

### Characteristic IR Absorption Frequencies of Organic Functional Groups

Functional Group	Type of Vibration	Characteristic Absorptions (cm <sup>-1</sup> )	Intensity
<b>Alcohol</b>			
O-H	(stretch, H-bonded)	3200-3600	strong, broad
O-H	(stretch, free)	3500-3700	strong, sharp
C-O	(stretch)	1050-1150	strong
<b>Alkane</b>			
C-H	stretch	2850-3000	strong
-C-H	bending	1350-1480	variable
<b>Alkene</b>			
=C-H	stretch	3010-3100	medium
=C-H	bending	675-1000	strong
C=C	stretch	1620-1680	variable
<b>Alkyl Halide</b>			
C-F	stretch	1000-1400	strong
C-Cl	stretch	600-800	strong
C-Br	stretch	500-600	strong
C-I	stretch	500	strong
<b>Alkyne</b>			
C-H	stretch	3300	strong, sharp
-C≡C-	stretch	2100-2260	variable, not present in symmetrical alkynes
<b>Amine</b>			
N-H	stretch	3300-3500	medium (primary amines have two bands; secondary have one band, often very weak)
C-N	stretch	1080-1360	medium-weak
N-H	bending	1600	medium
<b>Aromatic</b>			
C-H	stretch	3000-3100	medium
C=C	stretch	1400-1600	medium-weak, multiple bands
Analysis of C-H out-of-plane bending can often distinguish substitution patterns			
<b>Carbonyl</b>	<a href="#">Detailed Information on Carbonyl IR</a>		
C=O	stretch	1670-1820	strong
(conjugation moves absorptions to lower wave numbers)			
<b>Ether</b>			
C-O	stretch	1000-1300 (1070-1150)	strong
<b>Nitrile</b>			
CN	stretch	2210-2260	medium
<b>Nitro</b>			
N-O	stretch	1515-1560 & 1345-1385	strong, two bands

### IR Absorption Frequencies of Functional Groups Containing a Carbonyl (C=O)

Functional Group	Type of Vibration	Characteristic Absorptions (cm <sup>-1</sup> )	Intensity
<b>Carbonyl</b>			
C=O	stretch	1670-1820	strong
(conjugation moves absorptions to lower wave numbers)			
<b>Acid</b>			
C=O	stretch	1700-1725	strong
O-H	stretch	2500-3300	strong, very broad
C-O	stretch	1210-1320	strong

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<b>Aldehyde</b>			
C=O	stretch	1740-1720	strong
=C-H	stretch	2820-2850 & 2720-2750	medium, two peaks
<b>Amide</b>			
C=O	stretch	1640-1690	strong
N-H	stretch	3100-3500	unsubstituted have two bands
N-H	bending	1550-1640	
<b>Anhydride</b>			
C=O	stretch	1800-1830 & 1740-1775	two bands
<b>Ester</b>			
C=O	stretch	1735-1750	strong
C-O	stretch	1000-1300	two bands or more
<b>Ketone</b>			
acyclic	stretch	1705-1725	strong
cyclic	stretch	3-membered - 1850 4-membered - 1780 5-membered - 1745 6-membered - 1715 7-membered - 1705	strong
a,b-unsaturated	stretch	1665-1685	strong
aryl ketone	stretch	1680-1700	strong

A good general reference for more detailed information on interpretation of infrared spectra (as well as other spectroscopic techniques) is Silverstein, R.M.; Bassler, G.C.; and Morrill, T.C. *Spectrometric Identification of Organic Compounds*. 4th ed. New York: John Wiley and Sons, 1981. QD272.S6 S55

A more complete listing of functional group absorption frequencies may be found in: Nakanishi, Koji *Infrared Absorption Spectroscopy*. QD95.N383