

**AS – 6342 Spectroscopic Reactive Flow Diagnostics**  
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**Supplementary Exercise – 2**  
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**NOTE: For physical data about specific molecules refer to the website for Q data.**

1. (a) Plot the rovibronic spectrum of CO at 1 atm, 300 K. Assume that the fraction of molecules that go to lower level from a given level by emitting light is approximately  $1e-12$ . Assume that the transition probabilities are the same for all the levels for now.  
(b) repeat the above for  $T=600K$ , and  $1200K$   
(c) repeat (a) for first overtone spectrum of CO.  
(d) repeat (a) above for an isotope of CO with Carbon  $13a.m.u.$   $T=600K$ , and  $1200K$
2. Derive the expression for the wavenumber of possible rovibronic spectral line. Indicate how the expression changes for R and P branches. Include variation of energy due to centrifugal and vibrational corrections.
3. Consider effect of vibration on the rotational spectrum of CO gas. (a) Give the spectrum of CO for  $1000K$  with and without Vibrational correction. (b) Give the same at  $3500K$ . Explain each spectra and the changes between them.
4. Show by using energy level diagrams that there will be a band head in rovibronic spectrum in the R branch. Also show that P branch cannot have a band head. (When will P have a band head and R will not, mathematically? Is that physically possible?) Find the line at which band head will occur.
5. Find the line with peak emission in the R and P branches. (example R(4) P(5) etc) Show how the line number changes with temperature as shown in problem 1. Keep all the assumptions same as in problem 1.