

ORGANIC CHEMISTRY 1 LECTURE GUIDE 2019

BY RHETT C. SMITH

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# Organic Chemistry 1 Lecture Guide 2019

**By Rhett C. Smith, Ph.D.**

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Companion Books from the Proton Guru:

*Organic Chemistry 1 Reactions and Practice Problems 2019*

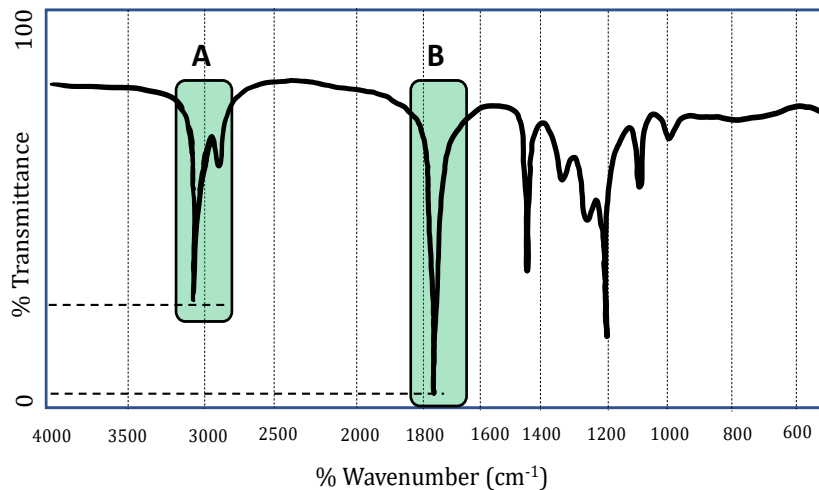
by Rhett C. Smith

*Organic Chemistry 1 Primer 2019,*

by Rhett C. Smith, Andrew G. Tennyson, and Tania Houjeiry

Lecture Topic VII.4. Infrared Spectroscopy  
Infrared spectrum and transmittance

A typical IR spectrum has this appearance:








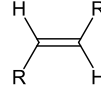
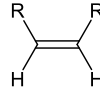
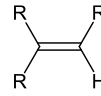
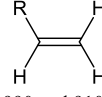
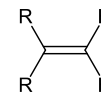
Band **A** corresponds to a set of bonds that absorbs  $\sim 75\%$  of the IR light at  $3000\text{ cm}^{-1}$  emitted by the source (i.e.,  $25\%$  transmittance), whereas band **B** corresponds to a set of bonds that absorbs nearly  $95\%$  of the IR light at  $1750\text{ cm}^{-1}$  (i.e.,  $5\%$  transmittance).

Notes

# Lecture Topic VII.4. Infrared Spectroscopy

## Infrared Table

Each type of bond has a characteristic energy of absorption for IR radiation:

<b>Bond</b>	<b>Energy (cm<sup>-1</sup>)</b>	<b>Intensity</b>	<b>C-H Bond (Stretch)</b>	<b>Energy (cm<sup>-1</sup>)</b>
<b>N≡C</b>	2255-2220	m-s	C≡C—H	3300-ish
<b>C≡C</b>	2260-2100	w-m	C=C—H	3100-3000
<b>C=C</b>	1675-1660	m	C—C—H	2950-2850
<b>N=C</b>	1650-1550	m		2820-ish and 2720-ish
	{ 1600 AND 1500-1425	w-s	<b>C-H Bond (Bending)</b>	
<b>C=O</b>	1775-1650	s	  	1450-1400
<b>C—O</b>	1250-1000	s		980-960 trans
<b>C—N</b>	1230-1000	m		730-670 cis
<b>O—H</b>	3650-3200	s (br)		840-800 trisubstituted
<b>O—H</b>	3300-2500	s (br)		990 and 910 monosubstituted
<b>N—H</b>	3500-3300	m (br)		890 disubstituted terminal
<b>C—H</b>	3300-2725	m		

Notes

## Lecture Topic VII.4. Infrared Spectroscopy

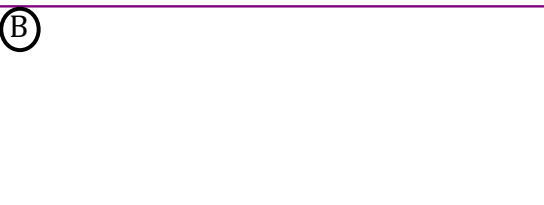
### Resonance effects on IR modes

There are several points worth noting:

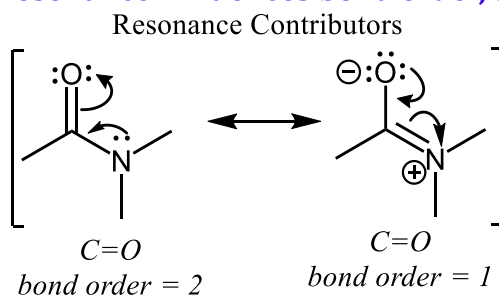
#### Stronger bonds:



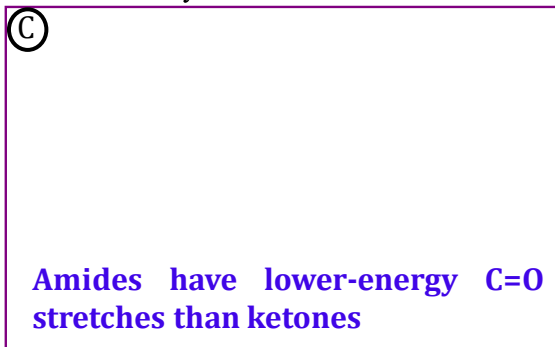
#### More polar bonds:




