

# NMR spektroskopie



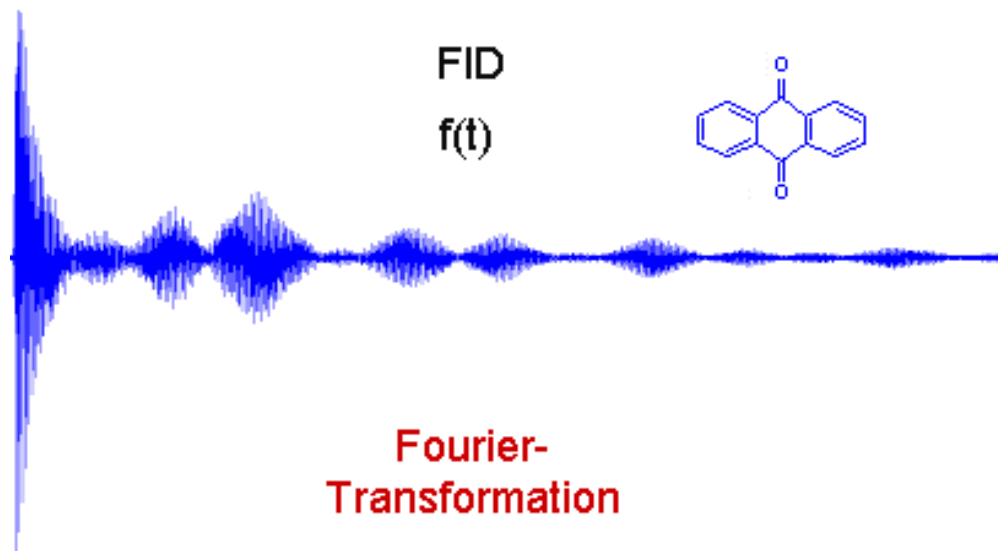
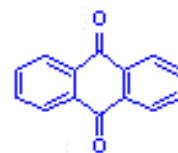
- spektroskopická metoda založená na měření absorpce elektromagnetického záření (rádiové frekvence od asi 4 do 900 MHz)
- spinová rezonance jader v silném magnetickém poli
- lze aplikovat pouze na atomy, jejichž jádro má spinový moment (lichý počet protonů nebo neutronů)

$I = 0$  (sudý počet protonů i neutronů)  $^{12}\text{C}$ ,  $^{16}\text{O}$ ,  $^{32}\text{S}$

$I = 1/2$  snadno měřitelná  $^{15}\text{N}$ ,  $^{19}\text{F}$ ,  $^{31}\text{P}$

je-li  $I > 1/2$ , jádra mají vedle jaderného magnetického momentu i kvadrupólový moment – obtížně měřitelná

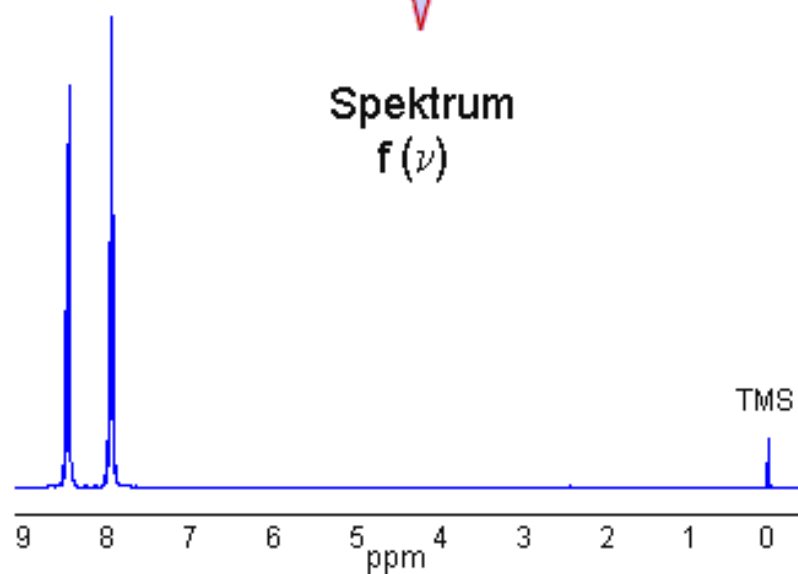
FID  
 $f(t)$



Fourier-  
Transformation



Spektrum  
 $f(\nu)$

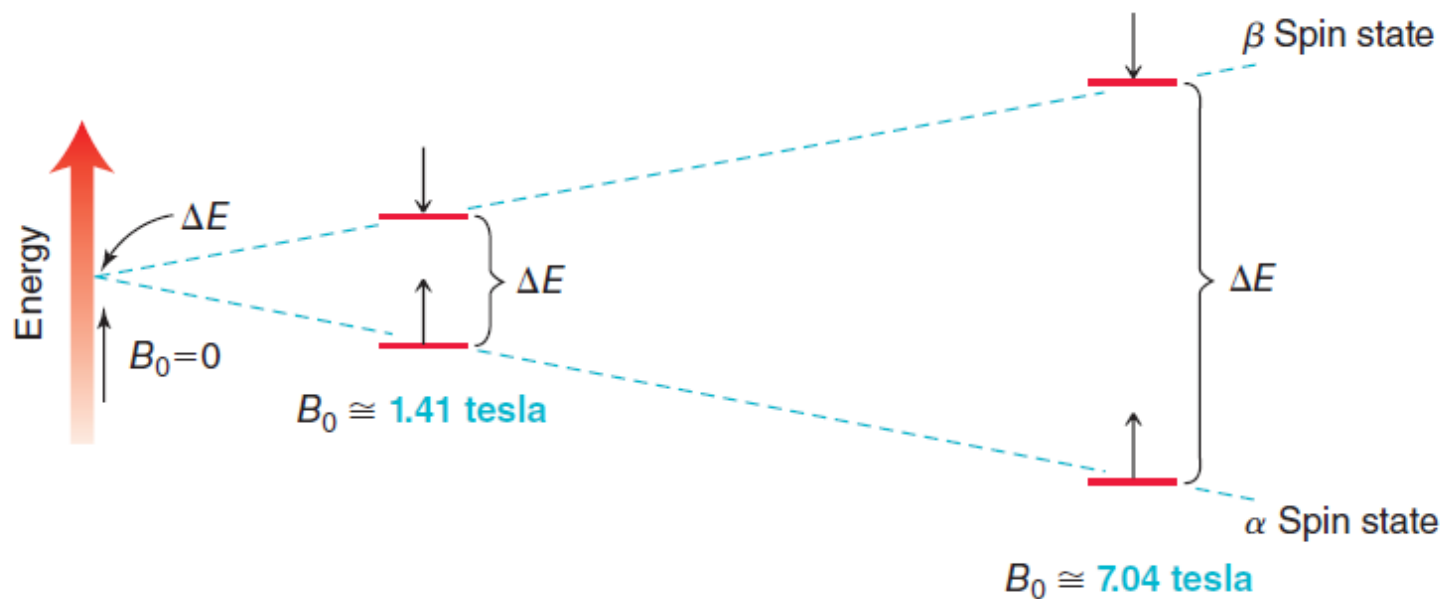


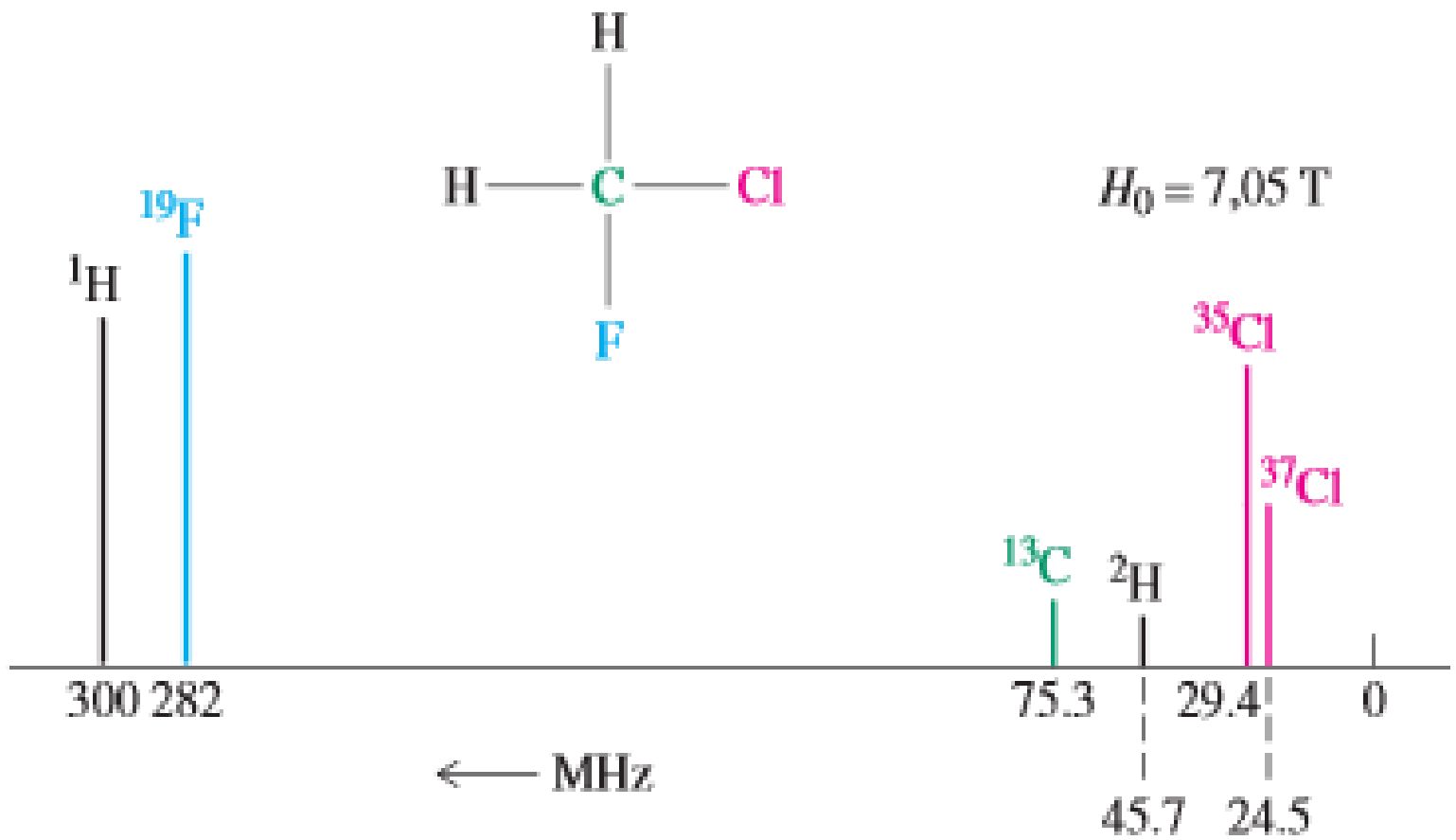
## Magnetic Field Strength Is Proportional to Resonance Frequency

