

CHM102
Assignment 5 (7-3-2017)

1. Using the recursion relation of the Hermite polynomials,
$$x H_v = v H_{v-1} + 0.5 H_{v+1}$$
derive the selection rule for the vibrational transitions for a harmonic oscillator.
2. Using the recursion relation given above, calculate the $\langle x \rangle$ for a harmonic oscillator.
3. If the rotational constant B for the H^{35}Cl molecule is 3.13×10^{11} Hz, calculate its internuclear distance.
4. If the lines in the rotational spectrum of the H^{79}Br molecule are spaced by 16.72 cm^{-1} , calculate the internuclear distance of HBr.
5. What are the eigenvalues of the L^2 and L_z operator for the following eigenfunctions of the rotor. (Write down the values by inspection of the eigenfunctions).
 - a) $(1/4\pi)^{0.5}$
 - b) $(3/4\pi)^{0.5} \cos \theta$
 - c) $(3/8\pi)^{0.5} \sin \theta e^{-i\varphi}$
 - d) $(3/8\pi)^{0.5} \sin \theta e^{i\varphi}$
 - e) $(15/32\pi)^{0.5} \sin^2 \theta e^{-2i\varphi}$
6. Show that L^2 and L_z operators commute.