Infrared Spectroscopy (IR)
By: Nada Saab

Electromagnetic radiation: Light and other forms of radiant energy.

Wavelength (λ): The distance between consecutive peaks on a wave..

Frequency (ν): The number of full cycles of a wave that pass a fixed point in a second; given the symbol (Greek nu) and reported in hertz (Hz)
Hearts (Hz) the unit in which frequency is measured: s^{-1} (read "per second").

Molecular spectroscopy: The study of which frequencies of electromagnetic radiation are absorbed or emitted by substances and the correlation between those frequencies and specific types of molecular structure.

Vibrational infrared region: The portion of the infrared region that extends from 4000 to 400 cm^{-1}.

Infrared spectroscopy: A spectroscopic technique in which a compound is irradiated with infrared radiation, absorption of which causes covalent bonds to change from a lower vibrational energy level to a higher one. Infrared (IR) spectroscopy is particularly valuable for determining the kinds of functional groups present in an organic molecule.

Wavenumber: The frequency of electromagnetic radiation expressed as the number of waves per centimeter. Symbol of wavenumber is:

$$\bar{\nu}$$

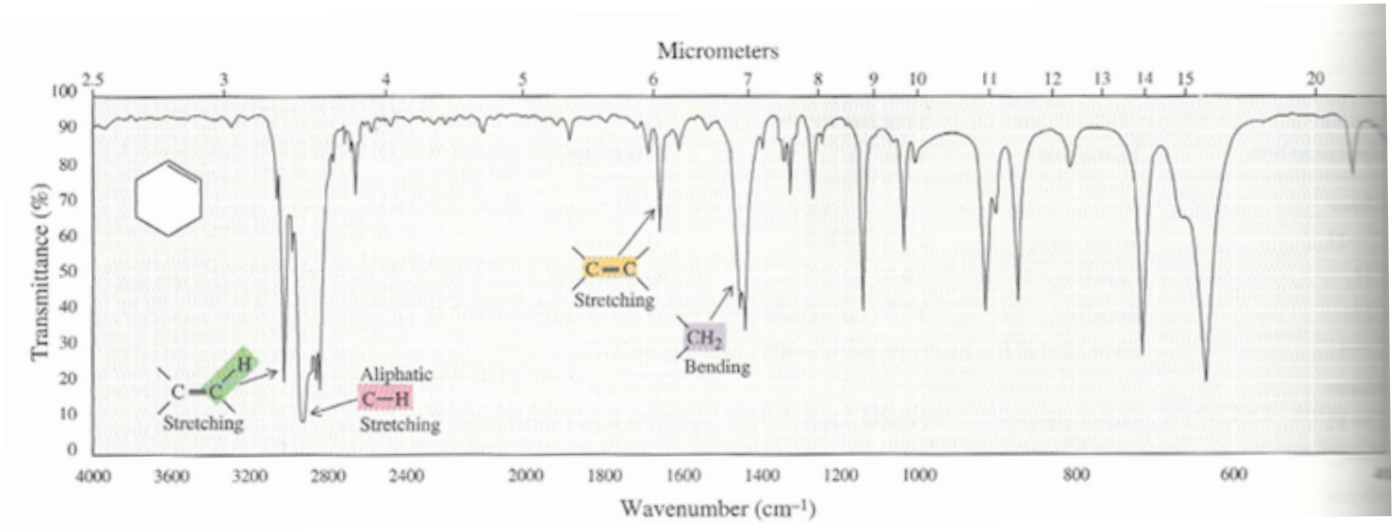
CHARACTERISTIC INFRARED ABSORPTION FREQUENCIES