#### Resonance influences bond order, and therefore bonds strength:



#### Resonance Hybrid

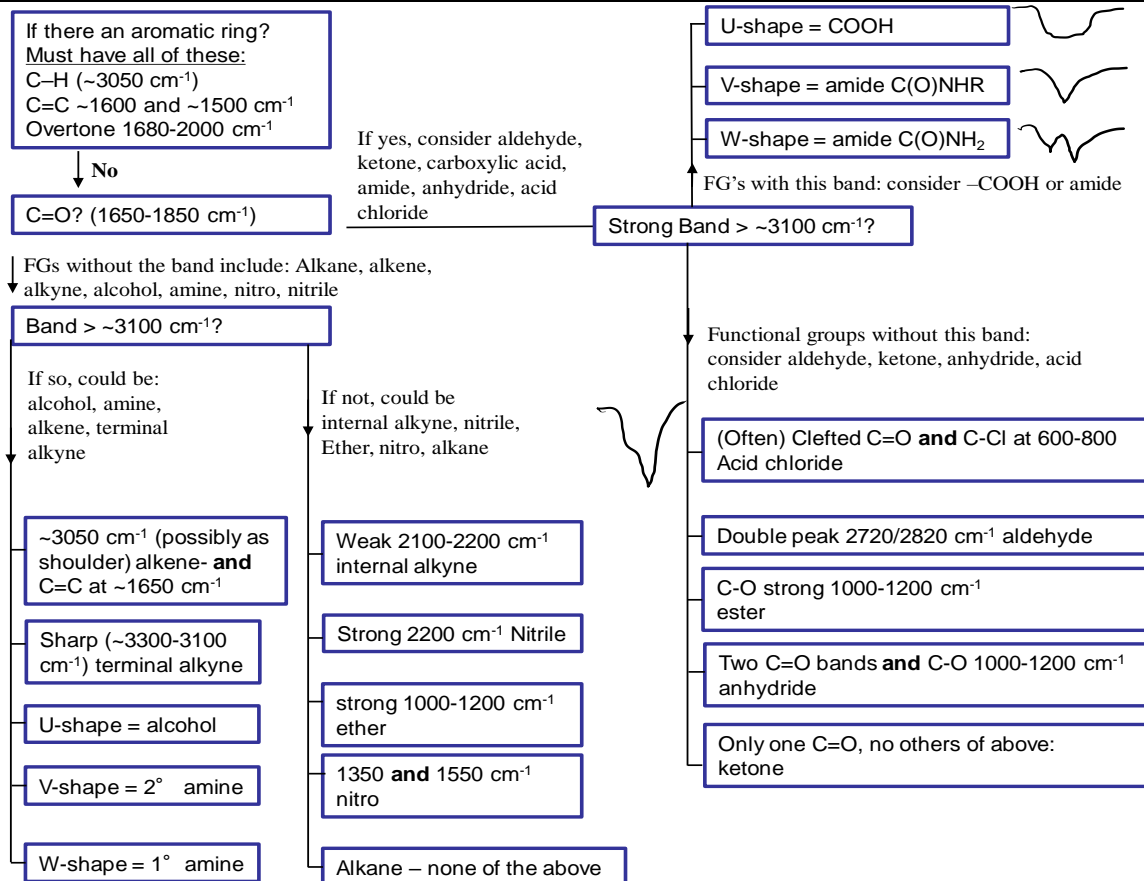


Notes



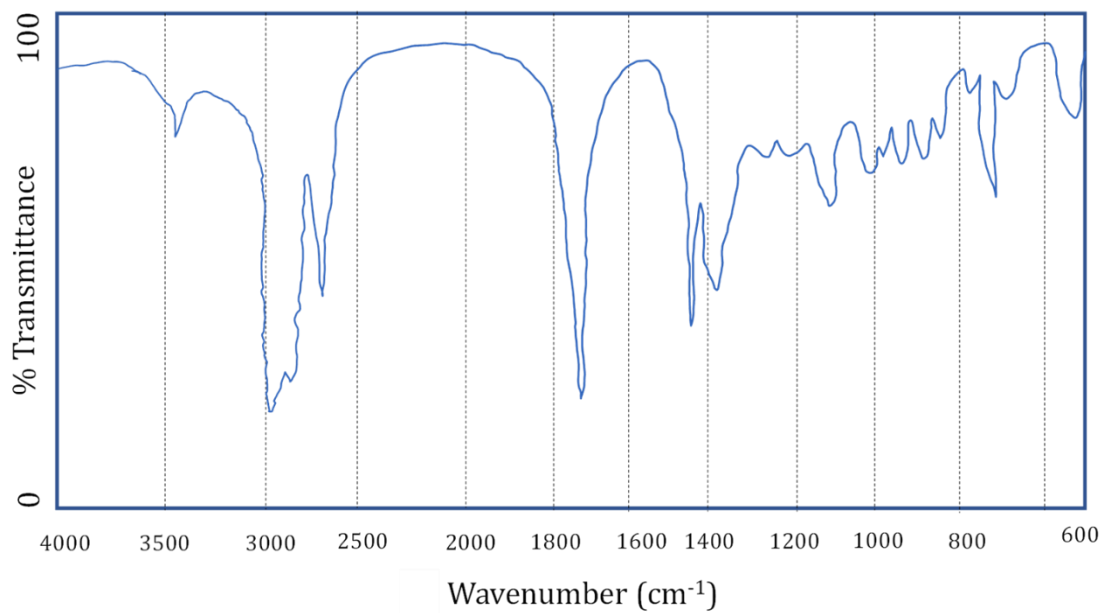
# Lecture Topic VII.4. Infrared Spectroscopy

