Pre-lab Questions Lab #2: Rotational/Vibrational Spectrscopy

The pre-lab questions and the data analysis for this lab are quite involved. But take heart – the lab itself is not too time consuming! I suggest tackling the data analysis during the lab session to help cut down on your lab report time.

1. Given that $R_e = 156.0$ pm and $k = 250.0\ N \cdot m^{-1}$ for $^{7}Li^{19}F$, calculate $\tilde{\nu}_0$ and $\tilde{B}$. Predict the vibrational/rotational spectrum of $^{7}Li^{19}F$ (see Example 13-3 in McQuarrie).

2. Using Equation 13.10 (in McQuarrie), determine the energy levels of $^{7}Li^{19}F$ in for $v = 0$ and $v = 1$. (Do this for the first 5 rotational levels).

3. Using Equations 13.12 and 13.13, determine the frequencies of the first four lines in the R and P branches of $^{7}Li^{19}F$.

4. For the R branch transitions:
    a. Show how Equation (14) was obtained from Equations (12).
    b. Show that substituting $n = J + 1$ into Equation (16) gives Equation (18).

   All of the equations in this problem refer to the lab handout.

5. Should $^{35}Cl/^{37}Cl$ substitution affect ν_o more or less than H/D substitution? Why? (Hint: Use Equation (6) in the lab handout to calculate the reduced masses in kg of $H^{35}Cl$, $H^{37}Cl$, $D^{35}Cl$, and $D^{37}Cl$. Then look at the dependence of ν_o on the reduced mass in Equation (7). Even though you don't know k, you can make a qualitative judgment.)