

PHY 504

Problem Set #10

due 11 November 2009

1. A molecule consists of 4 identical atoms which are constrained to lie along a straight line, with an equilibrium distance b between adjacent atoms. For small oscillations about equilibrium, adjacent atoms are subject to a Hooke's Law force with spring constant k .
 - a) Write down the Lagrangian for small oscillations.
 - b) Obtain the eigenfrequencies and normal modes. (See Exercise 6.6 for a hint.)
 - c) Draw a little sketch of each of the 4 normal modes.

2. A triatomic molecule consists of three equal masses connected by harmonic forces of equal strength and equilibrium length a . Assume that all motion takes place in the xy -plane.
 - a) Working in the center of mass frame, write down the lagrangian and the equations of motion.
 - b) Obtain the normal mode frequencies for oscillations about equilibrium.
 - c) Show that the 0-frequency mode is a rotation about the center of mass, and that another normal mode corresponds to symmetrical stretching of all three vertices of the molecule.