## IR decision tree



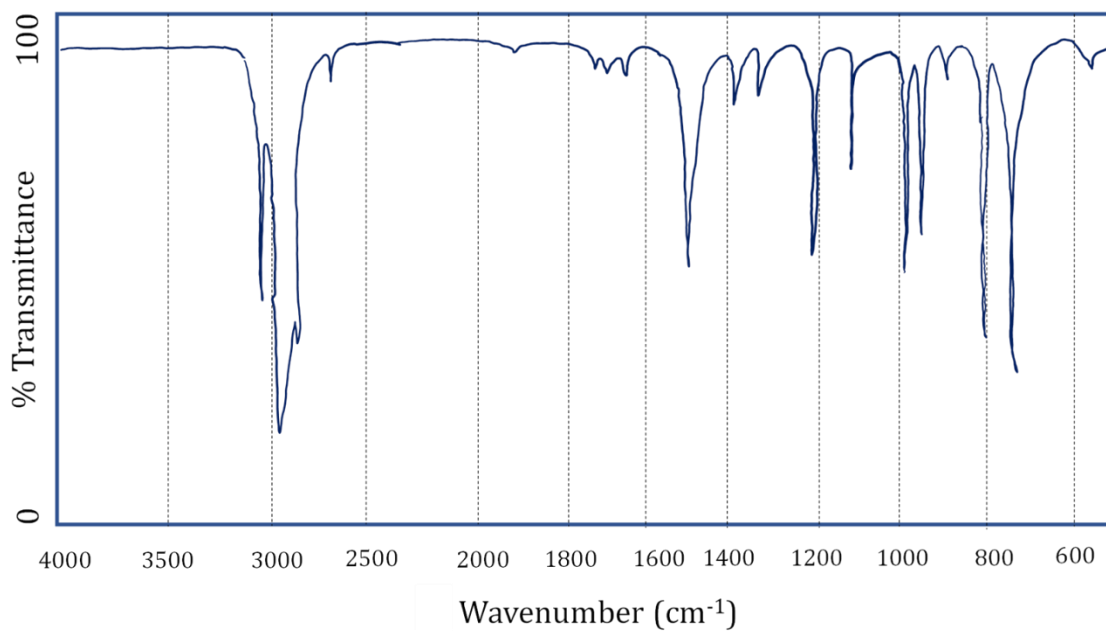
## Notes

IR Spectrum for Hexanal



Notes

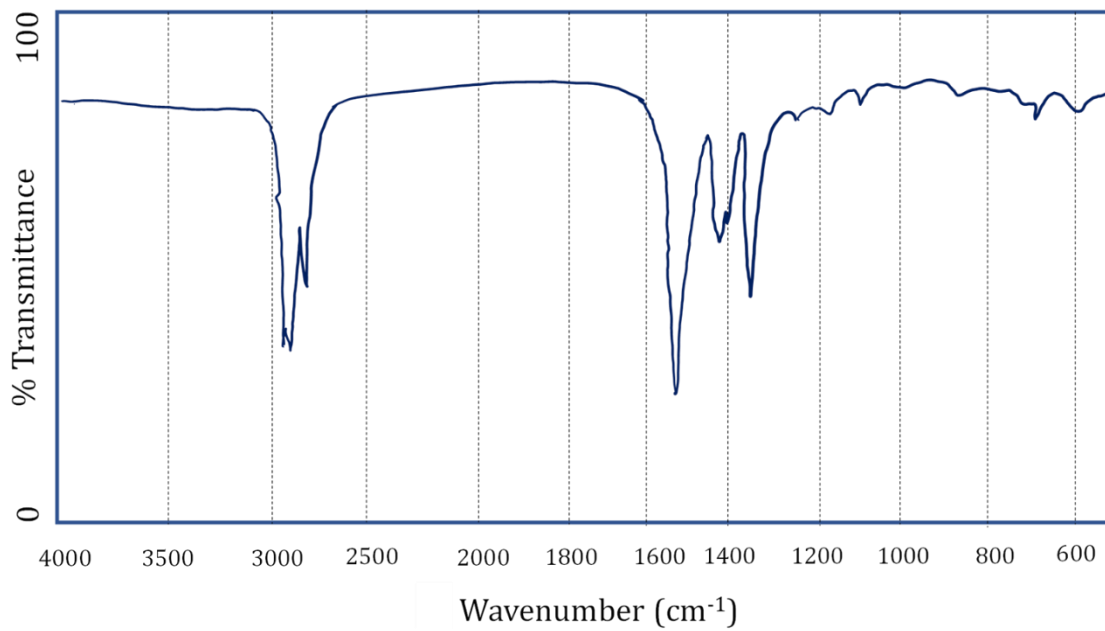
IR Spectrum for cyclohexene



Notes

