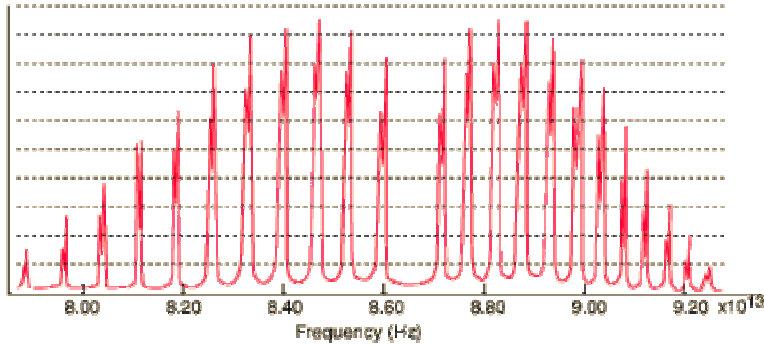


Physics 330 Example Exam 3  
April 9, 2007  
100 points total

1) Consider the vibrational-rotational absorption lines for the HCl molecule:



- (5 pts) What type of bond is this?
  - (10 pts) What is the vibrational frequency?
  - (10 pts) What is the moment of inertia of the molecule?
  - (15 pts) For H:  $A=1$ , for Cl:  $A=17$ . Use the above spectrum to calculate the bond length
- 2) When deriving the Rutherford cross section, we equated two expressions of  $\Delta p$  to get an equation relating the impact parameter to the scattering angle.
- (5 pts) What is the resulting equation?
  - (15 pts) Show the derivation of one of the  $\Delta p$  terms. (pick your favorite)
- 3) You have a selection of  $1\text{cm} \times 1\text{cm} \times 1\mu\text{m}$  foils that you were planning to use for some very high energy scattering experiments. Someone opened the door to your lab at a bad time, and a breeze mixed up all your foils. You figure you can use Rutherford scattering to figure out what they are. The first one you try is a shiny-silver colored foil. It weighs  $2.7 \times 10^{-4}\text{g}$ . Determine what your sample is. Conveniently, you keep a source of  $^{210}\text{Po}$  in your lab.
- (10 pts) What is the kinetic energy of the alpha particles emitted from  $^{210}\text{Po}$ ?
  - (10 pts) You setup a collimated beam that gives  $10^6$  alphas per second, but in doing so, you accidentally put your hand in the beam for 1 s. What is the radiation dose equivalent of your exposure? Should you be worried about your health?
  - (20 pts) The foil scatters 2.36 alphas per second at an angle greater than  $\pi/2$ . What is the foil made from? State all your assumptions, and show your reasoning.