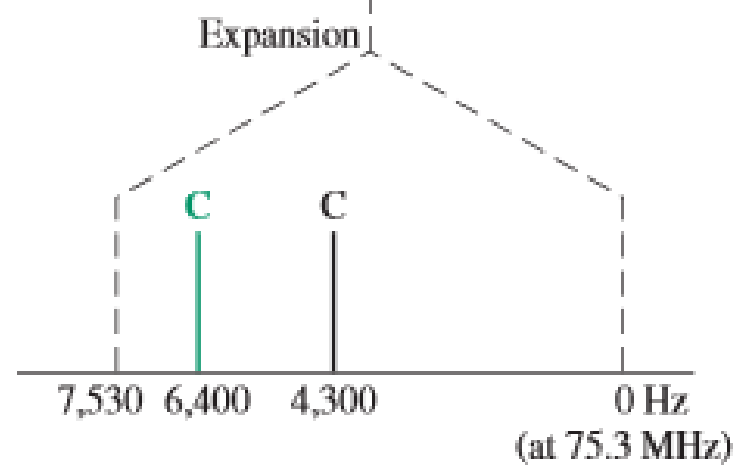
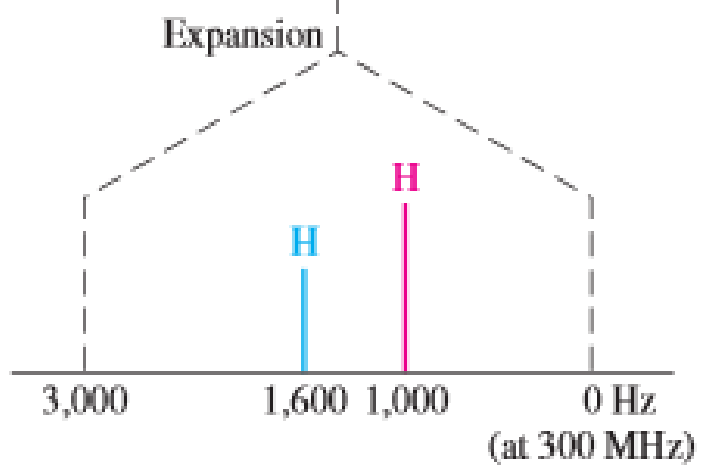
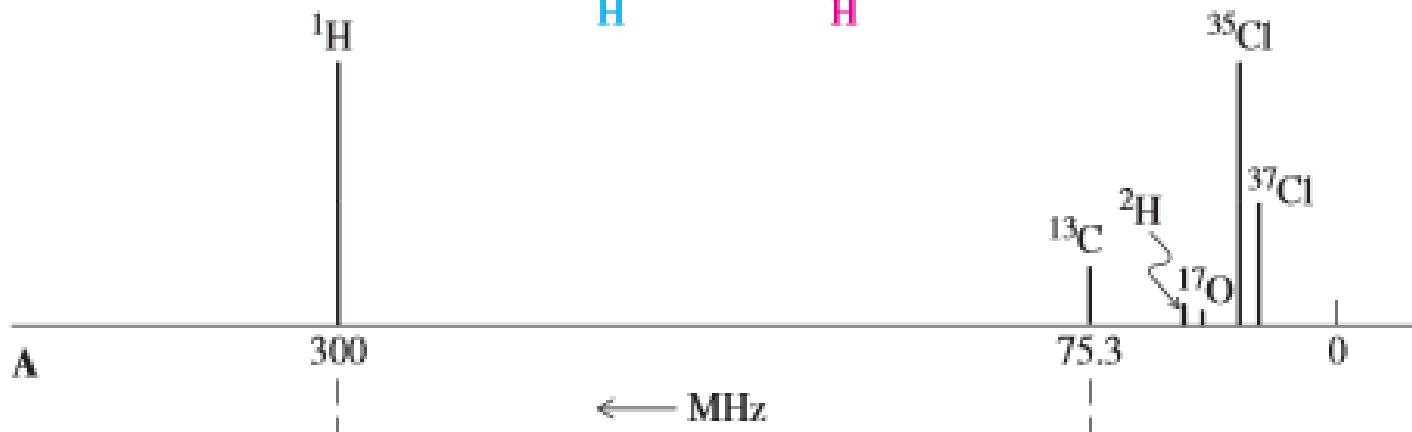
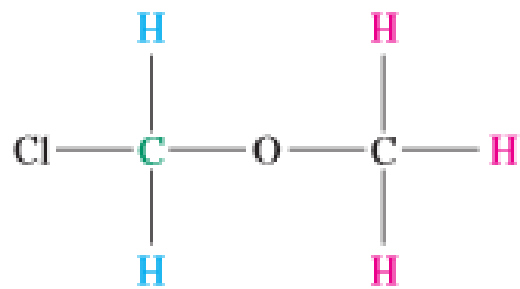
Increasing  $H_0$

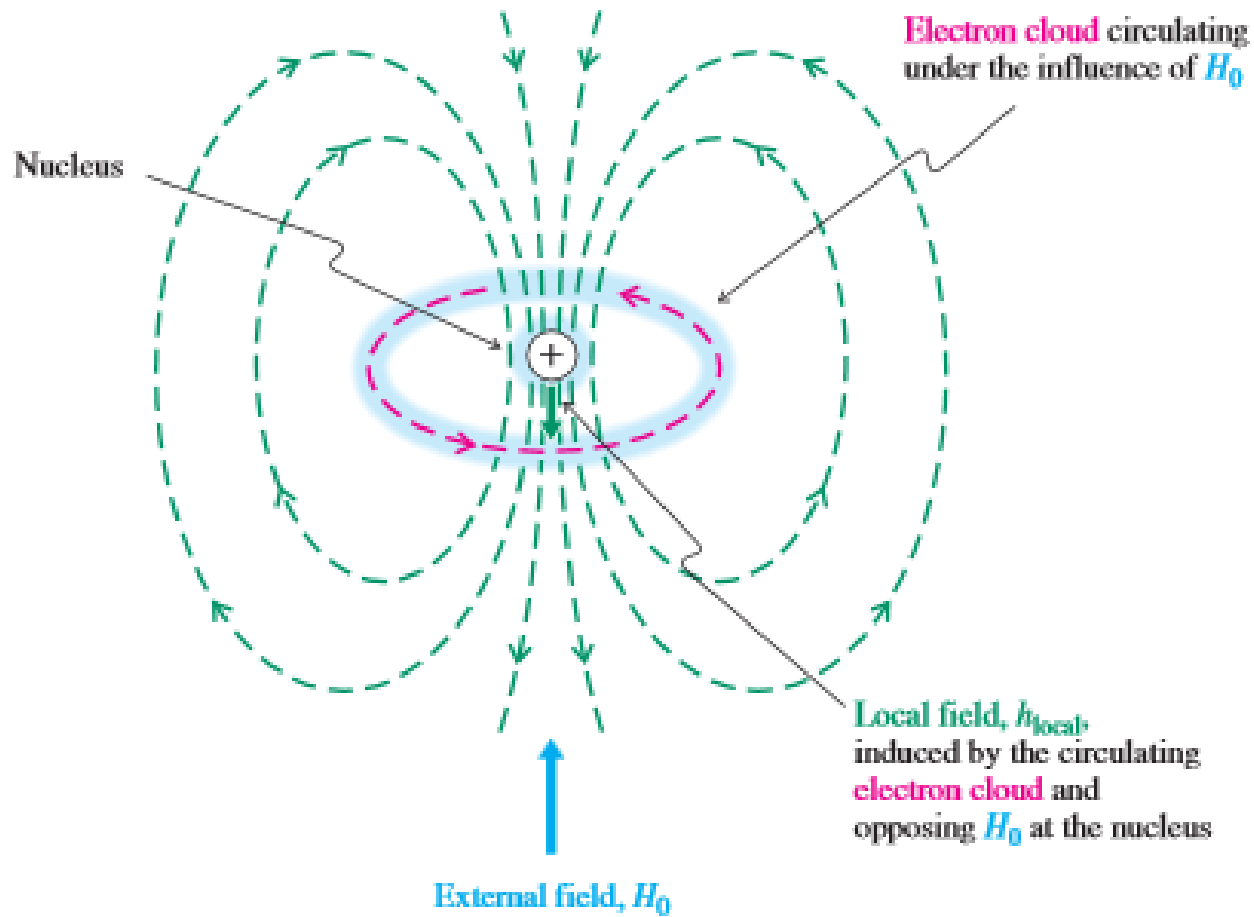
Magnetic field strength $H_0$ (tesla):	2.11	4.23	7.05	11.8	14.1	21.1	T
Hydrogen resonance frequency $\nu$ (megahertz):	90	180	300	500	600	900	MHz

Increasing  $\nu$



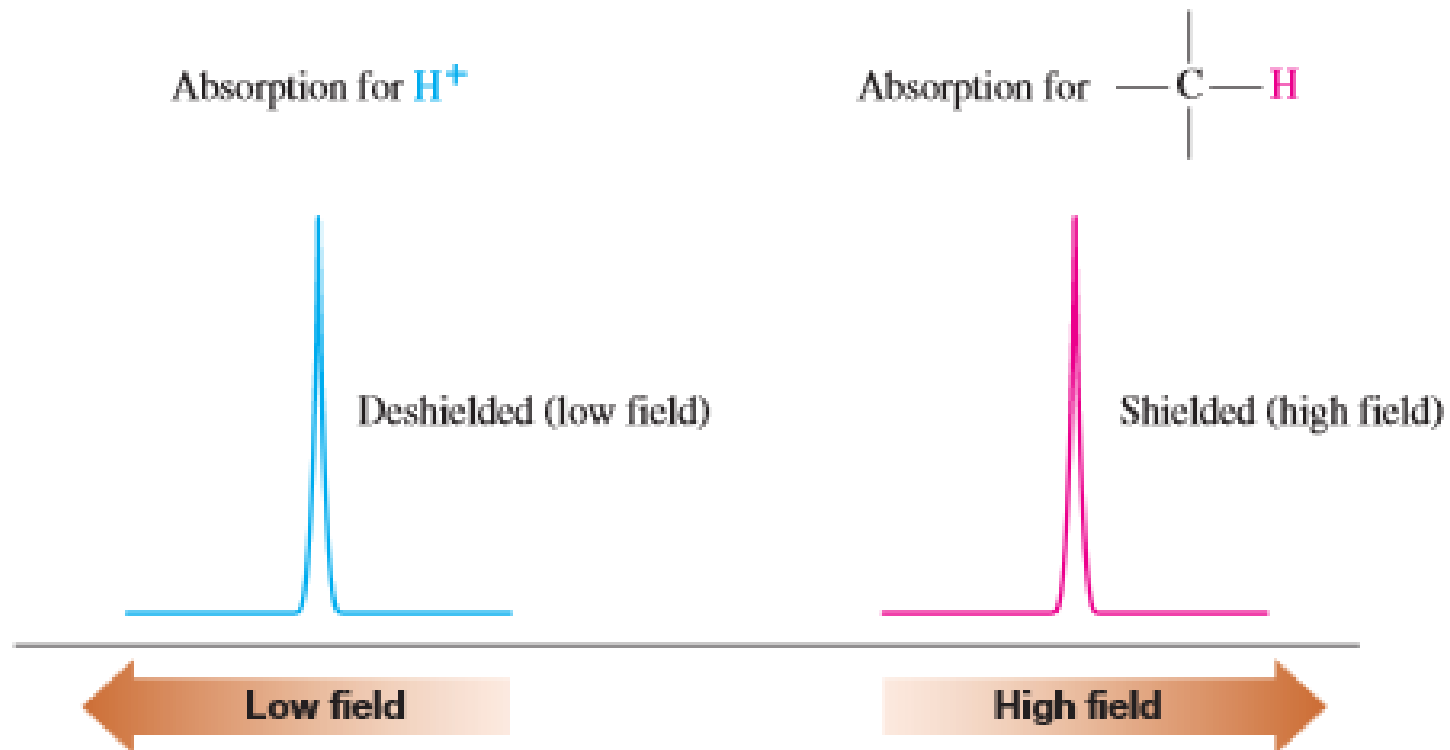






## » Chemický posun

$$\delta = \frac{\text{vzdálenost píku od } (\text{CH}_3)_4\text{Si v Hz}}{\text{frekvence spektrometru v MHz}}$$



