Name Key

3. The NO molecule has a doubly degenerate (*i.e.*, degeneracy = 2) excited electronic level 121 cm^{-1} above the doubly degenerate ground state.
If the temperature is 100 K what is the ratio of the numbers of molecules in the two states?
Note/ Please be very careful about the units.

$$\frac{n_2}{n_1} = \left(\frac{\text{degen}_2}{\text{degen}_1}\right) e^{-\Delta\epsilon/kT} = \left(\frac{2}{1}\right) e^{-\Delta\epsilon/kT}$$

$$\Delta\epsilon = h\nu = \frac{hc}{\lambda} = hc\tilde{\nu}$$

$$\frac{\Delta\epsilon}{kT} = \frac{hc\tilde{\nu}}{kT} = \frac{hc\tilde{\nu}N_A}{RT}$$

$$= \frac{(6.626\times10^{-34}\ J\cdot s)(2.998\times10^{10}\ \frac{cm}{s})(121\ cm^{-1})(6.022\times10^{23}\ mol^{-1})}{(8.314\ J/mol\text{-}K)(100\ K)}$$

$$= 1.74$$

$$\frac{n_2}{n_1} = e^{-1.74} = 0.175$$