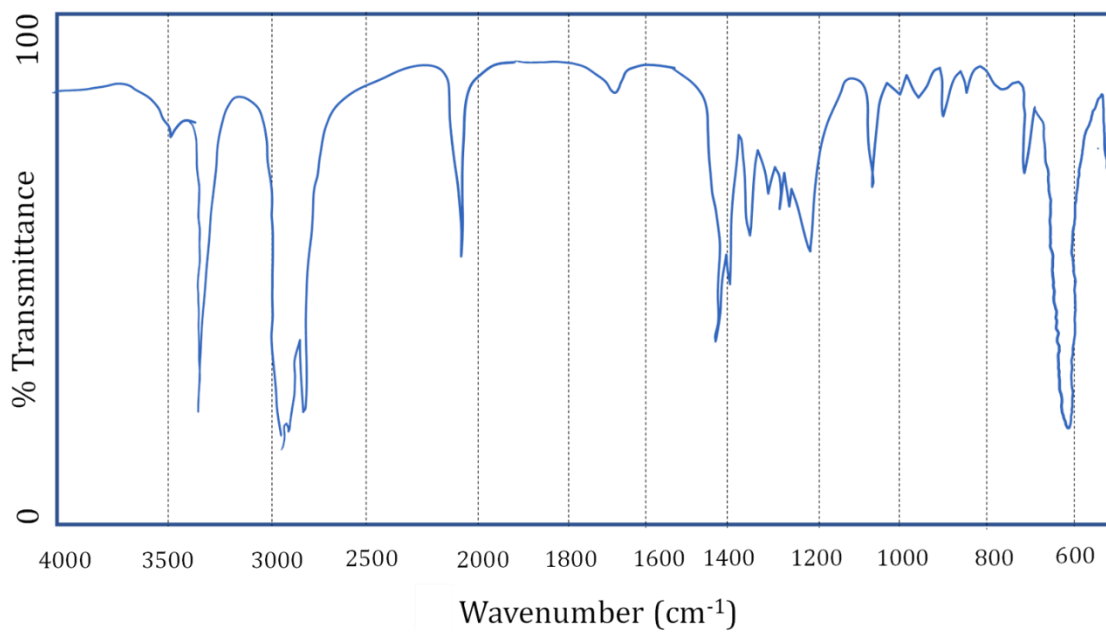


IR Spectrum for nitrohexane



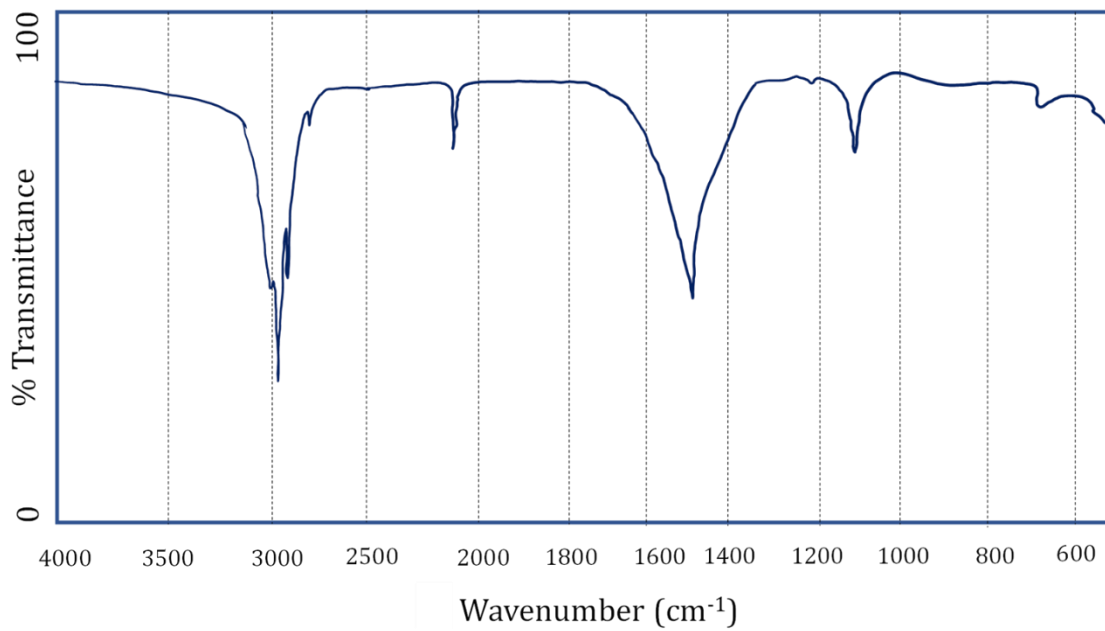
Notes

IR Spectrum for 1-hexyne



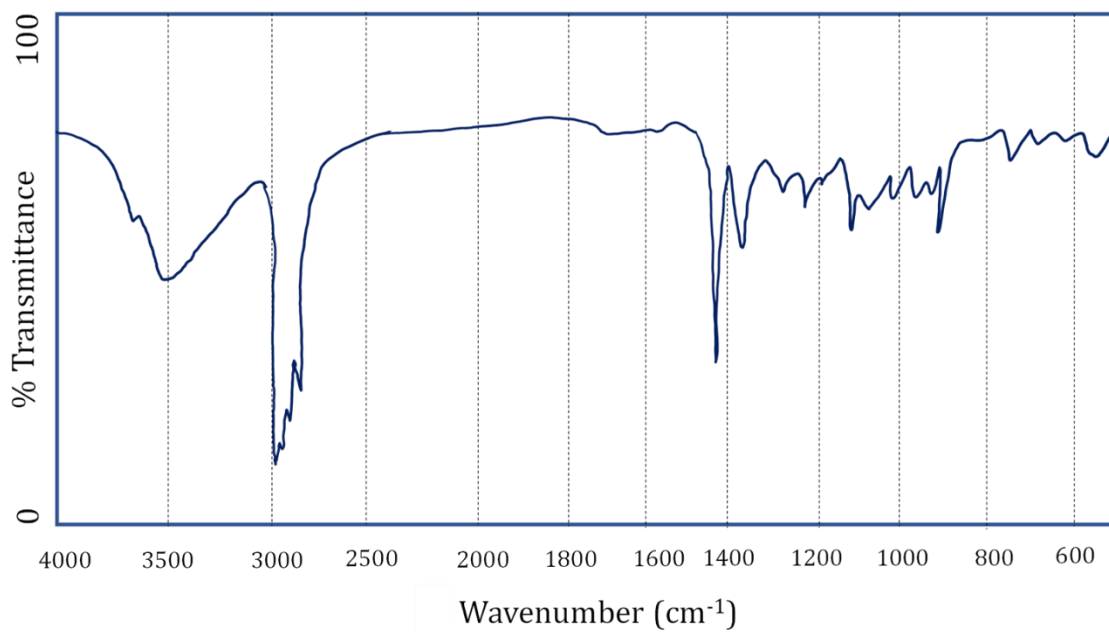