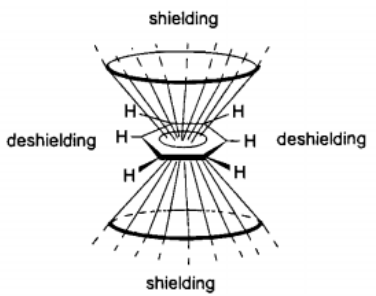
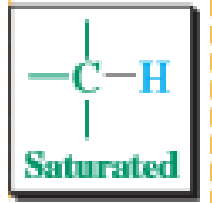
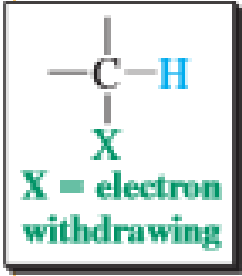
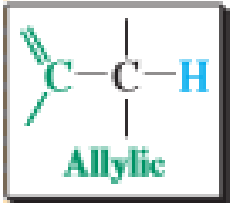
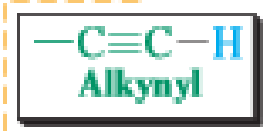
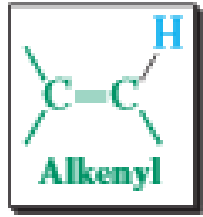
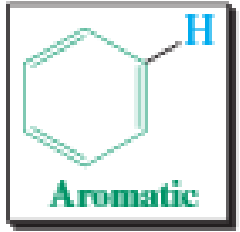
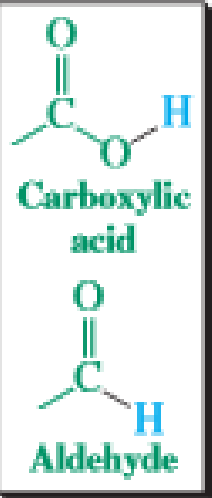
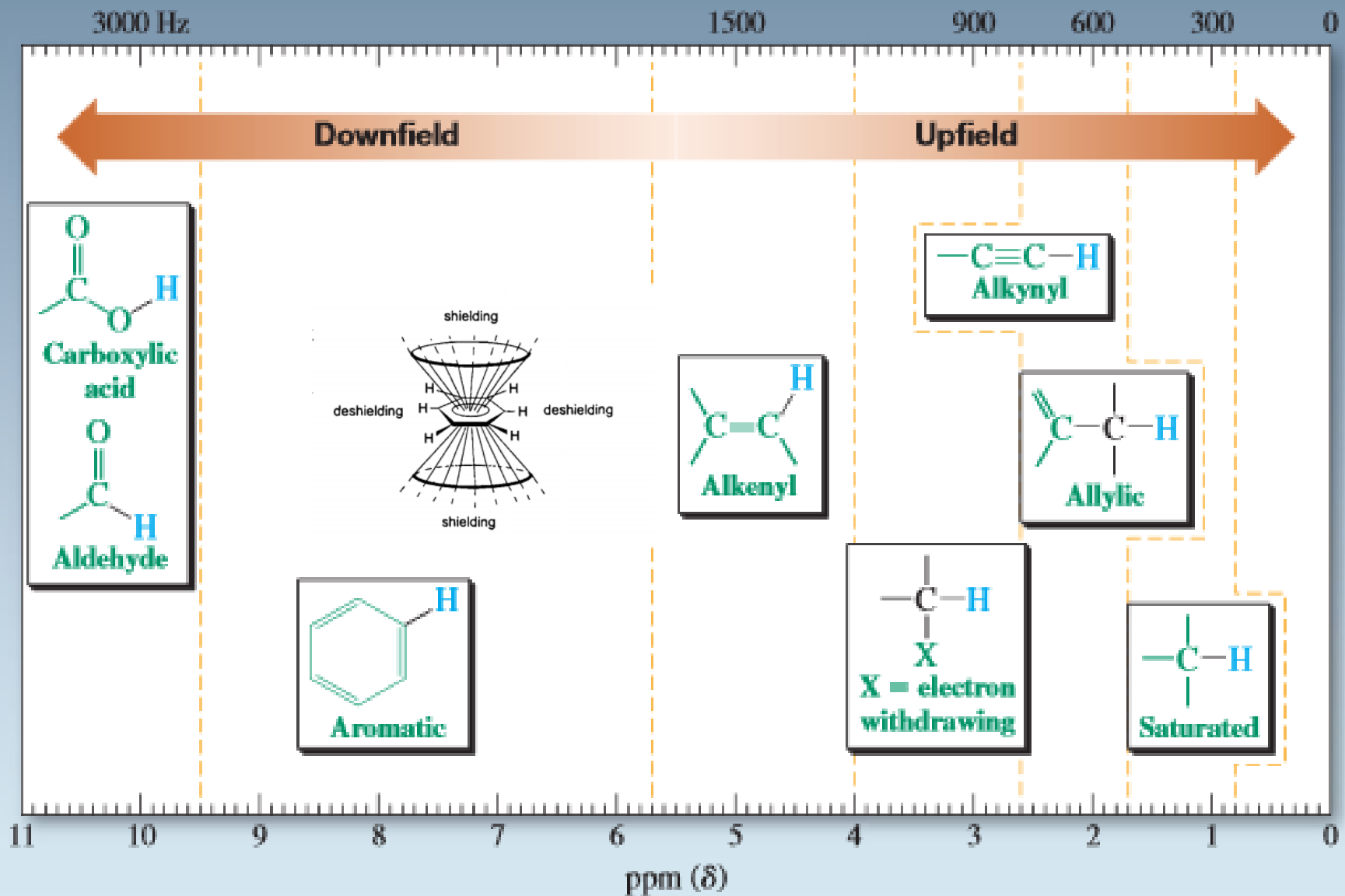



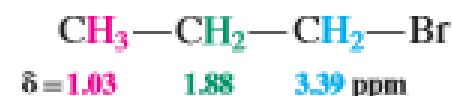
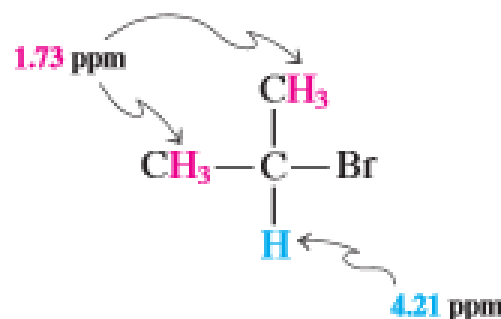


Table 10-3

## The Deshielding Effect of Electronegative Atoms

$\text{CH}_3\text{X}$	Electronegativity of X (from Table 1-2)		Chemical shift $\delta$ (ppm) of $\text{CH}_3$ group
$\text{CH}_3\text{F}$	4.0	 Increasing electronegativity	4.26
$\text{CH}_3\text{OH}$	3.4		3.40
$\text{CH}_3\text{Cl}$	3.2		3.05
$\text{CH}_3\text{Br}$	3.0		2.68
$\text{CH}_3\text{I}$	2.7		2.16
$\text{CH}_3\text{H}$	2.2		0.23

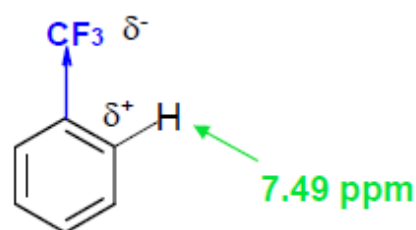
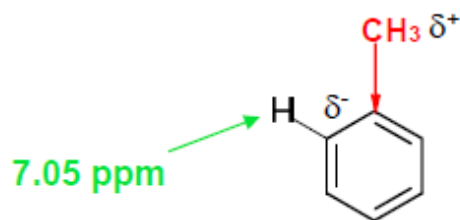

 Shielding


 Deshielding


## Indukční a mezomerní efekty

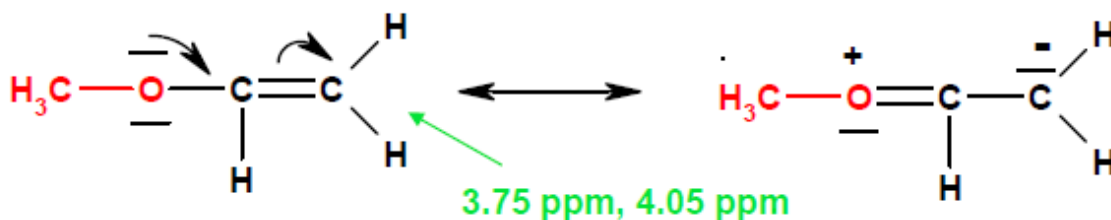
Indukční efekt (I-efekt) se týká posunu elektronů na  $\sigma$  vazbách.

I<sup>+</sup> je způsoben  
elektrondonorními  
substituenty.

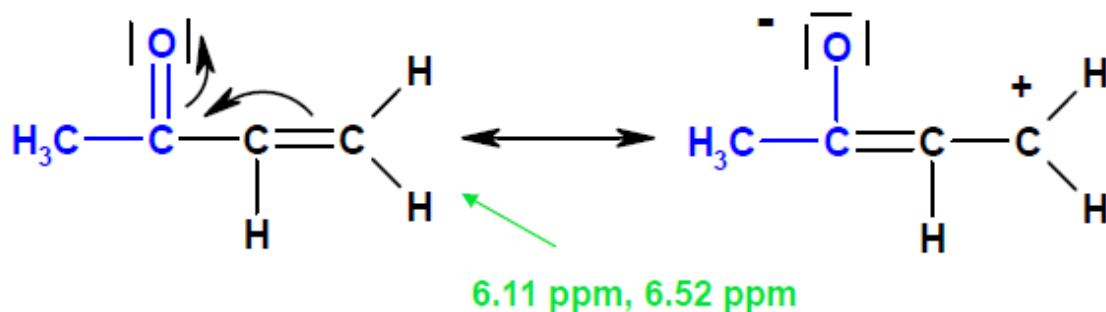


I<sup>-</sup> je způsoben  
elektronakceptorními  
substituenty.

Mezomerní efekt (M-efekt) se týká posunu elektronů na konjugovaných vazbách  $\pi$  nebo interakcí ne vazebných elektronových párů s násobnou vazbou.



M<sup>+</sup> způsobují substituenty  
poskytující ne vazebné  
elektrony.



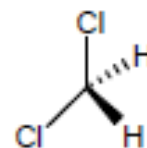
M<sup>-</sup> způsobují  
substituenty přitahující  
elektrony.

# Symetrie molekuly pomáhá určit chemickou ekvivalenci



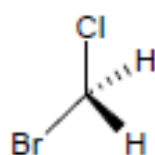
- NMR spektrum odráží symetrii molekuly
- o tom, zda dvojice atomů poskytne dva různé signály nebo jen jeden, rozhoduje jejich vzájemný vztah při operacích symetrie

## Homotopické atomy

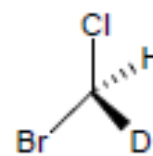
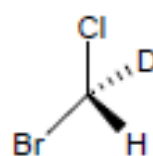


$C_2$  osa symetrie  
ekvivalentní  
1 signál ve spektru

## Enantiotopické atomy



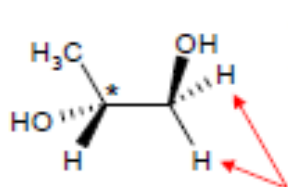
deuteriová  
substituce  
→



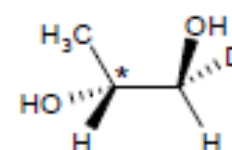
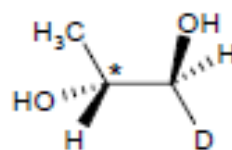
enantiomery

rovina symetrie  
není osa symetrie  
ekvivalentní  
1 signál ve spektru

## Diastereotopické atomy (molekuly s chirálním centrem)



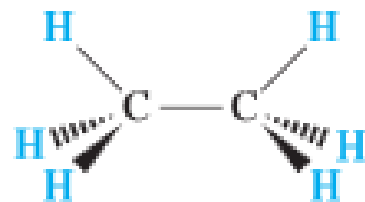
deuteriová  
substituce  
→



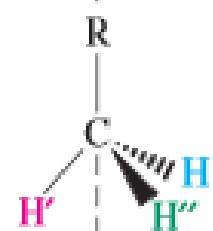
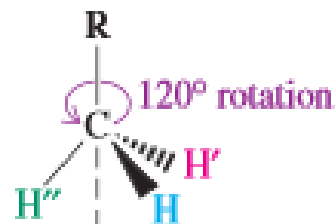
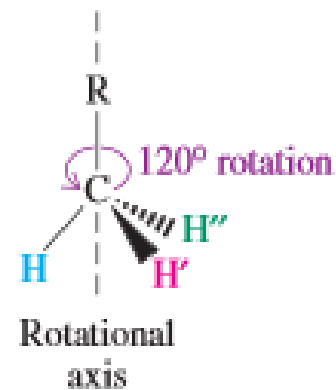
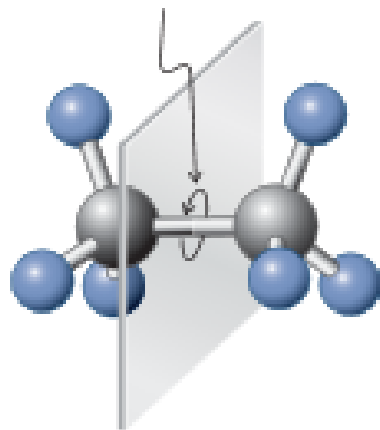
diastereomery

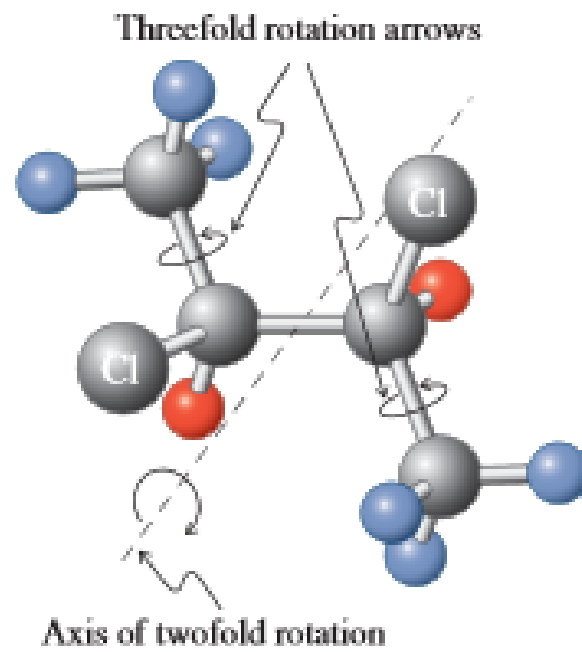
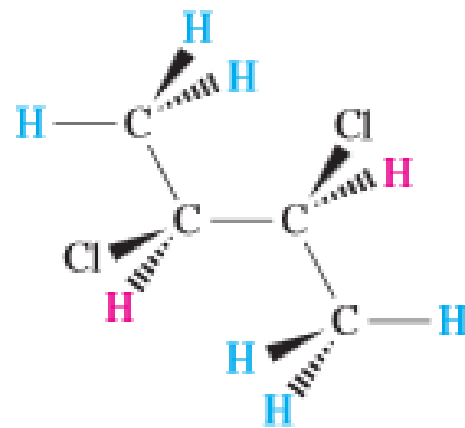
není osa symetrie  
není rovina symetrie  
neekvivalentní  
rozišitelné ve spektru

diastereotopické  
metylenové vodíky



Threefold rotation arrow





## » Vyměnitelné protony

- protony v OH, NH, SH, proměnlivé chemické posuny
- kyselý charakter
- H můstky, chemická výměna
- závislost na koncentraci, teplotě, rozpouštědle ...
- chemické posuny reprodukovatelné za přesně definovaných podmínek  
multiplety nebo široké singlety (v závislosti na rychlosti chemické výměny)
- přítomnost více vyměnitelných protonů; inter nebo intramolekulární chem. výměna
- praktické využití výměny protonů za deuterium ( $D_2O$ ,  $CD_3$  COOD)