Bonding		Frequency (cm^{-1})	Intensity*	Type of Vibration (Stretching unless noted
C—H	Alkane	2850–3000	w–m	
	$-CH_3$	1375 and 1450	w–m	Bending
	$-CH_2-$	1450	m	Bending
	Alkene	3000–3100	w–m	
		650–1000	s	Out-of-plane bending
	Alkyne	~3300	s	
	Aromatic	3000–3100	s	
		690–900	s	Out-of-plane bending
	Aldehyde	2700–2800	w	
		2800–2900	w	
C=C	Alkene	1600–1680	w–m	
	Aromatic	1450 and 1600	w–m	
C≡C	Alkyne	2100–2250	w–m	
C—O	Alcohol, ether, ester, carboxylic acid, anhydride	1000–1100 (sp^3 C—O)	s	
			s	
		1200–1250 (sp^3 C—O)	s	
C=O	Amide	1630–1680	s	
	Carboxylic acid	1700–1725	s	
	Ketone	1705–1780	s	
	Aldehyde	1705–1740	s	
	Ester	1735–1800	s	
	Anhydride	1760 and 1810	s	
	Acid chloride	1800	s	
O—H	Alcohol, phenol			
	Free	3600–3650	m	
	Hydrogen bonded	3200–3500	m	
	Carboxylic acid	2500–3300	m	
N—H	Amine and amide	3100–3550	m–s	
C≡N	Nitrile	2200–2250	m	

*m = medium, s = strong, w = weak

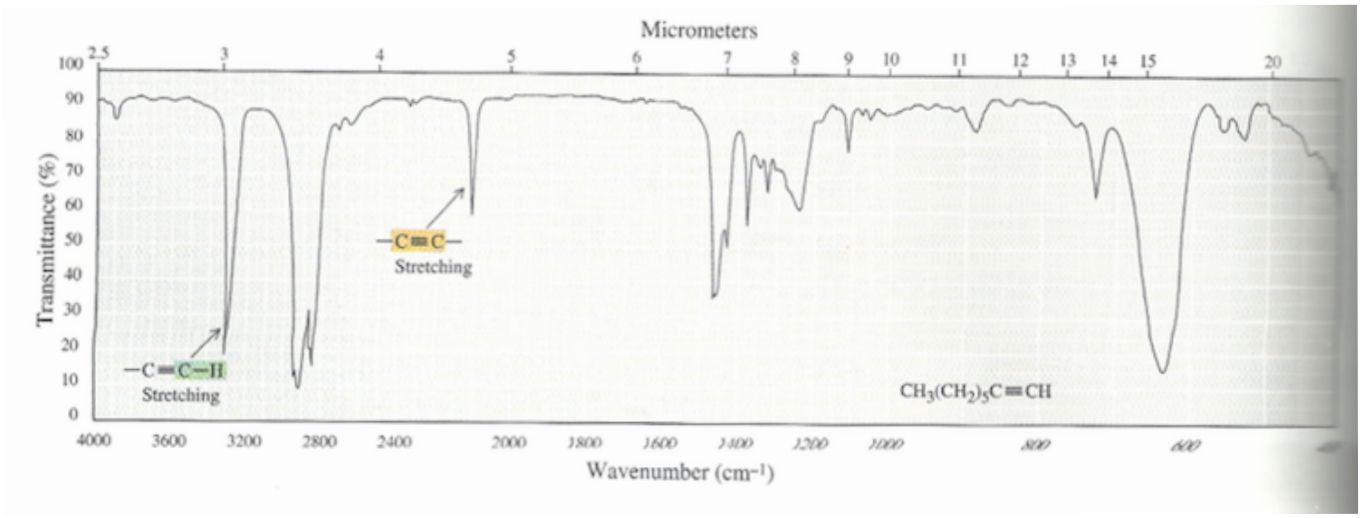
Exercise A:

Look at the table (characteristics of Infrared Absorption Frequencies) and explain the assignment of the infrared spectrum of cyclohexene.



