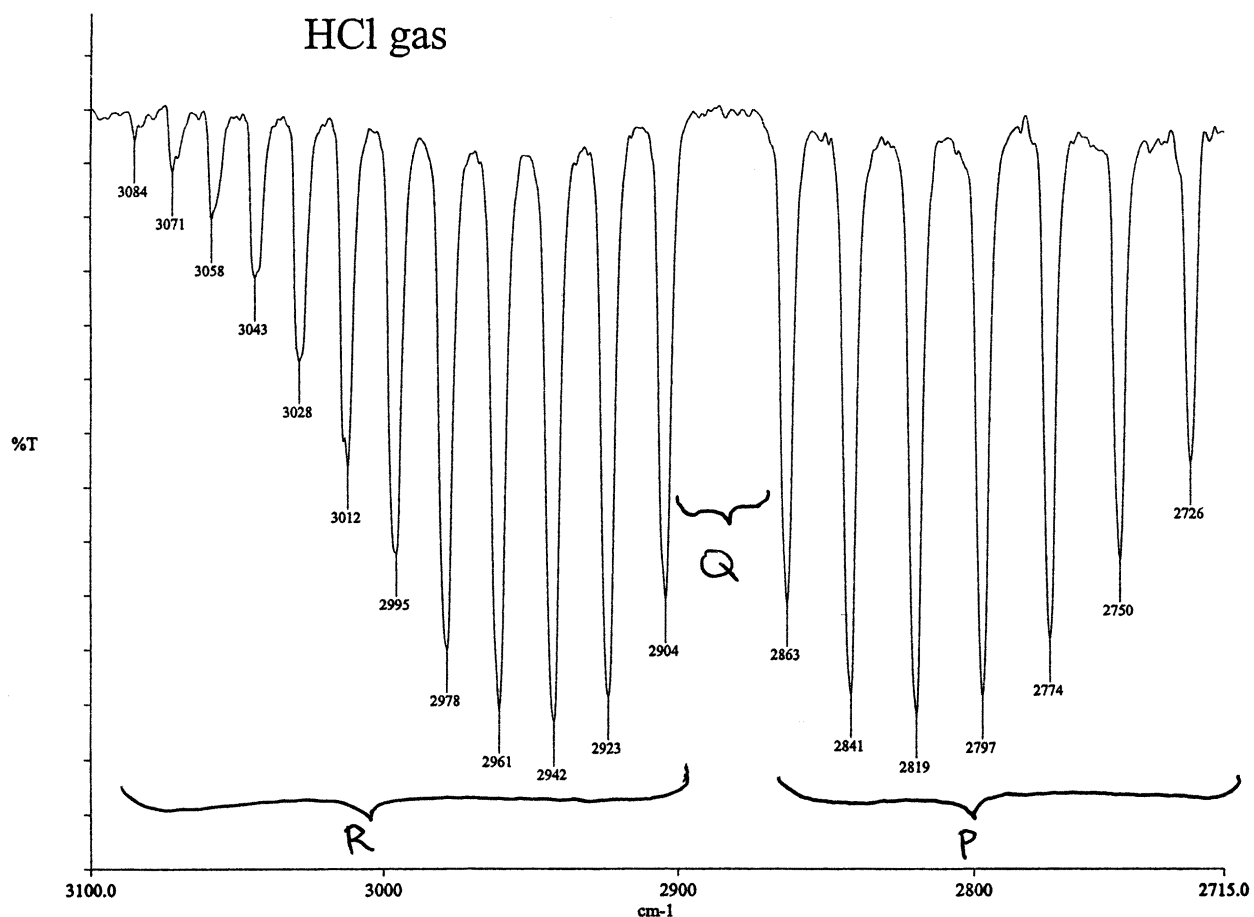


T3 Practice Problem (Refer to page C22 in the online manual)



Based on the IR spectrum of HCl shown above, answer the following questions.

- Label the P, Q and R branches of the spectrum.
P = right hand (low E) side of spectrum R = left hand (high E) side of spectrum
Q = empty middle of spectrum (where ν_0 would occur)
- The spaces between the lines appear to increase from left to right. Why?
As the diatomic molecule rotates more quickly (higher E) perpendicular to the bond, the distance between the atoms increases. (Your TA will demonstrate this with the model.) The equations in the introduction show that as r increases, I increases and B decreases. Since B is a measure of the gaps between the lines in the spectrum, the high energy side of the spectrum (left hand side) should have smaller gaps than the low energy side (right hand side).
- Calculate the ν_0 of HCl.
Average of center lines = $(2904 + 2863) \div 2 = 2883.5 \text{ cm}^{-1}$

Based on the theory of a simple harmonic oscillator, answer the following questions.

- Would the spectrum of DCl have a higher or lower ν_0 than HCl? Why?
Because D is heavier than H, DCl would have a lower ν_0 than HCl, as ν_0 is inversely proportional to μ and m .
- Would the spectrum of DCl have larger or smaller gaps between the lines than HCl? Why?
DCl would have smaller gaps, as B is inversely proportional to I , μ and m .