### OH

alkoholy 1 – 5 ppm  
fenoly 4 – 10 ppm  
kyseliny 9 – 13 ppm  
enoly 10 – 17 ppm

### NH

aminy 1 – 5 ppm  
amidy 5 – 6,5 ppm  
amidické skupiny v  
peptidech 7 – 10 ppm

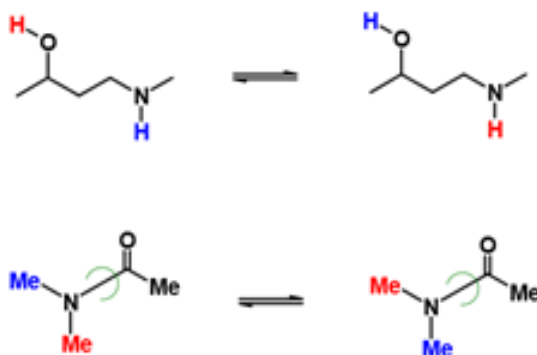
### SH

alifatické thioly 1 – 2,5 ppm  
aromatické thioly 3 - 4 ppm



## Počet signálů - Chemická výměna

Buď se jedná o skutečný chemický proces (reakci) nebo se jedná změnu konformace, například v důsledku rotace kolem vazby.



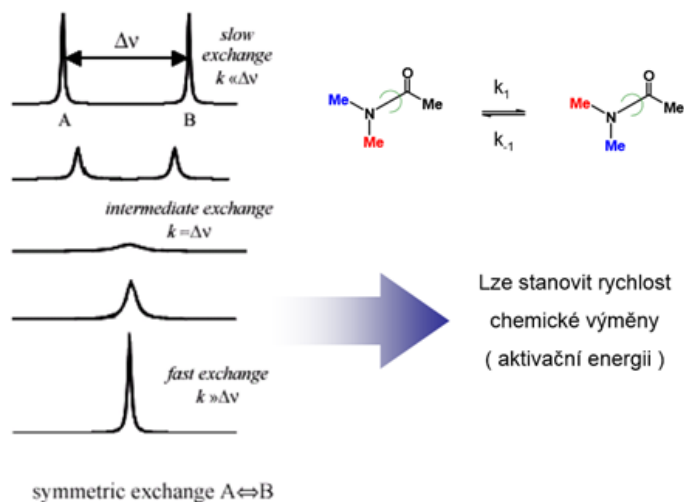
Chemická výměna je na časové škále NMR

a) Rychlá = pozorujeme průměrnou hodnotu

b) Střední = pozorujeme velmi široký signál

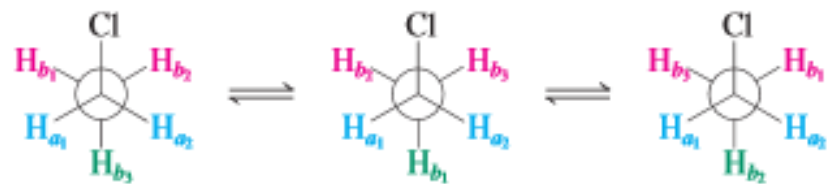
c) Pomalá = pozorujeme signály krajních stavů

## Počet signálů - Vliv teploty

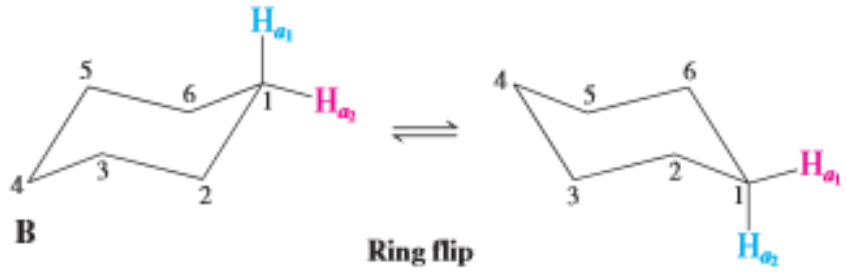
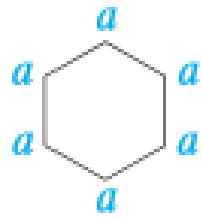


Lze stanovit rychlost chemické výměny (aktivační energii)

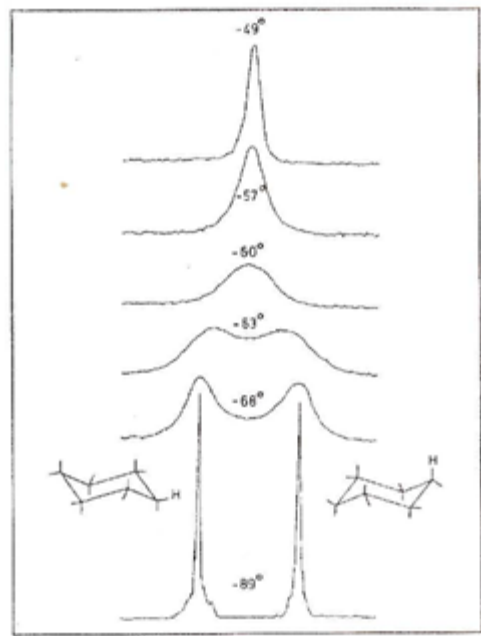




**A**     Rotation of the methyl group, located in the back



**B**     Ring flip

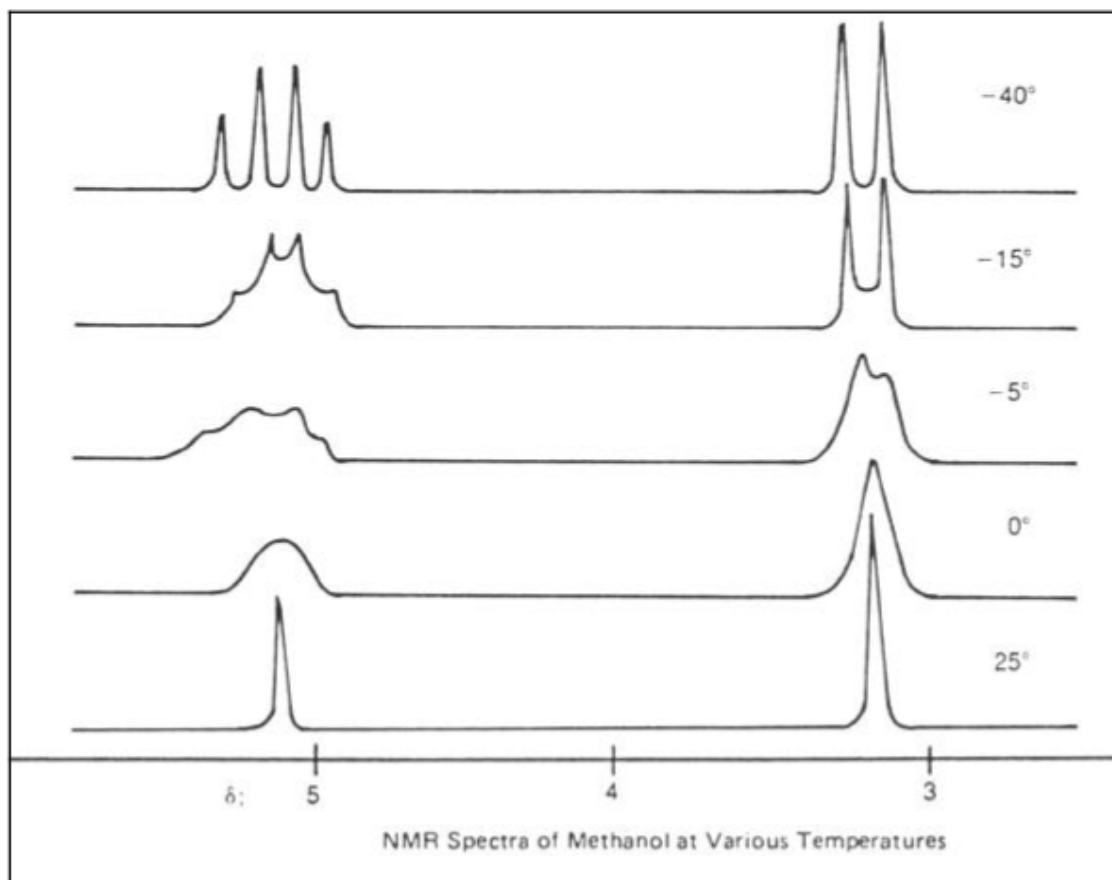


Obr. 31-3  $^1\text{H}$  NMR spektrum (60 MHz) jediného vodíku cyklohexanu- $\text{d}_{11}$  v závislosti na teplote.

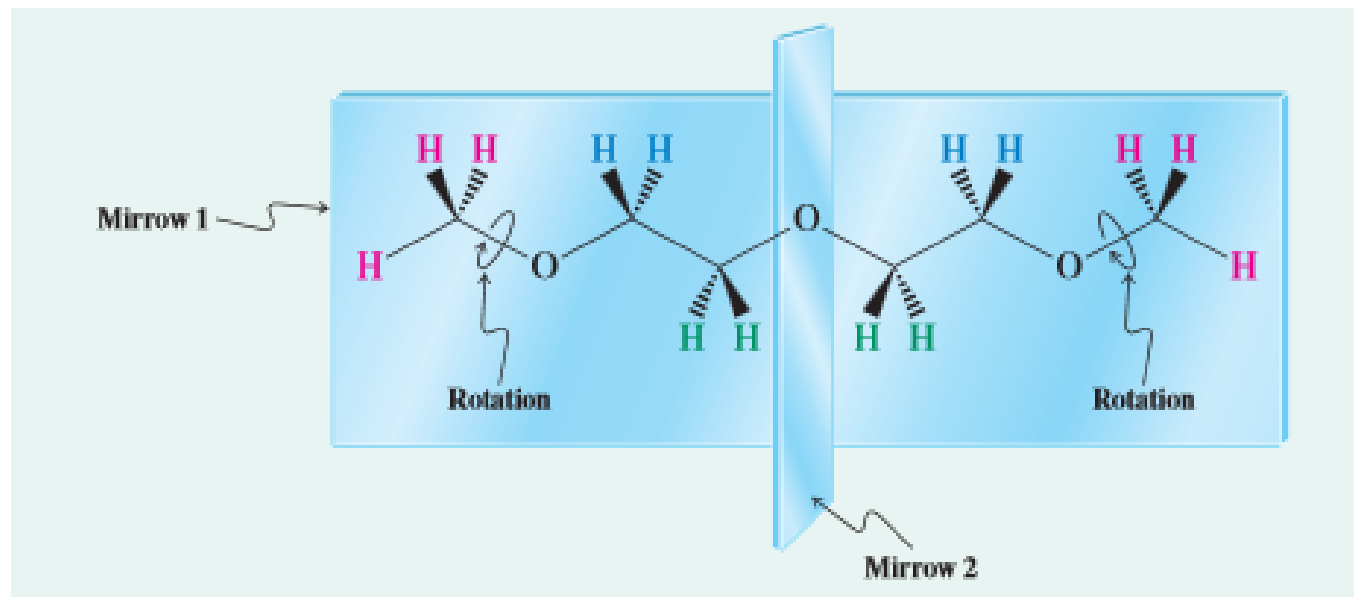
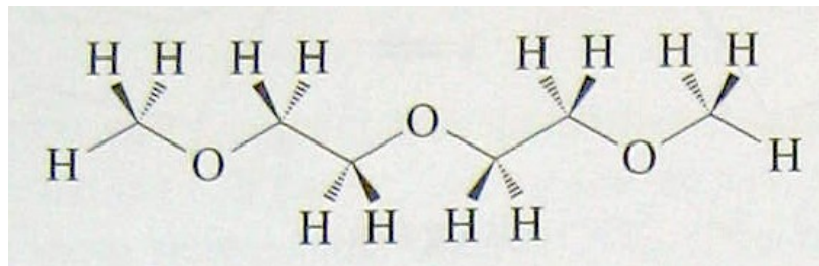


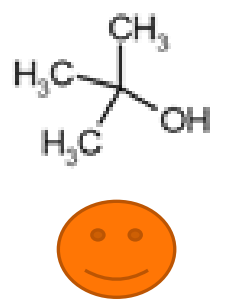
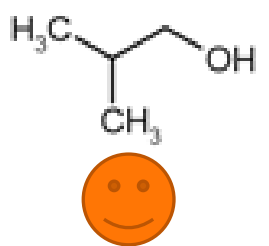
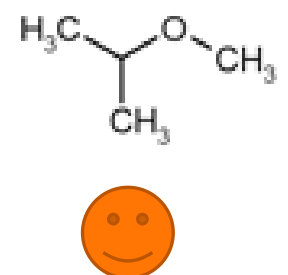






## $^1\text{H}$ NMR spektrum methanolu $\text{CH}_3\text{OH}$ při různých teplotách



Kolik  $^1\text{H}$  NMR signálů očekáváte u níže uvedené molekuly?