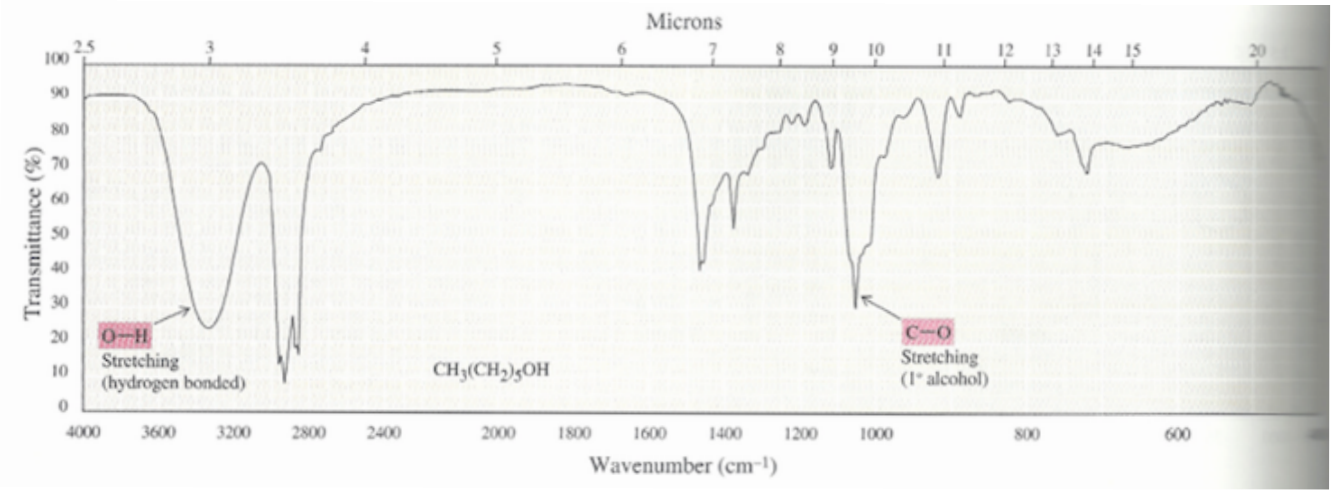
Exercise B:

Look at the table (characteristics of Infrared Absorption Frequencies) and explain the assignment of the infrared spectrum of 1- octyne



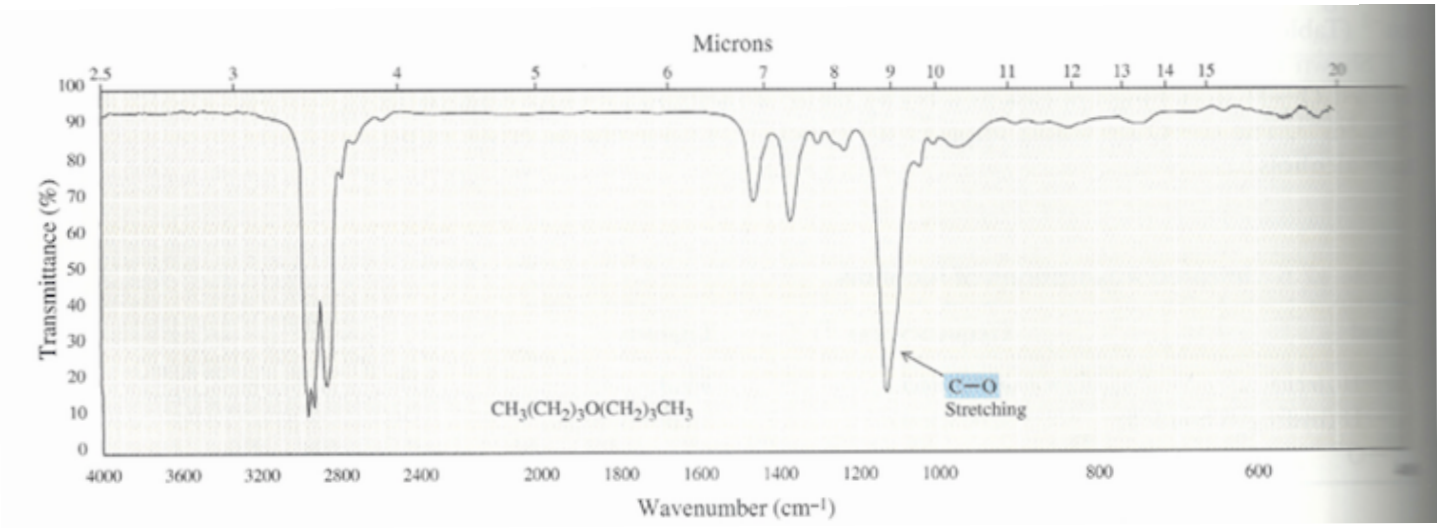
Exercise D:

Look at the table (characteristics of Infrared Absorption Frequencies) and explain the assignment of the infrared spectrum of 1- hexanol.



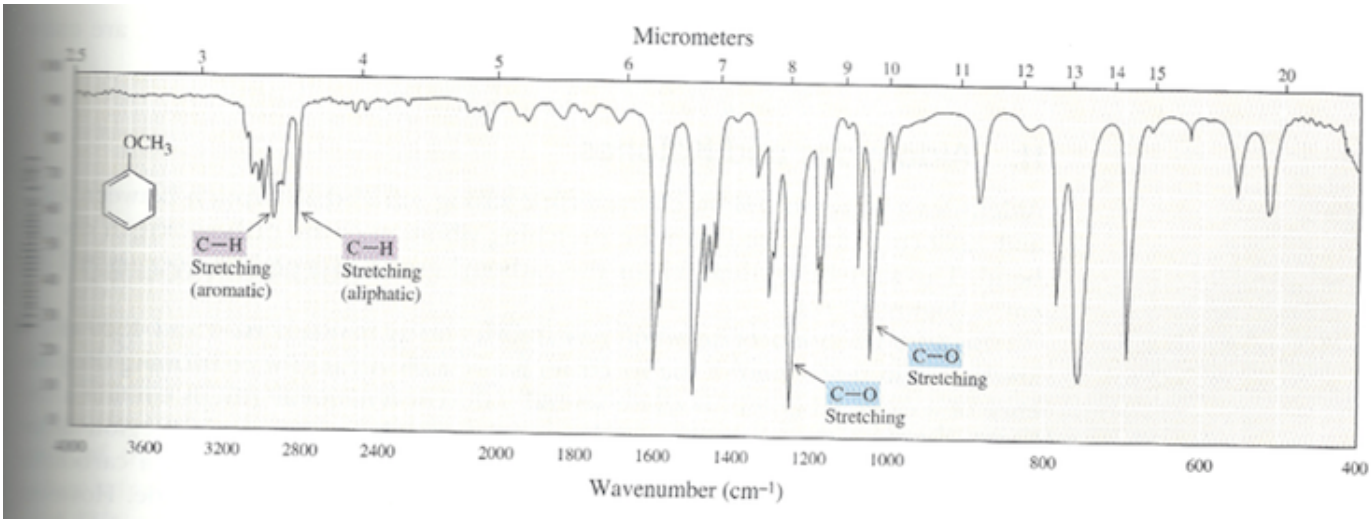
Exercise E:

Look at the table (characteristics of Infrared Absorption Frequencies) and explain the assignment of the infrared spectrum of dibutylether.



