This homework is due on Monday, March 8, **at the start of class**.

1. The $^{12}\text{C}^{16}\text{O}$ molecule may be considered to be a two-particle rigid rotor with an atom distance of 1.13 Å.
   a. Find the reduced mass on a kg per molecule basis.
   b. Find the moment of inertia.
   c. Find the energies of the five lowest energy levels.
   d. Find the degeneracies of each of the five lowest energy levels.
   e. Find the frequency of the energy absorbed when a molecule changes from the $J=0$ to $J=1$ state. To what portion of the electromagnetic spectrum would this frequency correspond?
2. Consider the $\text{H}^{35}\text{Cl}$ molecule with a fundamental infrared absorption at 2886 cm$^{-1}$. The frequency of this vibration is related to an equation similar to 17.73 where the mass, $m$, is replaced by the reduced mass, $\mu$.

   a. Based on this information and atomic masses, what would you predict for the force constant for the $\text{H}^{35}\text{Cl}$ molecule?

   b. What would the energy separation be between the $v=0$ and $v=1$ vibrational states for $\text{H}^{35}\text{Cl}$?

   c. If the force constant does not change with an isotopic substitution, what would you predict for the value of the wavenumber of the infrared absorption band for $\text{D}^{35}\text{Cl}$?

   d. What would you predict for the value of the infrared absorption band for $\text{H}^{37}\text{Cl}$?