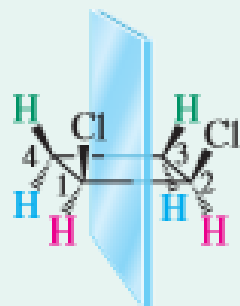




<chem>CO</chem>	<chem>CC(C)(C)OC</chem>	<chem>CCOC</chem>	<chem>CC(C)(C)CO</chem>
			



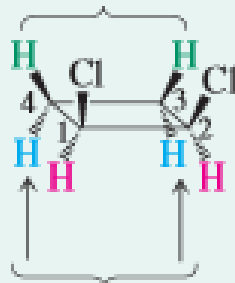
Kolik signálů očekáváte v  $^1\text{H}$  NMR spektru *cis*- a *trans*-1,2-dichlorocyklobutanu?



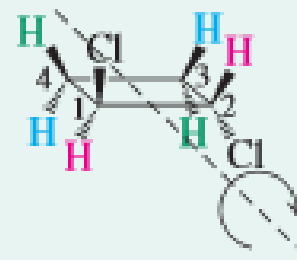
Mirror plane bisecting the molecule

*cis*-1,2-Dichlorocyclobutane

Cis to the chlorine atoms

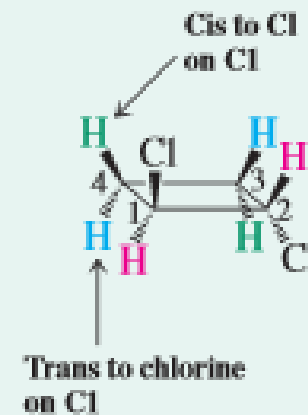


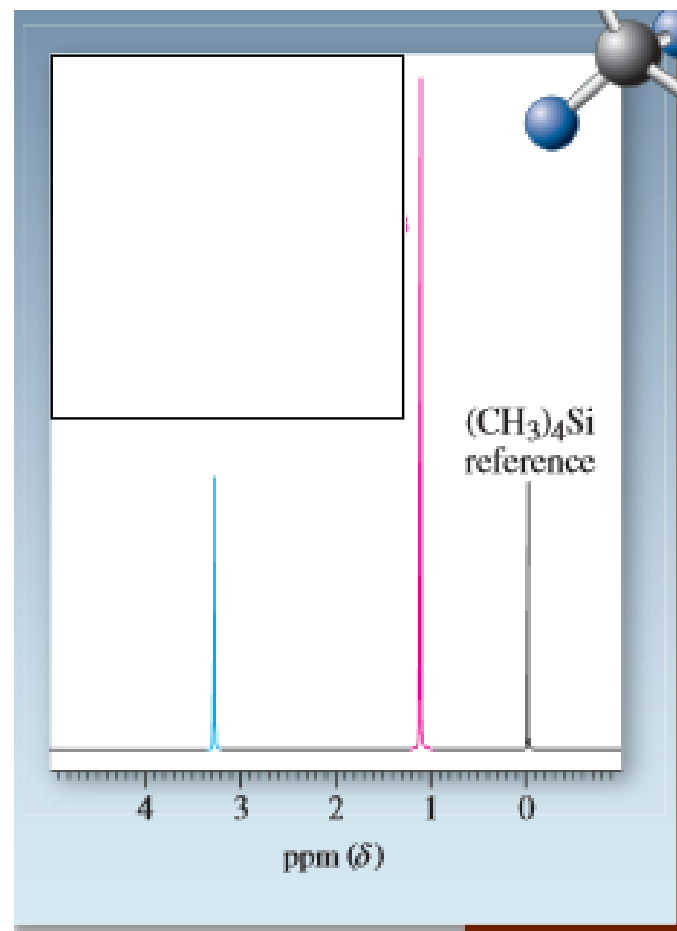
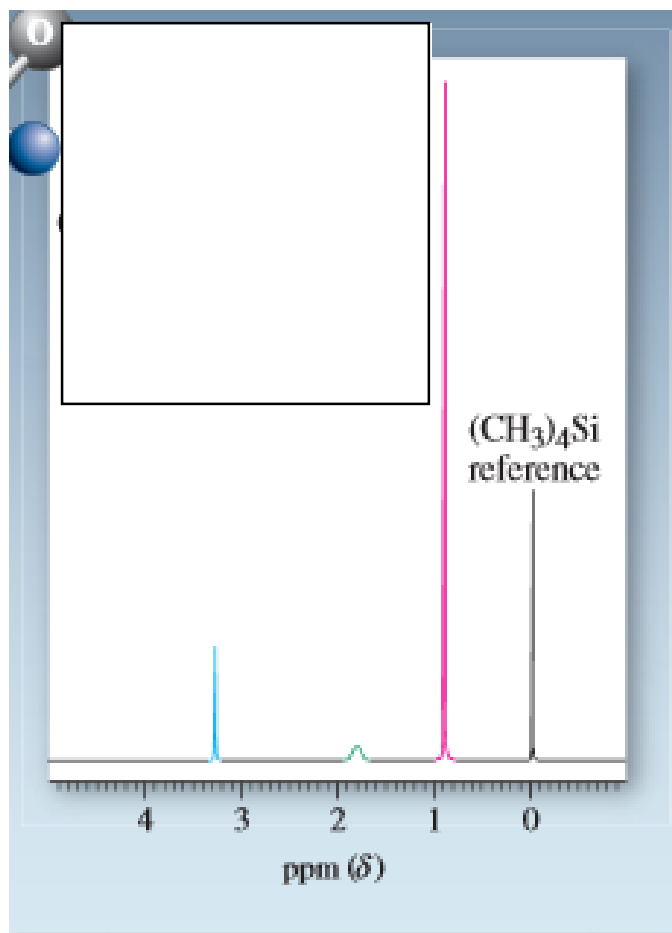
Trans to the chlorine atoms



Twofold rotational axis

*trans*-1,2-Dichlorocyclobutane





Rozhodněte, které spektrum náleží molekule *(t*-butyl)(methyl)etheru a které molekule 2,2-dimethylpropanolu?



$^1\text{H}$  NMR



15 mm  
(equivalent to 6 H)

10 mm (equivalent to 4 H)

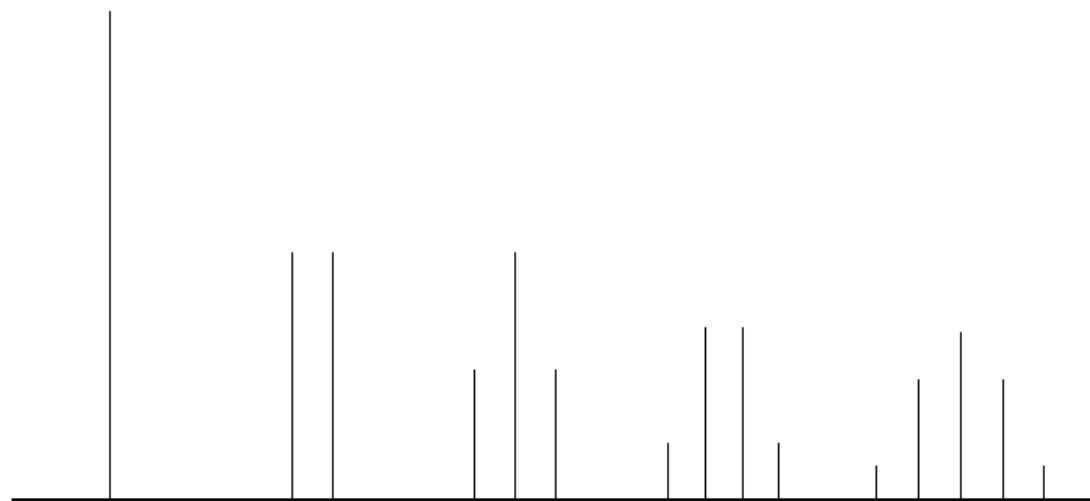
9 8 7 6 5 4 3 2 1 0

ppm ( $\delta$ )

**B**



## » Multiplicita signálů



singlet

dublet

triplet

kvartet

kvintet

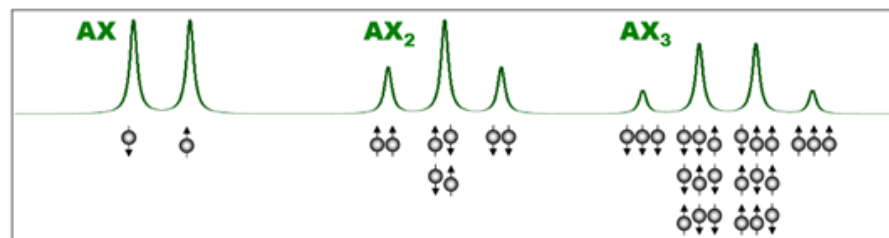
1 : 1

1 : 2 : 1

1 : 3 : 3 : 1

1 : 4 : 6 : 4 : 1

Multiplicita signálu – Počet linií pro  $I = \frac{1}{2}$



	Splitting pattern for $H_a$	Structure	Splitting pattern for $H_b$	
$H_a$ has <b>one neighbor</b> $H_b$ : 2 peaks or <b>doublet</b>				$H_b$ has <b>one neighbor</b> $H_a$ : 2 peaks or <b>doublet</b>
$H_a$ has <b>one neighbor</b> $H_b$ : 2 peaks or <b>doublet</b>				$H_b$ has <b>two neighbors</b> $H_a$ : 3 peaks or <b>triplet</b>
$H_a$ has <b>two neighbors</b> $H_b$ : 3 peaks or <b>triplet</b>				$H_b$ has <b>two neighbors</b> $H_a$ : 3 peaks or <b>triplet</b>
$H_a$ has <b>one neighbor</b> $H_b$ : 2 peaks or <b>doublet</b>				$H_b$ has <b>three neighbors</b> $H_a$ : 4 peaks or <b>quartet</b>
$H_a$ has <b>two neighbors</b> $H_b$ : 3 peaks or <b>triplet</b>				$H_b$ has <b>three neighbors</b> $H_a$ : 4 peaks or <b>quartet</b>
$H_a$ has <b>one neighbor</b> $H_b$ : 2 peaks or <b>doublet</b>				$H_b$ has <b>six neighbors</b> $H_a$ : 7 peaks or <b>septet</b>

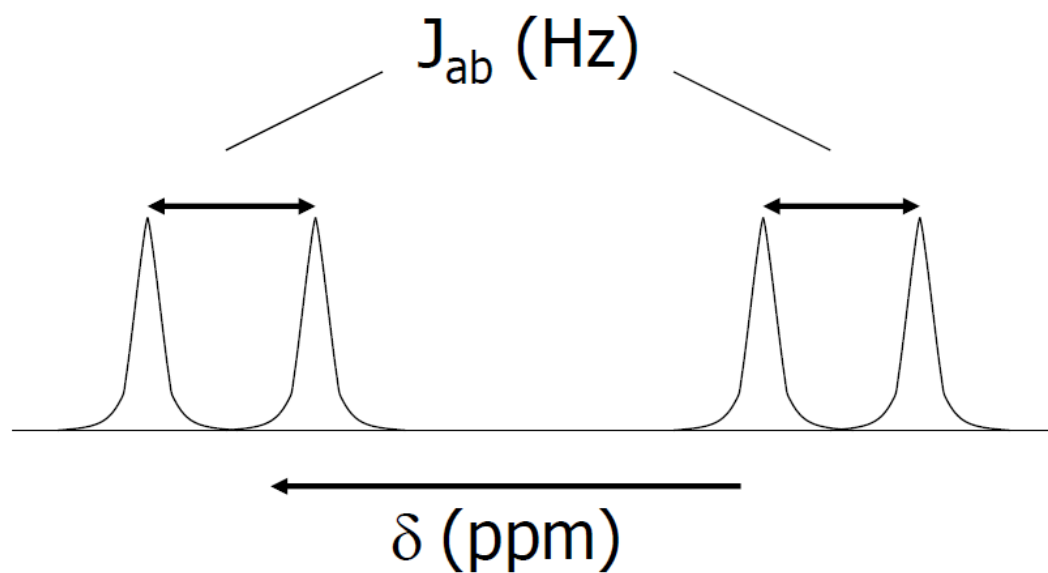
Note:  $H_a$  and  $H_b$  are not equivalent and have no other coupled nuclei in their vicinity.