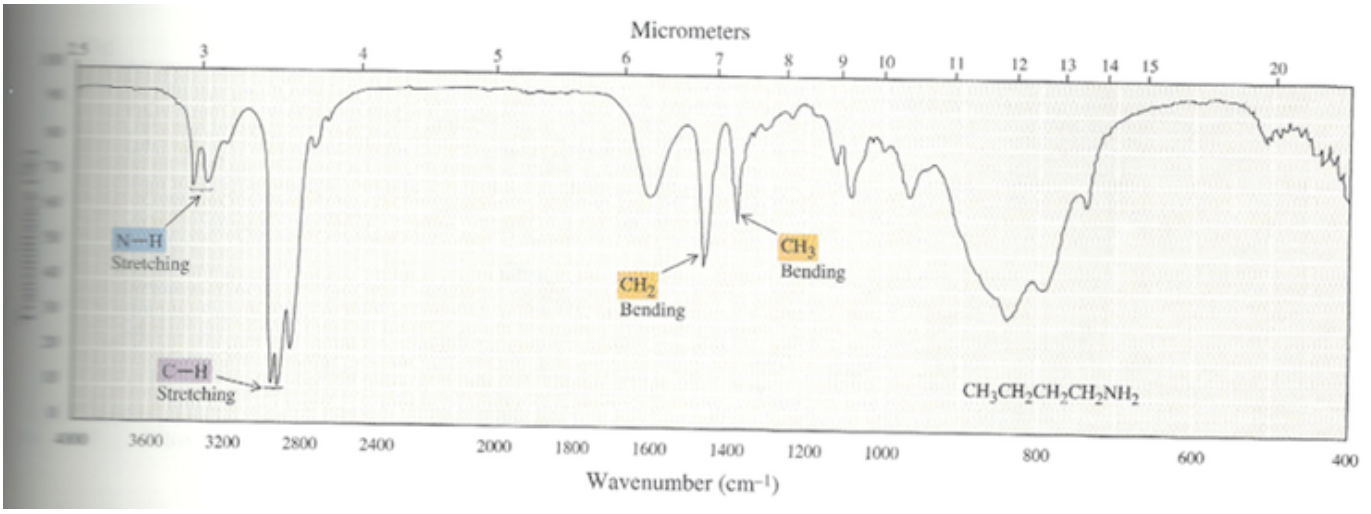
Exercise F:

Look at the table (characteristics of Infrared Absorption Frequencies) and explain the assignment of the infrared spectrum of anisole.



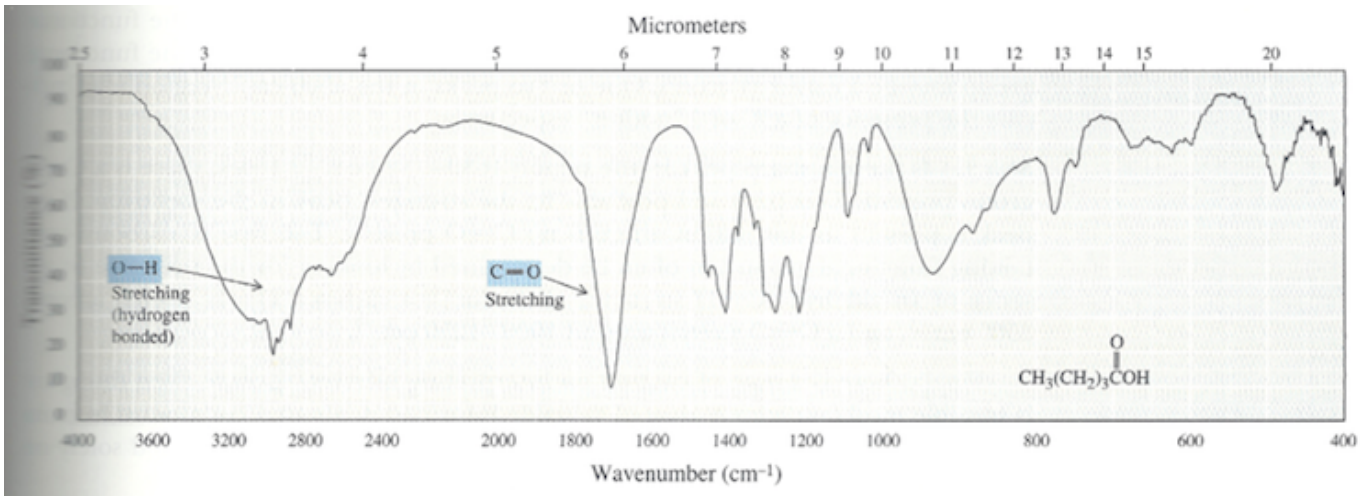
Exercise G:

Look at the table (characteristics of Infrared Absorption Frequencies) and explain the assignment of the infrared spectrum of 1-butamine.



