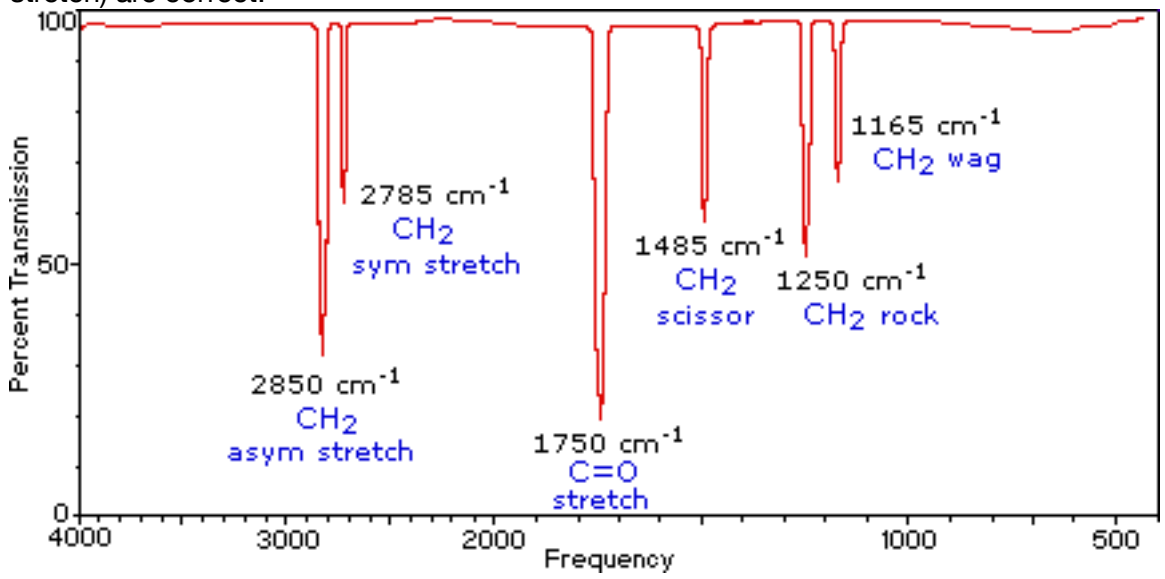
(1) Model the Diels-Alder reaction between butadiene and ethylene to form cyclohexene. Show using IRC calculations that the transition state obtained corresponds to this reaction.

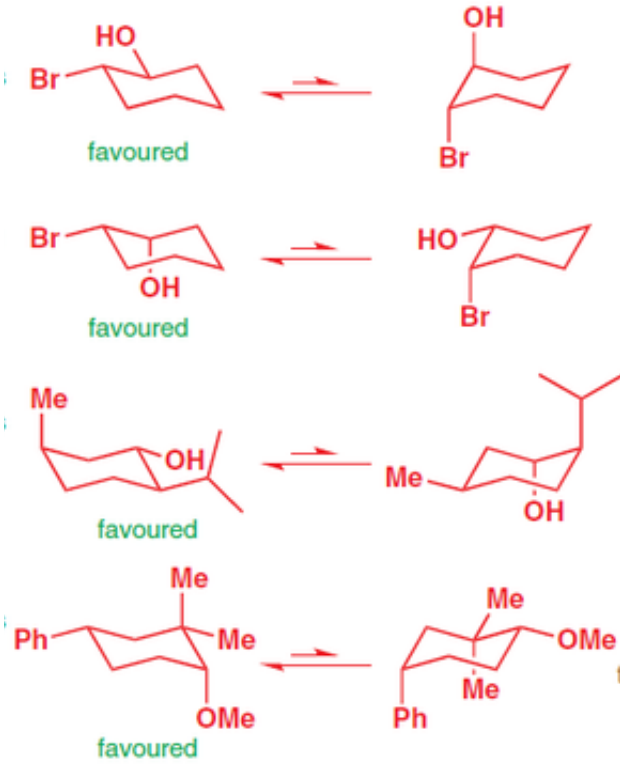
(2) Perform conformational analysis on ethane, propane and butane. Plot all the three energy curves in the same graph. Explain the observed trend of change in energies.

(3) Below is the Infrared (vibrational) spectrum of formaldehyde obtained using experiments. Compute the spectrum using HF/STO-3G method and compare the two. Check if the assignment of the frequencies of the peaks (for eg. 2850 cm^{-1} is assigned as asymmetric stretch) are correct.



Source: chemistry.msu.edu

(4) Verify the following by calculating the energy differences between the two conformational states in each case.



Source: qph.fs.quoracdn.net