Notes

IR Spectrum for 2-butyne



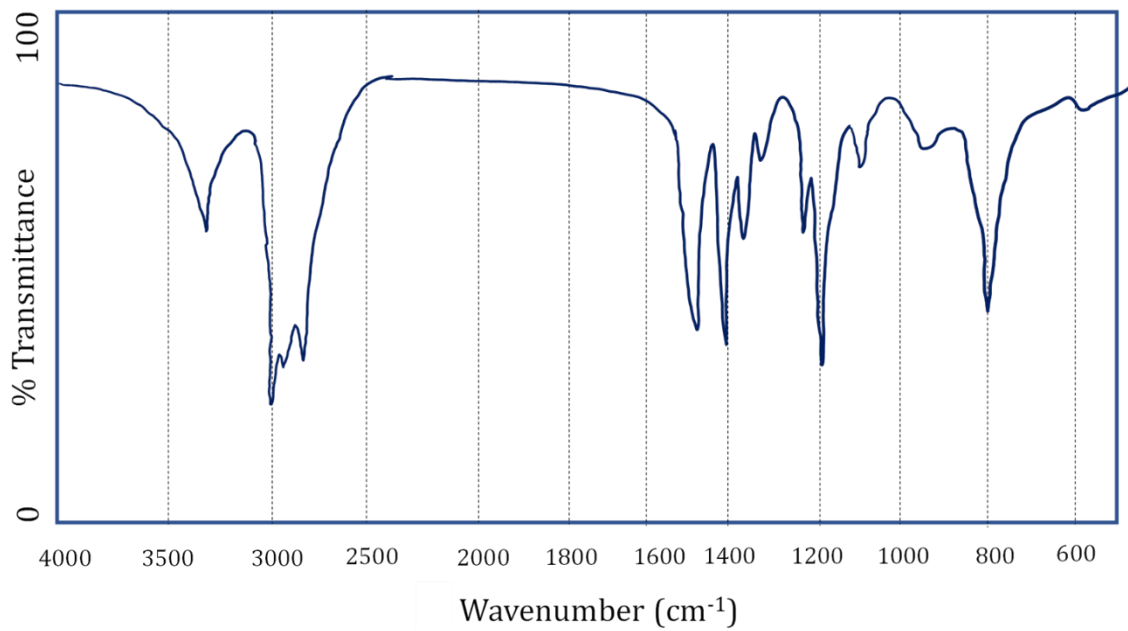
Notes

IR Spectrum for 3-octanol



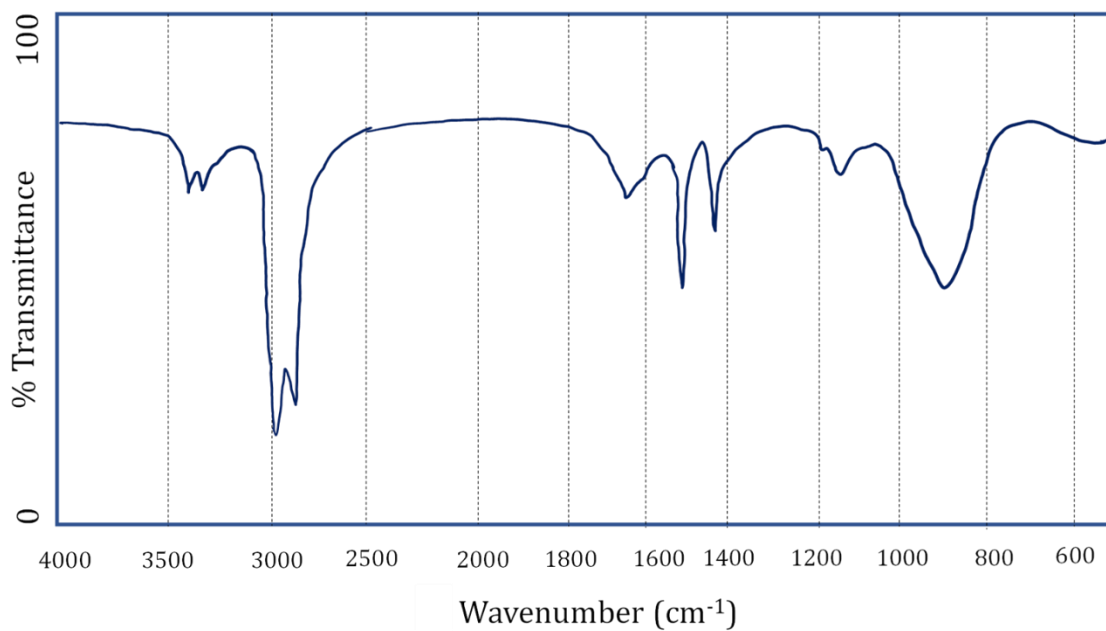
Notes

IR Spectrum for diethylamine