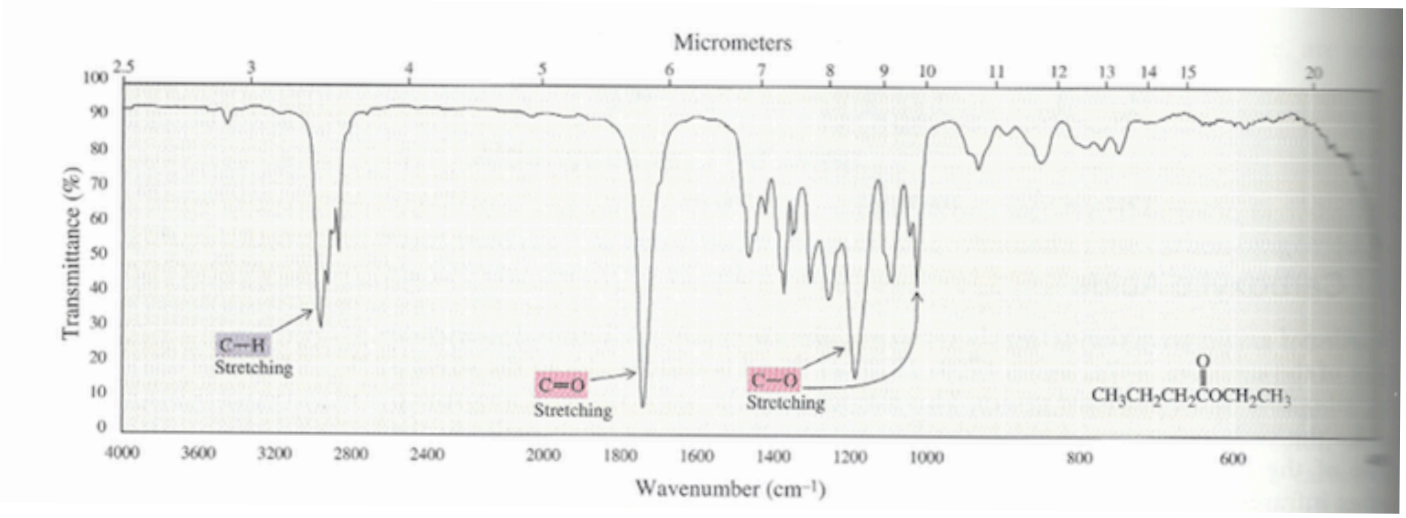
Exercise H:

Look at the table (characteristics of Infrared Absorption Frequencies) and explain the assignment of the infrared spectrum of 1-pentanoic acid.