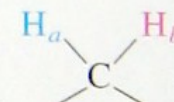
# » Interakční konstanta

nezávisí na  $H_0$  vnějšího magnetického pole

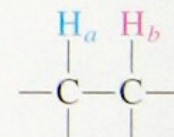


	$J(H,H)$ [Hz]	$J(C,H)$ [Hz]
geminální	1J	125 - 250
vicinální	2J	0 - 30
	3J	-10 až 20
dalekého dosahu (long range)	$3+nJ$	1 - 10
		<1

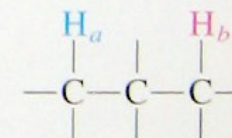
## Coupling Between Close-Lying Hydrogens



$J_{ab}$ , geminal coupling, variable 0-18 Hz



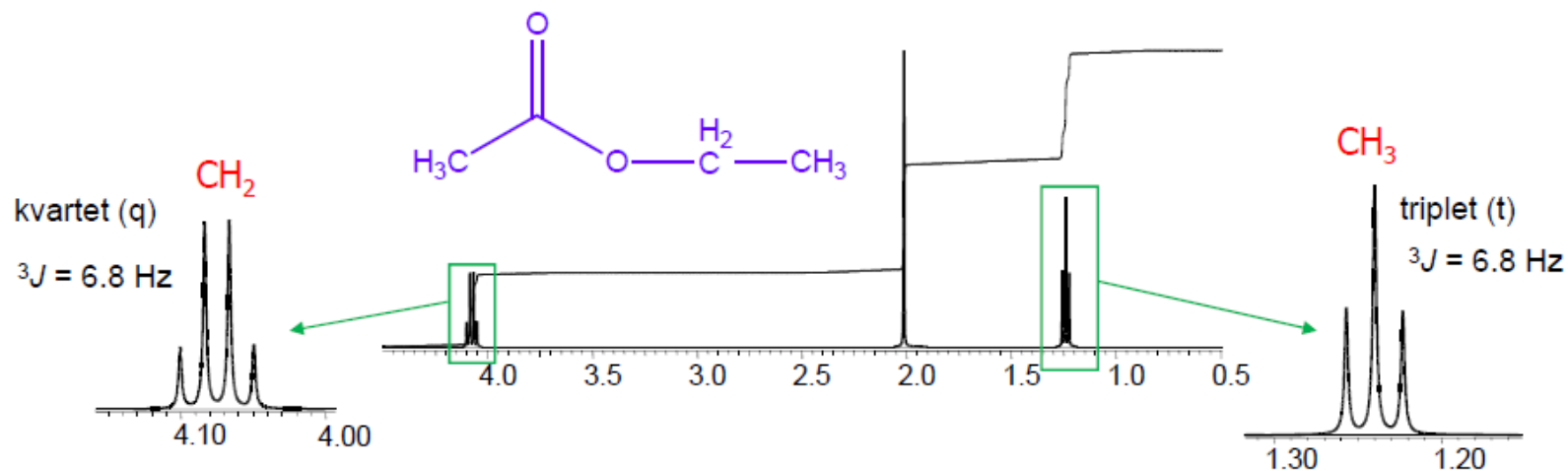
$J_{ab}$ , vicinal coupling, typically 6-8 Hz



$J_{ab}$ , 1,3-coupling, usually negligible



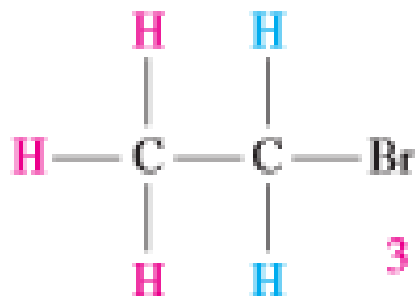
## » $^1\text{H}$ NMR spektrum ethyl-acetátu



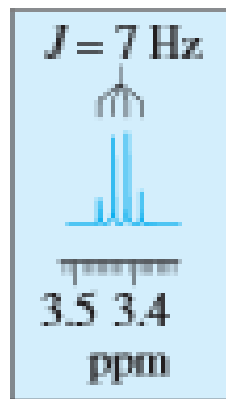
- spektrum 1. řádu:  $\Delta\nu \gg J$ , AX systém
- methylen vidí 4 různé stavy methylu (kvartet), methyl vidí 3 různé stavy methyleny (triplet)
- počet složek multipletu pro  $I = 1/2$ :  $n+1$ ,  $n$  je počet interagujících jader v sousedním multipletu
- vzdálenost složek multipletu v Hz - interakční konstanta  $J$
- střed multipletu - hodnota chemického posunu  $\delta$



$^1\text{H}$  NMR



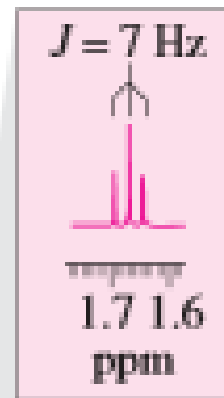
3 H neighbors:  
quartet



2 H

2 H neighbors:  
triplet

3 H



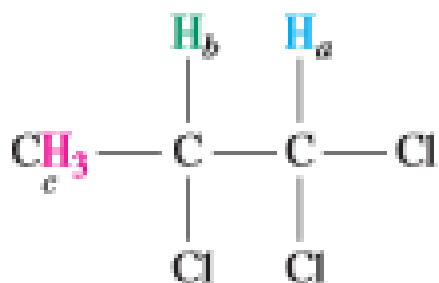
$(\text{CH}_3)_4\text{Si}$

9 8 7 6 5 4 3 2 1 0

ppm ( $\delta$ )



$^1\text{H NMR}$



1 H neighbor:  
doublet

$$J_{ab} = 3.6 \text{ Hz}$$



3 H neighbors: quartet  
 $J_{bc} = 6.8 \text{ Hz}$

1 H neighbor: doublet  
 $J_{ab} = 3.6 \text{ Hz}$

1 H

1 H

3 H

1 H neighbor:  
doublet

$$J_{bc} = 6.8 \text{ Hz}$$



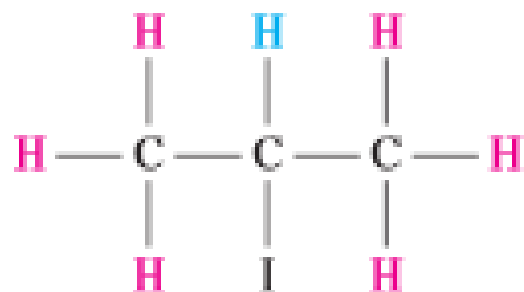
$(\text{CH}_3)_4\text{Si}$

9 8 7 6 5 4 3 2 1 0

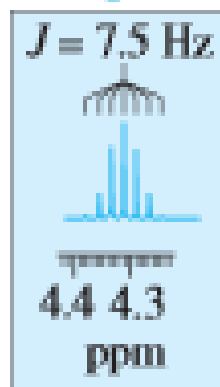
ppm ( $\delta$ )