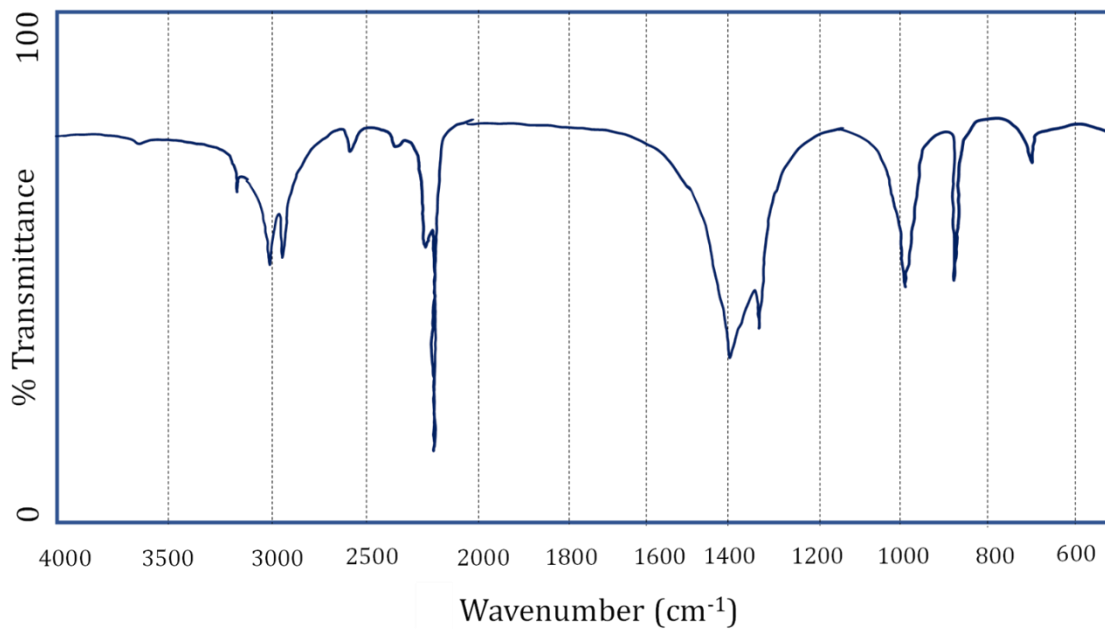
Notes

IR Spectrum for hexylamine



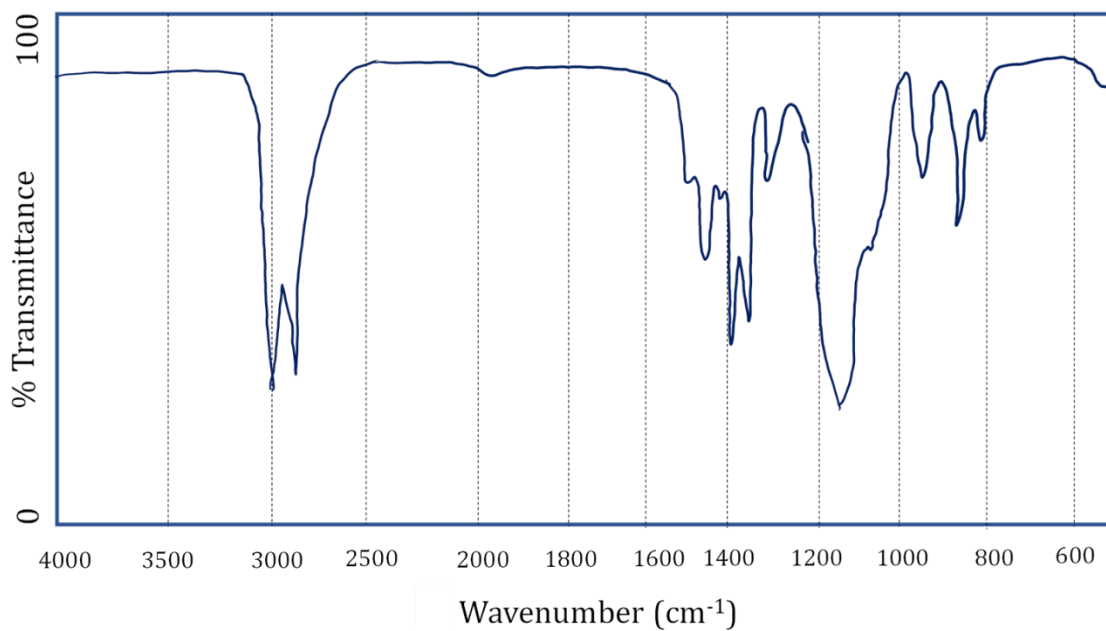
Notes

IR Spectrum for acetonitrile ( $\text{CH}_3\text{CN}$ )