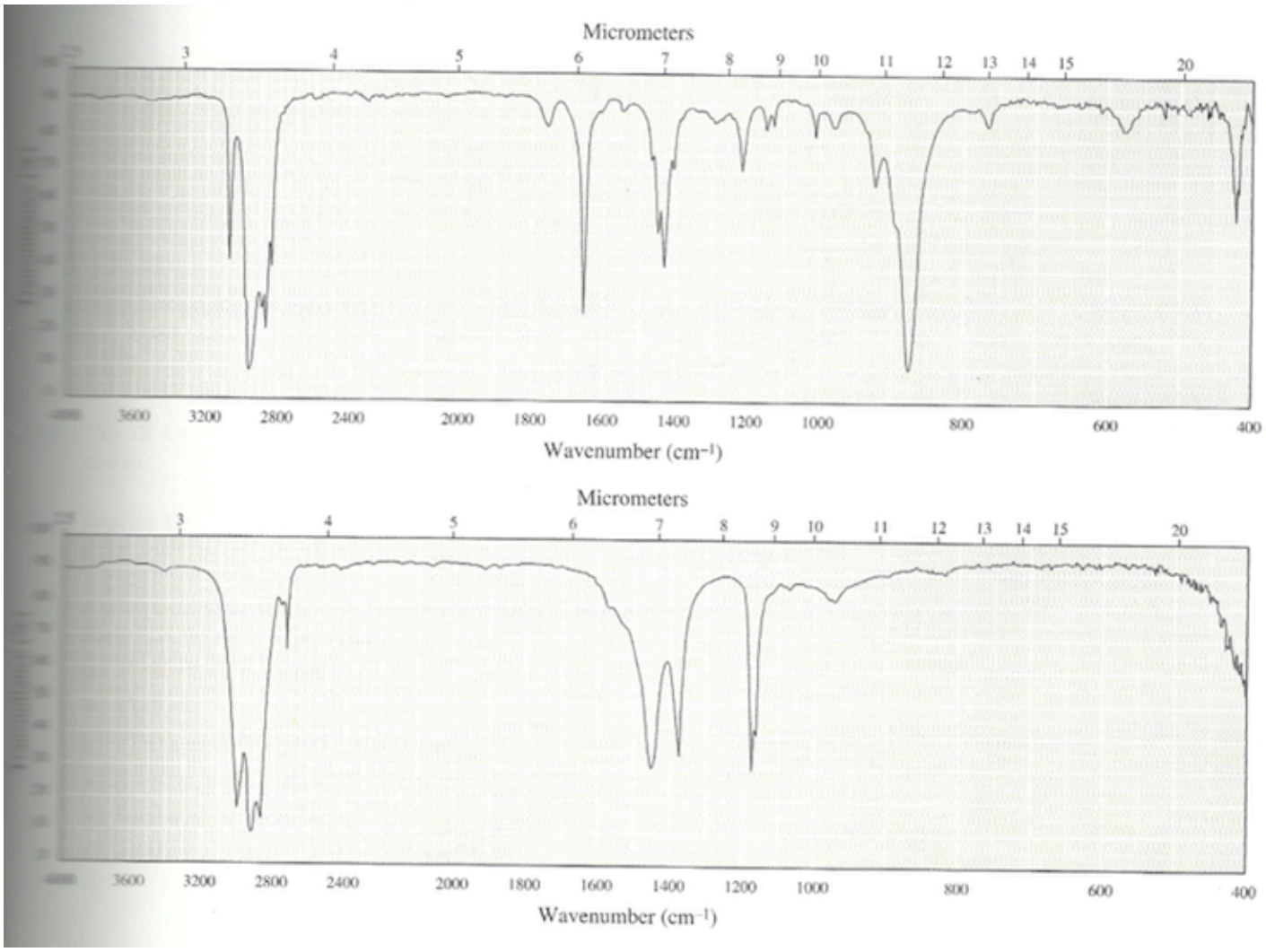
Exercise I:

Look at the table (characteristics of Infrared Absorption Frequencies) and explain the assignment of the infrared spectrum of ethylbutanoate.