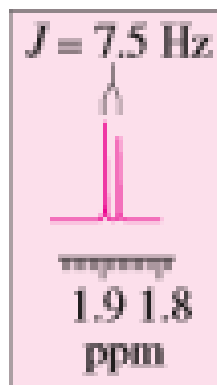
$^1\text{H}$  NMR



6 H neighbors:  
septet



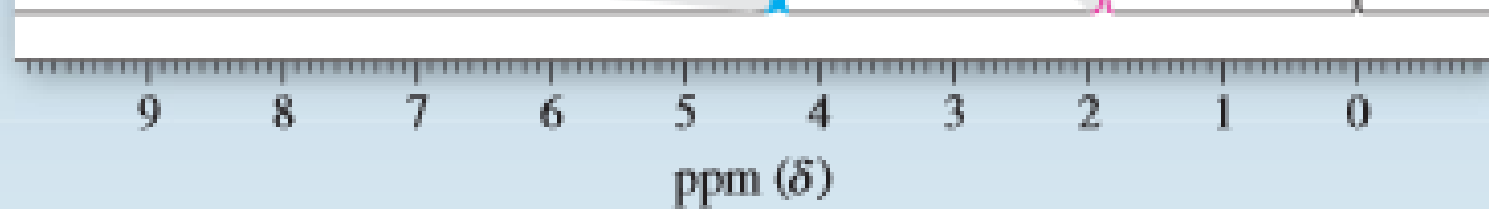
1 H neighbors:  
doublet



6 H

$(\text{CH}_3)_4\text{Si}$

1 H

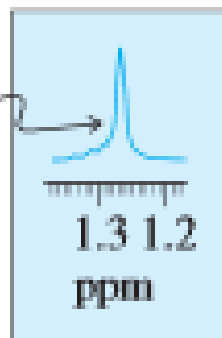


$^1\text{H}$  NMR

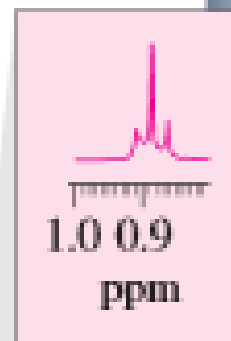


$\delta$  Values are close

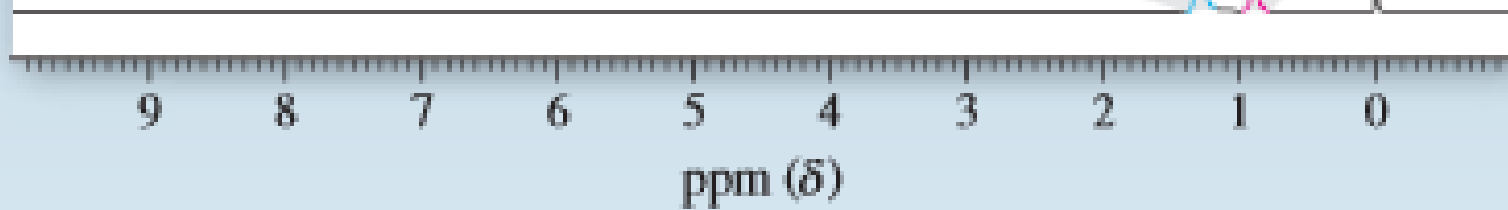
Non-first-order



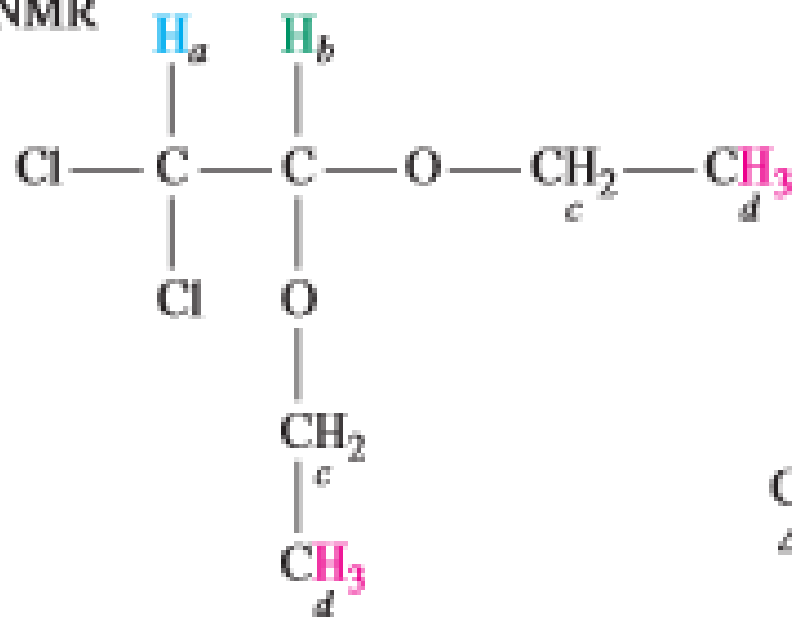
12 H  
6 H



$(\text{CH}_3)_4\text{Si}$



$^1\text{H}$  NMR



$\text{CH}_3$   
6 H

CH  
1 H

CH  
1 H

$\text{CH}_2$   
4 H

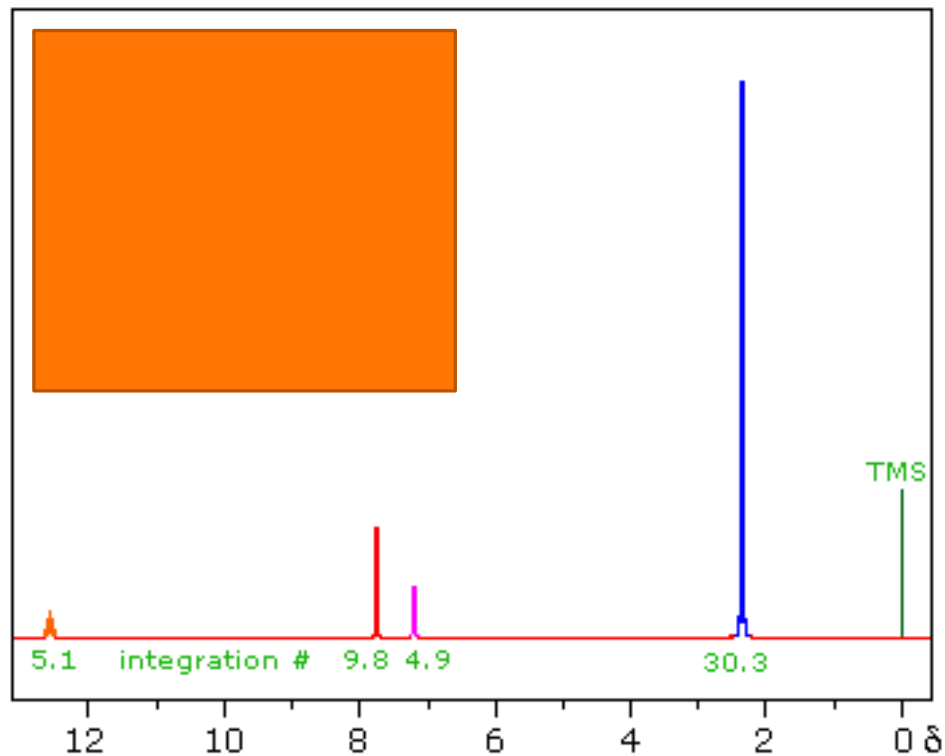
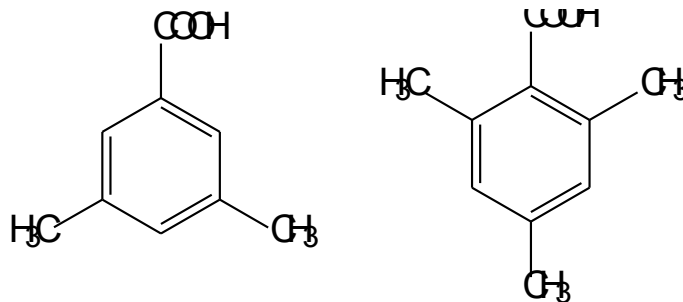
$(\text{CH}_3)_4\text{Si}$

9 8 7 6 5 4 3 2 1 0

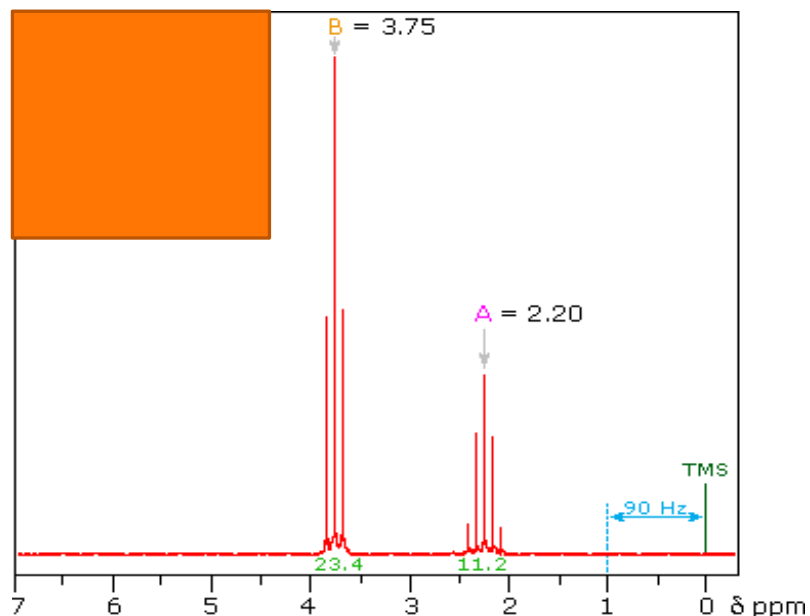
ppm ( $\delta$ )



Rozhodněte, které z následujících sloučenin odpovídá níže uvedené  $^1\text{H}$  NMR spektrum.





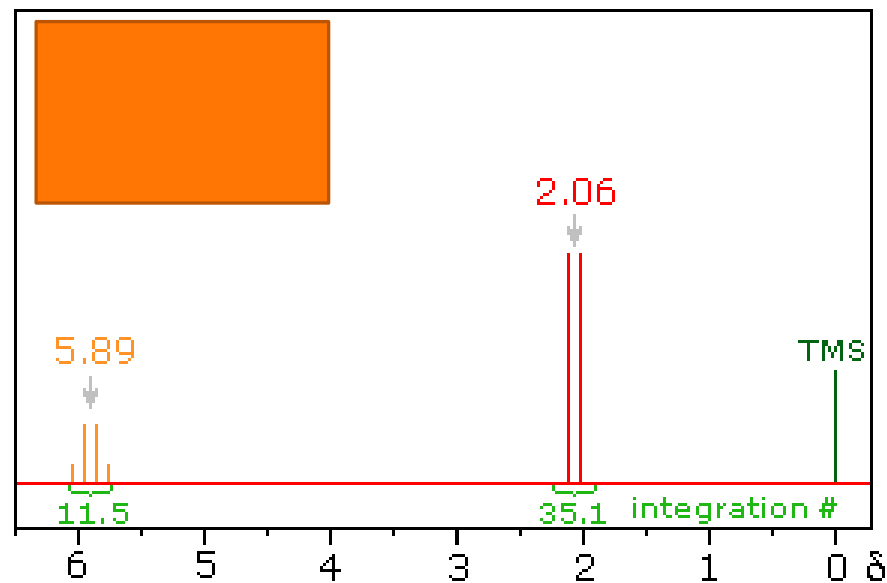
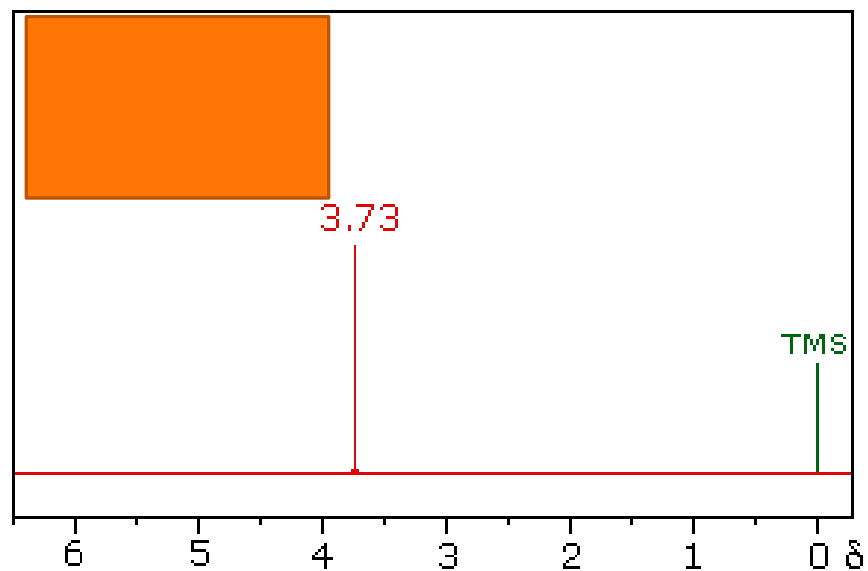


Přiřadte následující  $^1\text{H}$  NMR spektra níže uvedeným sloučeninám:

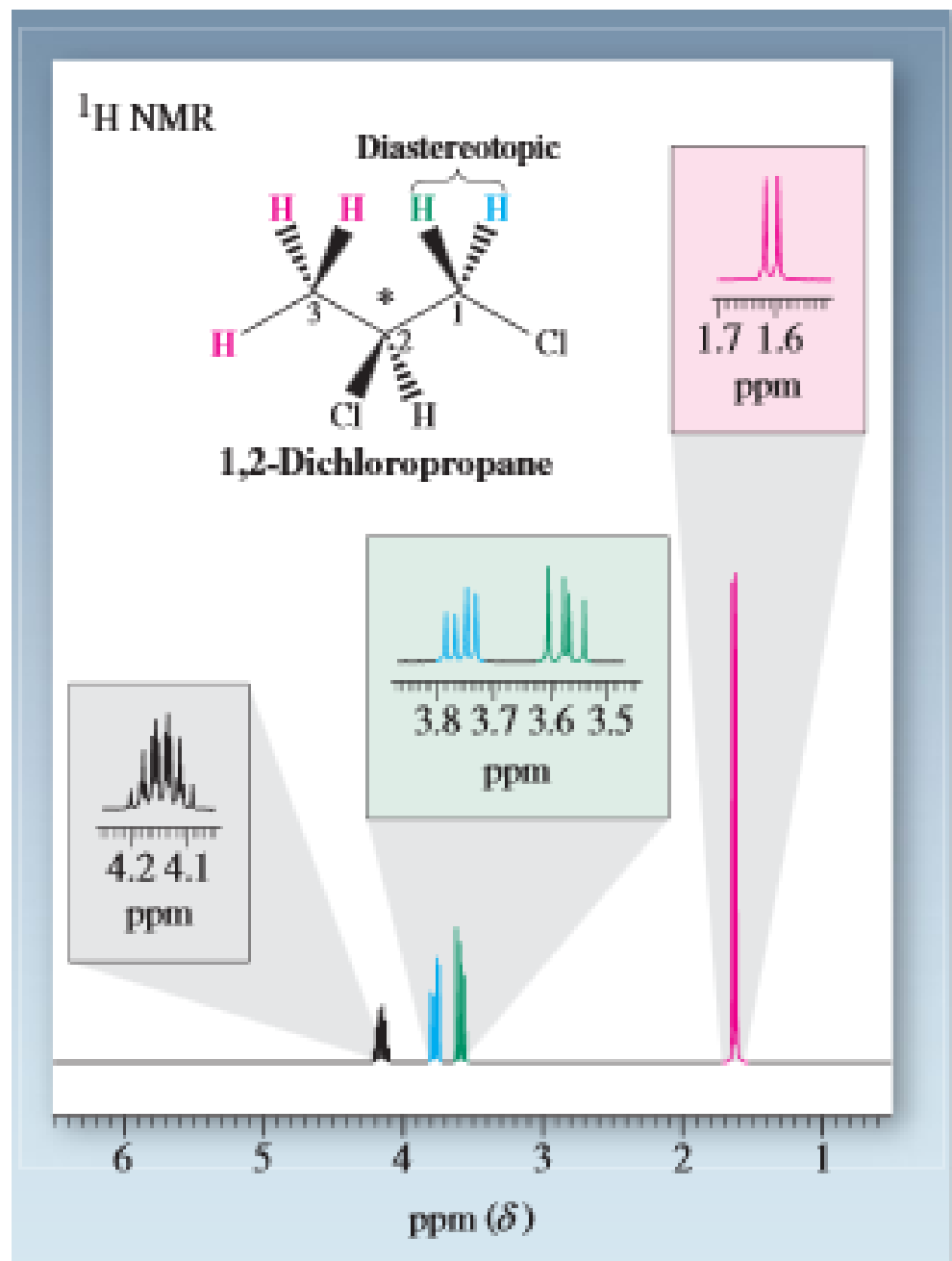
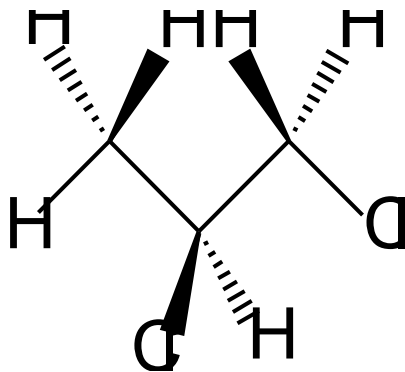
1,1-dichlorethan

