow 5.17 > n$$

$\Rightarrow$ levels $n=1$ to $n=5$ have energies less than $1.6 \times 10^{-18}\,J$

3. The natural frequency of the N_2 molecule corresponds to a wavenumber of 2360 cm^{-1}. Calculate the zero-point energy and the energy corresponding to $v = 1$.

$$\nu_0 = c \cdot \frac{1}{\lambda_0} = 2.998 \times 10^{10}\,\frac{cm}{s} \times 2360\,\frac{1}{cm}$$

$$= 7.075 \times 10^{13}\,Hz$$

Zero point energy $= \frac{1}{2} h\nu_0 = 0.5 \times 7.075 \times 10^{13} \times 6.624 \times 10^{-3}$

$= 2.34 \times 10^{-20}\,J$

Energy of $v=1$ $\quad \frac{3}{2} h\nu_0 = 7.03 \times 10^{-20}\,J$