



भारतीय विज्ञान शिक्षा एवं अनुसंधान संस्थान (मोहाली)  
INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH MOHALI  
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1. Without calculating the specific values, arrange the following molecules in order of increasing value of their rotational constants,  $B$ :

HF, DF, HC≡C–C≡C–C≡N,  $^{12}\text{C}^{16}\text{O}$ ,  $^{13}\text{C}^{16}\text{O}$ ,  $^{12}\text{C}^{18}\text{O}$ , ClCN

2. The rotational terms of a diatomic molecule (the energy levels expressed as wavenumbers) are given to a good approximation by:

$$\epsilon_J = BJ(J + 1) - DJ^2(J + 1)^2$$

- i) Write the meaning/name of the terms and their expressions for  $J$ ,  $B$  and  $D$ .
- ii) By applying selection rules for pure rotational spectroscopy, derive an expression for the energy of transitions observed in a high resolution rotational spectrum.
- iii) In a high resolution microwave study of  $^2\text{H}^{19}\text{F}$ , the consecutive four lines in the spectrum were observed at:  
22.0180  $\text{cm}^{-1}$   
44.0218  $\text{cm}^{-1}$   
65.9970  $\text{cm}^{-1}$   
87.9295  $\text{cm}^{-1}$   
Deduce the values of  $J$  for each transitions,  $B$  and  $D$  for  $^2\text{H}^{19}\text{F}$ .  
Can we deduce  $J$  using the above transitions, if we only use energy expression for rigid-linear rotor?