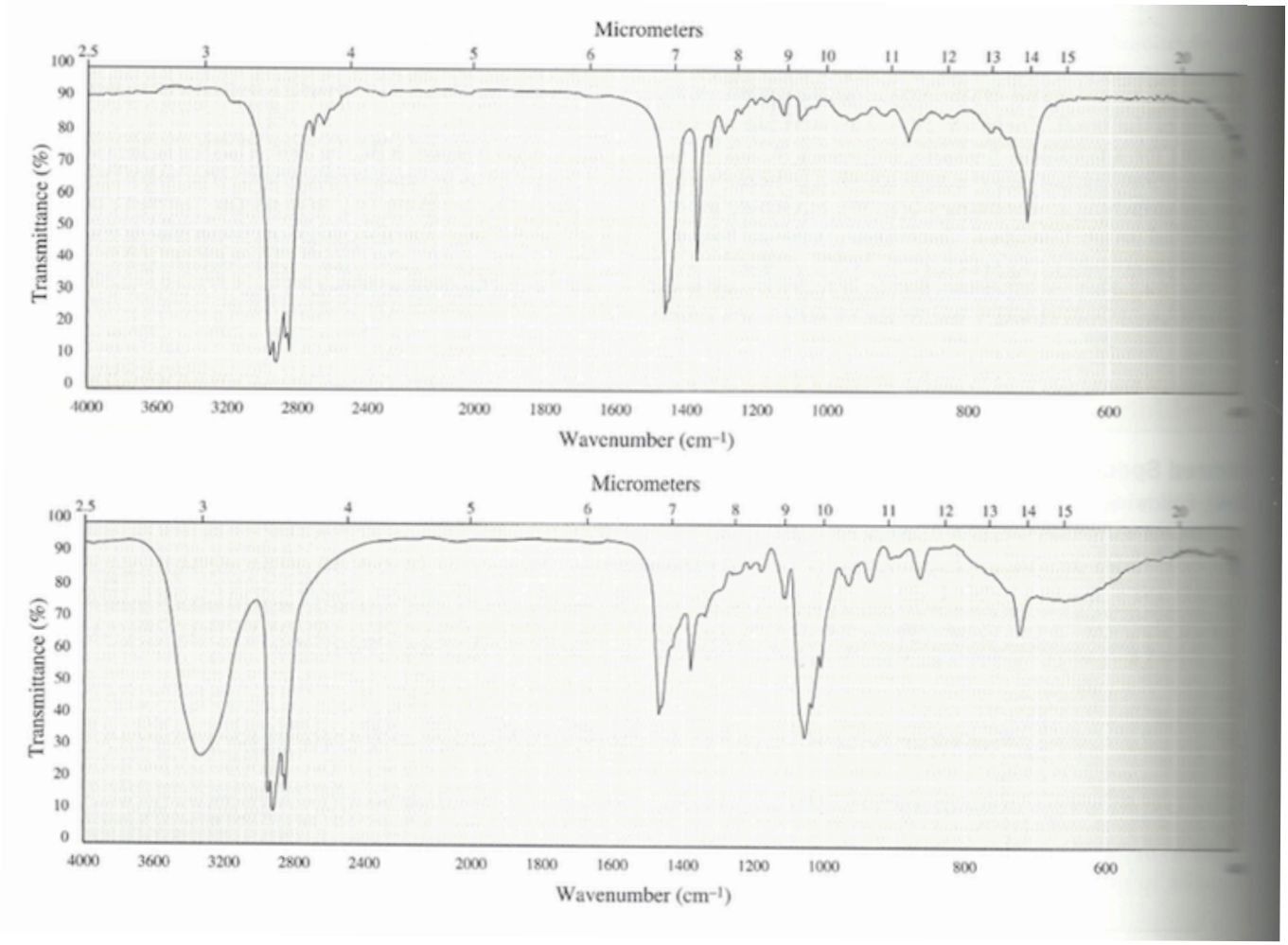
Exercice J:

Following are infrared spectra of methyenecyclopentane and 2, 3 dimethyl-2-butene. Assign each compound its correct spectrum.



Exercice K:

Following are infrared spectra of nonane and 1-hexanol. Assign each compound its correct spectrum.



Exercice L:

Following are infrared spectra of 2-methyl-1-butanol and *tert*-butyl methyl ehter. Assign each compound its correct spectrum.