Notes

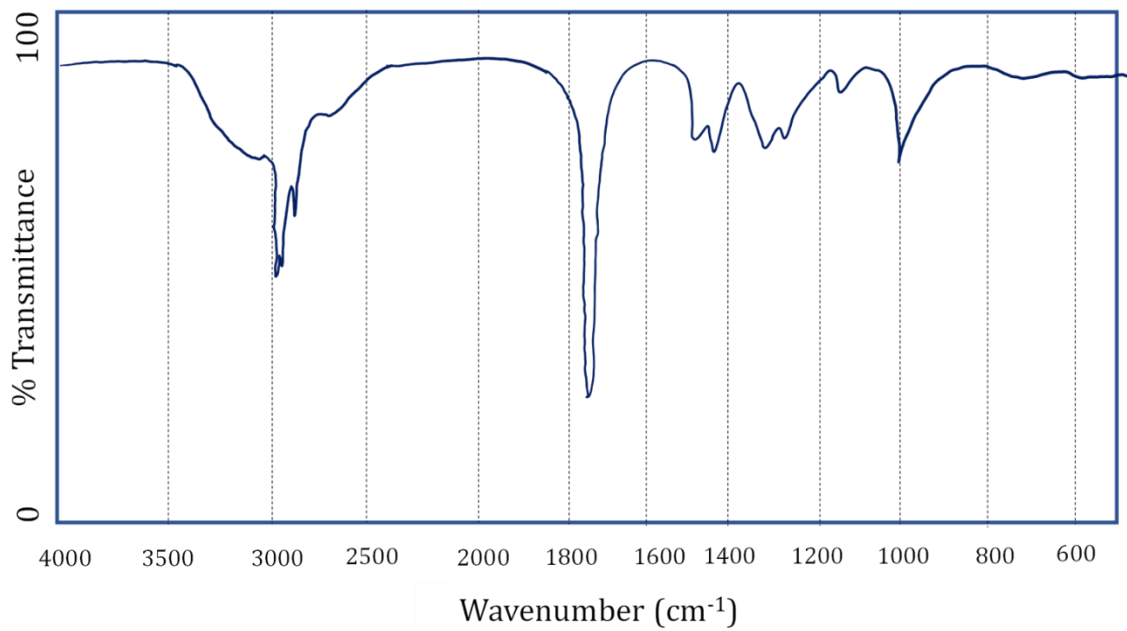
IR Spectrum for diethylether



Notes

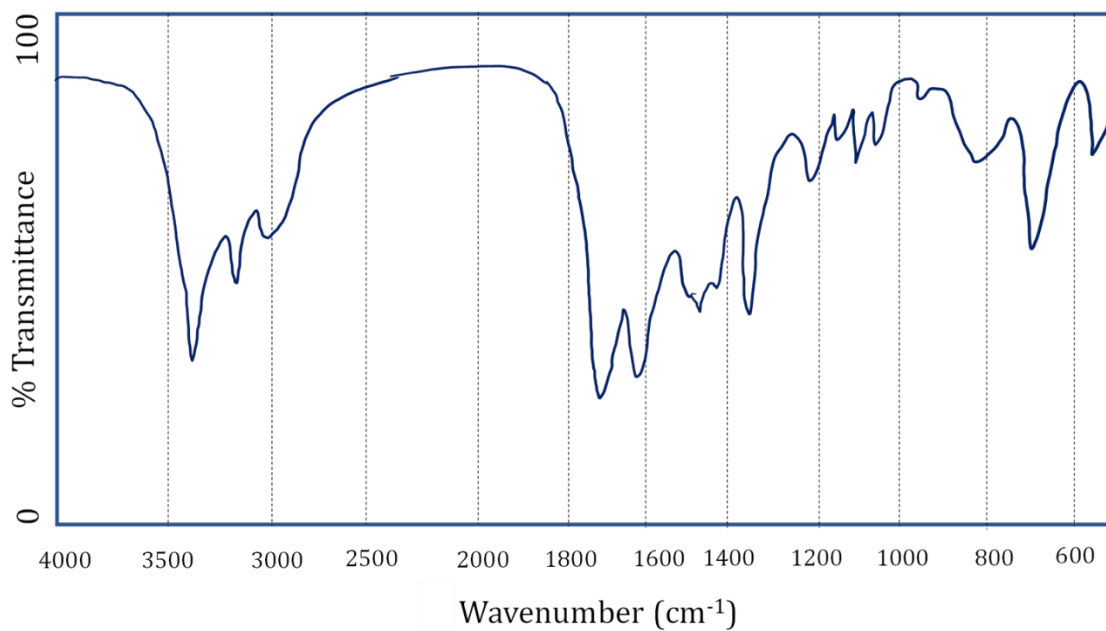


IR Spectrum for hexanoic acid



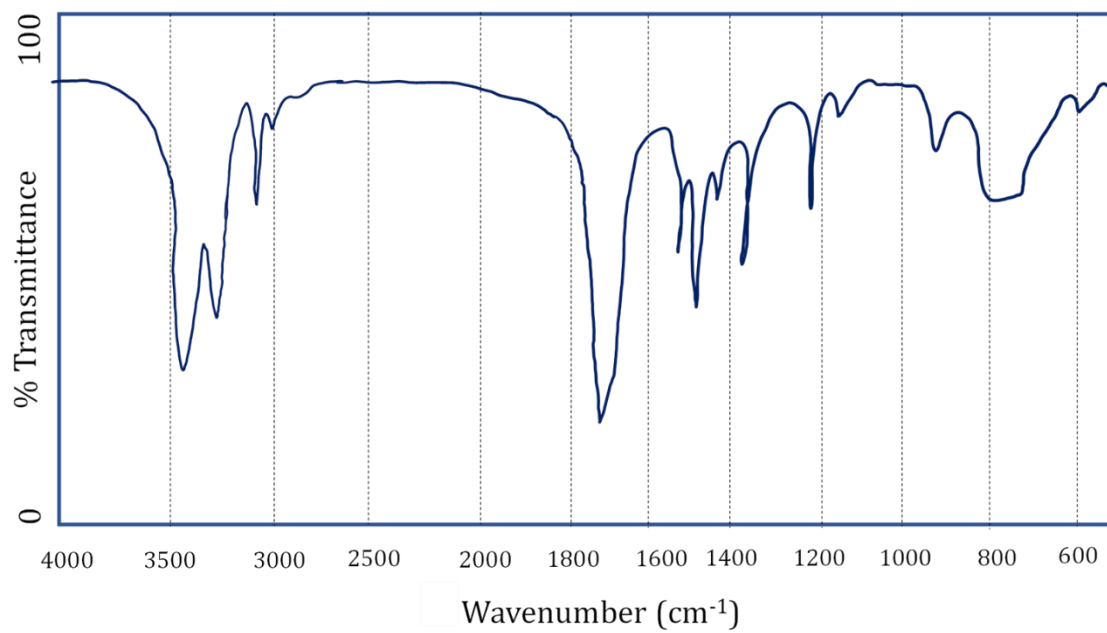
Notes

IR Spectrum for *N*-methylacetamide ( $\text{CH}_3\text{C}(\text{O})\text{N}(\text{H})\text{CH}_3$ )



