Interaction-7

Coupled Oscillations with center of mass fixed

One can imagine the CO2 molecule as a carbon atom connected by springs to two oxygen atoms.

If we consider three coordinates in the longitudinal direction, as we do in class, one finds that there is one mode of oscillation with frequency “zero”. This is equivalent to uniform translation! The other two modes represent symmetric and anti-symmetric modes.

I like for you to solve the problem differently: reduce the problem to just two effective coordinates, for example x1 (for the oxygen atom on the ‘left’) and x3 (for the oxygen atom on the ‘right’), and impose that the center of mass is at the Origin of your coordinate system (which could be translating with constant velocity!!). This way, you can find the position of the carbon atom from the position of the two oxygen atoms. However, now you are dealing with just a two-dimensional problem instead of the three dimensional problem we solve in class.

Show that you also get a symmetric and anti-symmetric modes with the same frequencies as the non-zero frequencies of the three dimensional problem.

I’ll tell you something: Physics makes sense! ☺☺