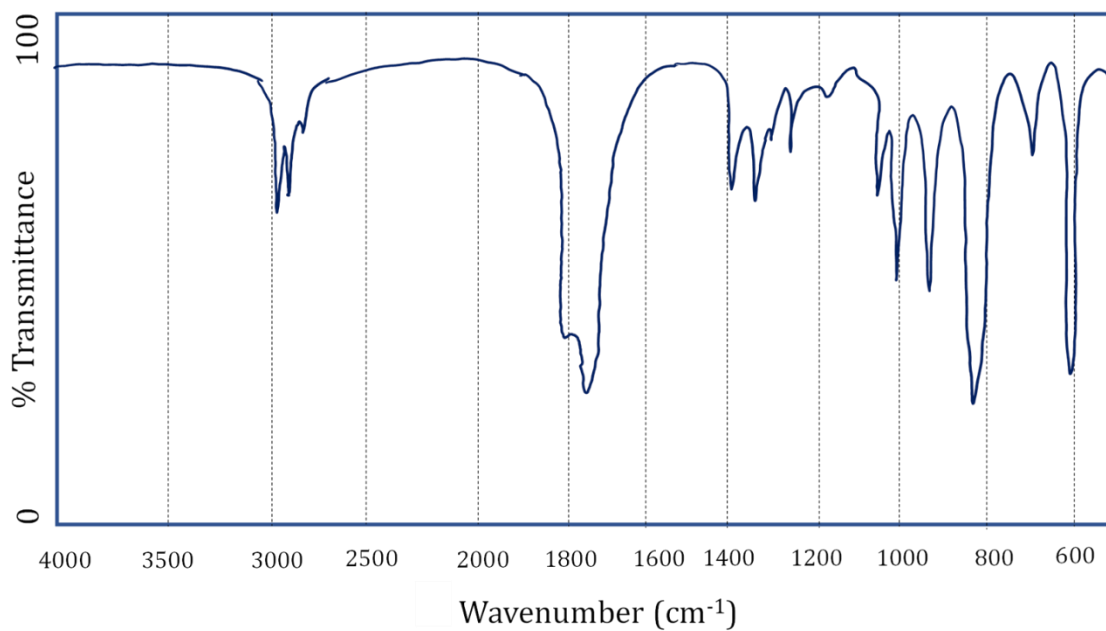
Notes

IR Spectrum for propamide ( $\text{CH}_3\text{CH}_2\text{C}(\text{O})\text{NH}_2$ )



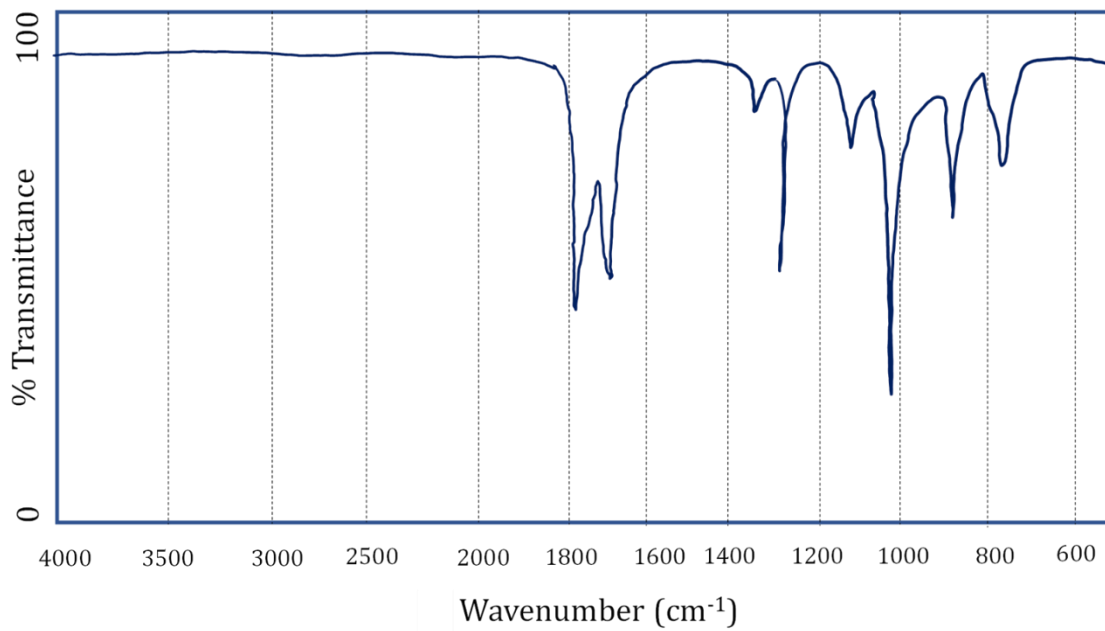
Notes

IR Spectrum for propanoyl chloride



Notes

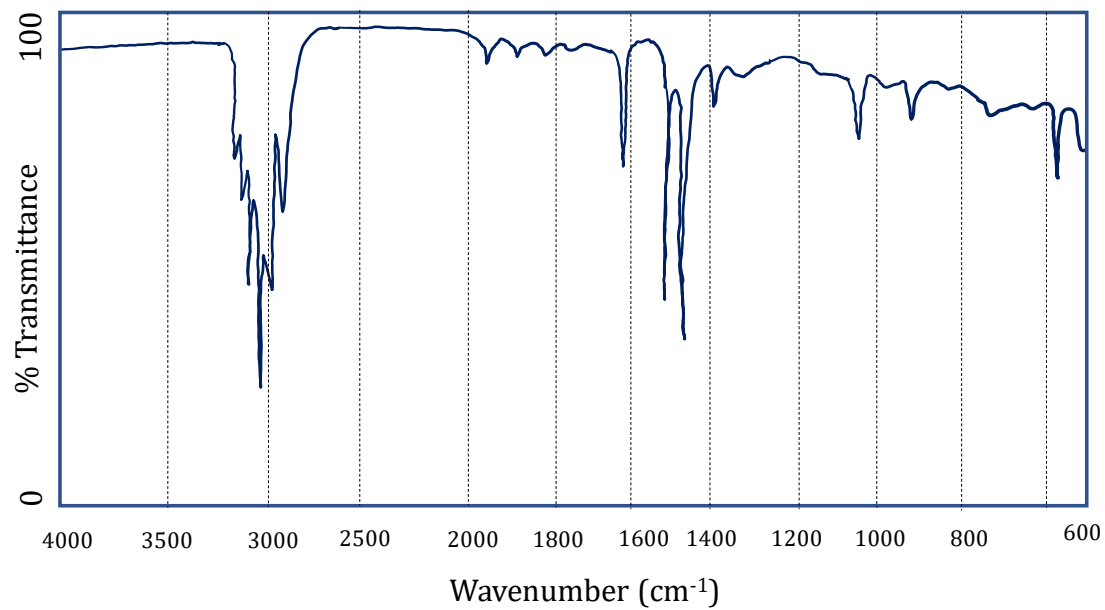
IR Spectrum for acetic anhydride



Notes

## Lecture Topic VII.4. Infrared Spectroscopy

### IR Practice



Notes