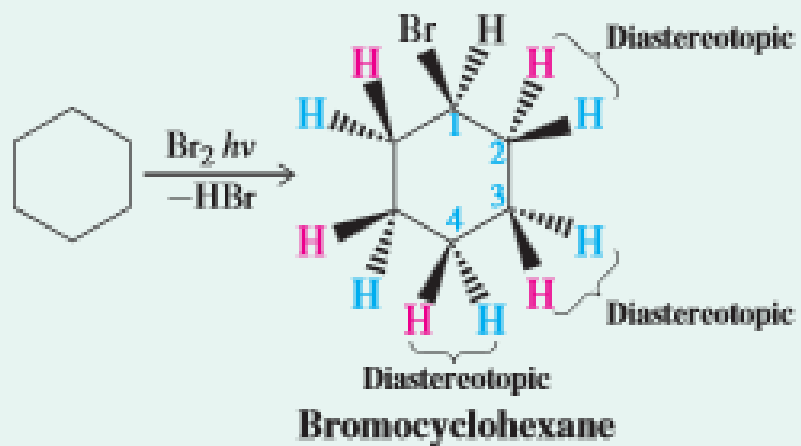
1,2-dichlorethan

1,3-dichlorpropan

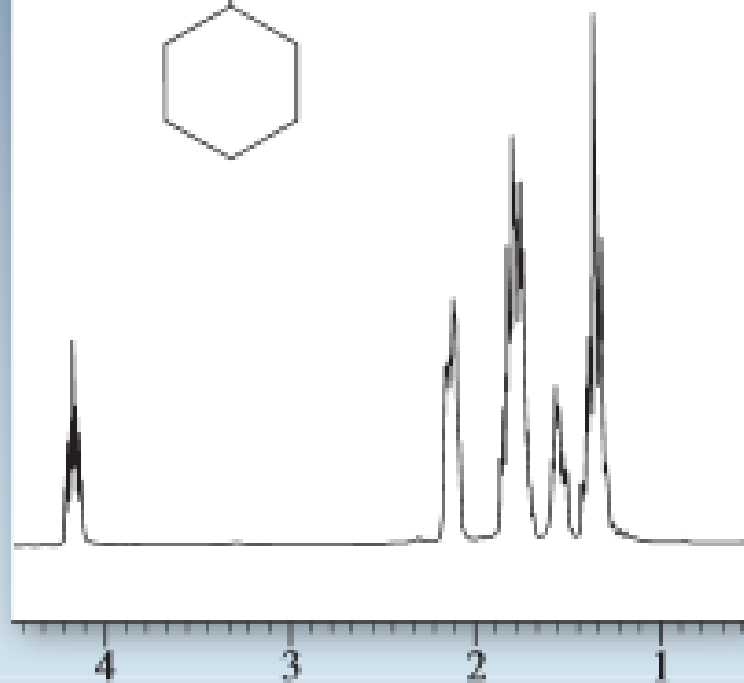


Pokuste se navrhnout, jak bude vypadat  $^1\text{H}$  NMR spektrum uvedené sloučeniny



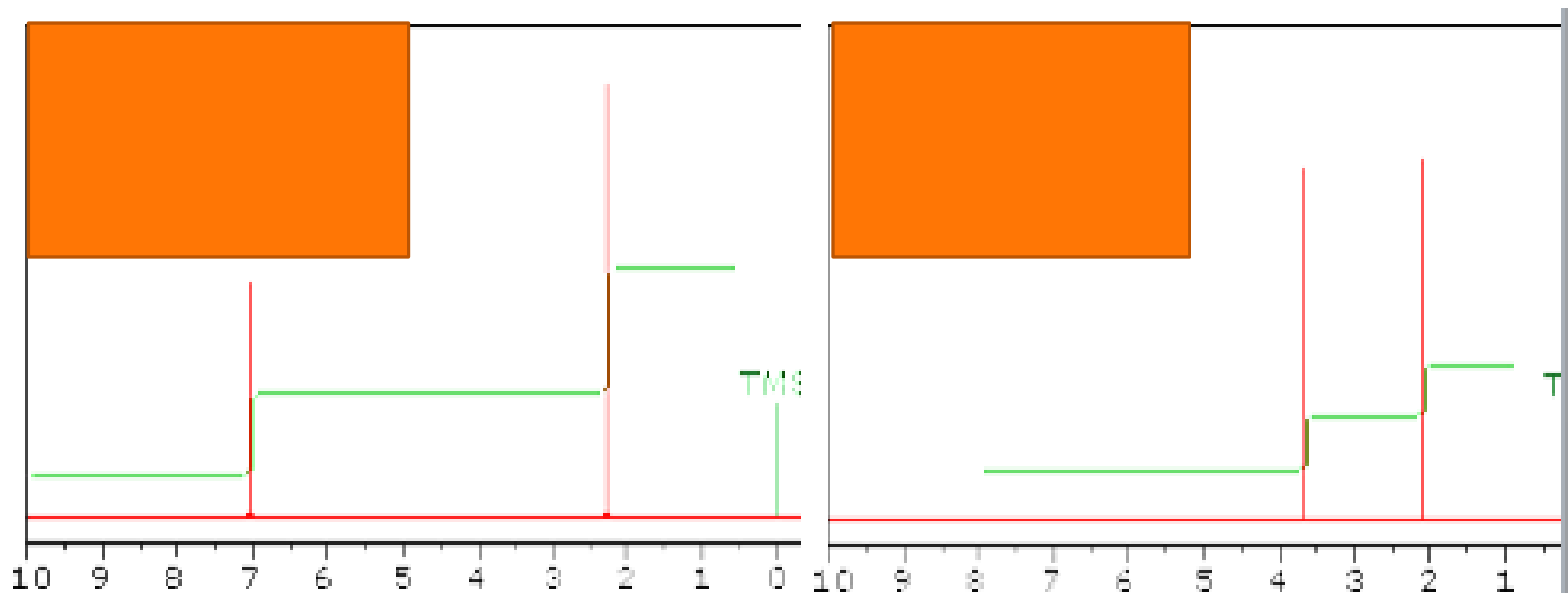
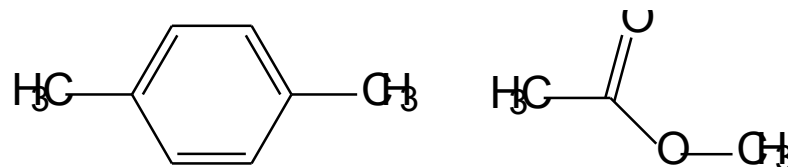


$^1\text{H}$  NMR

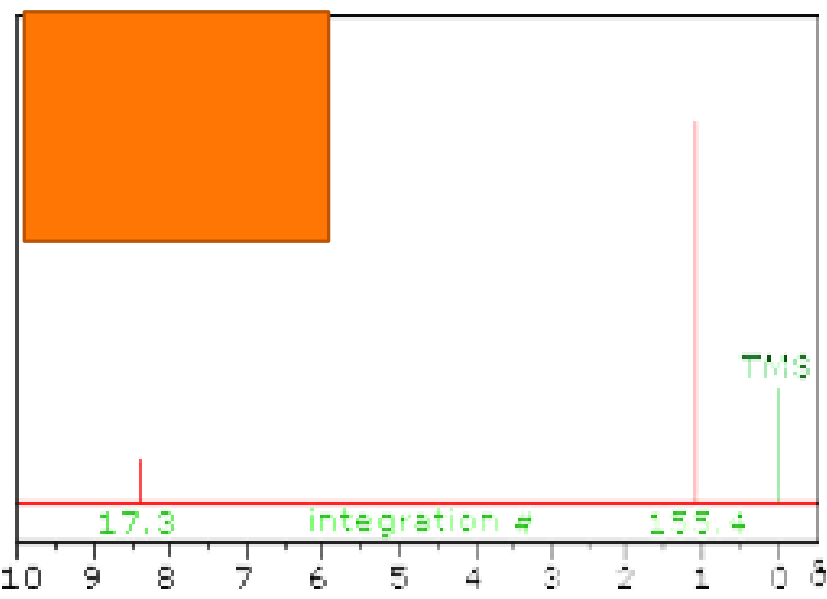
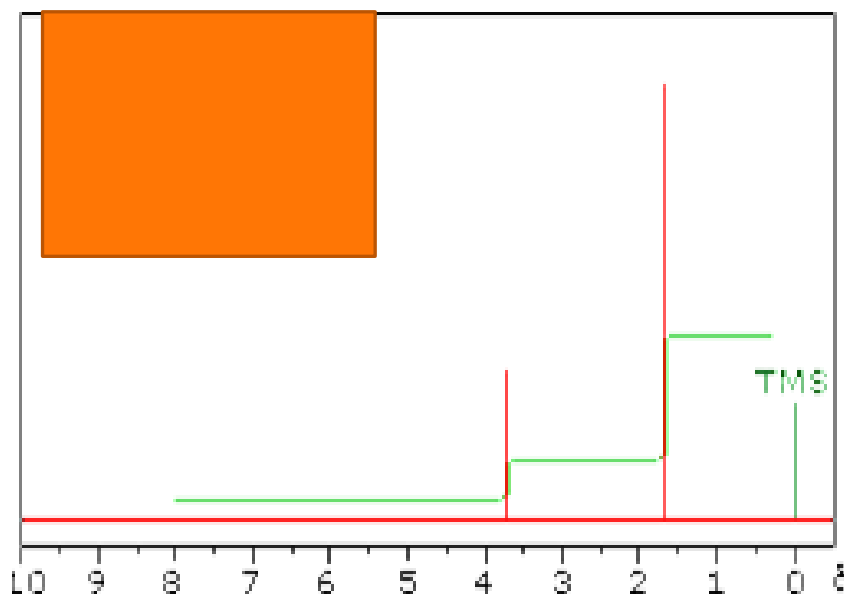
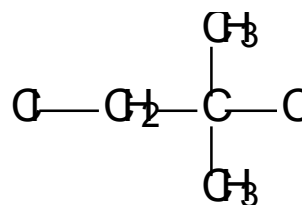
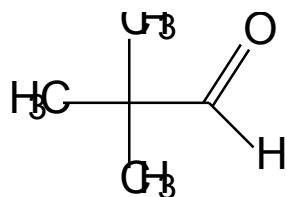


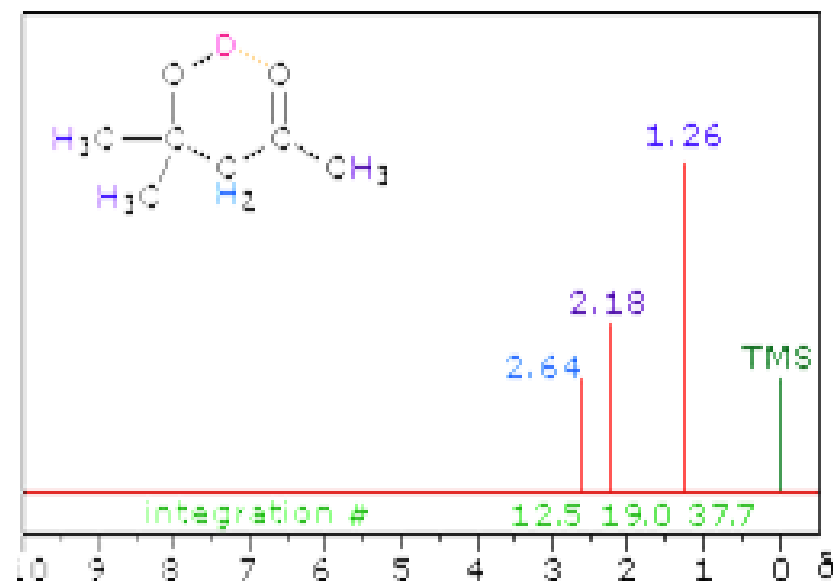
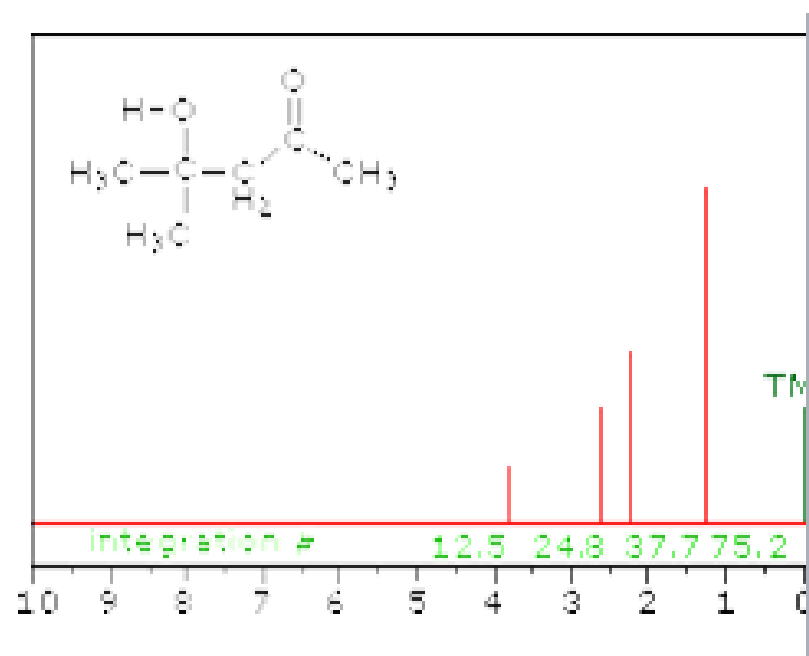
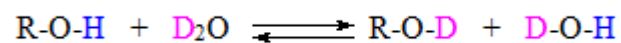
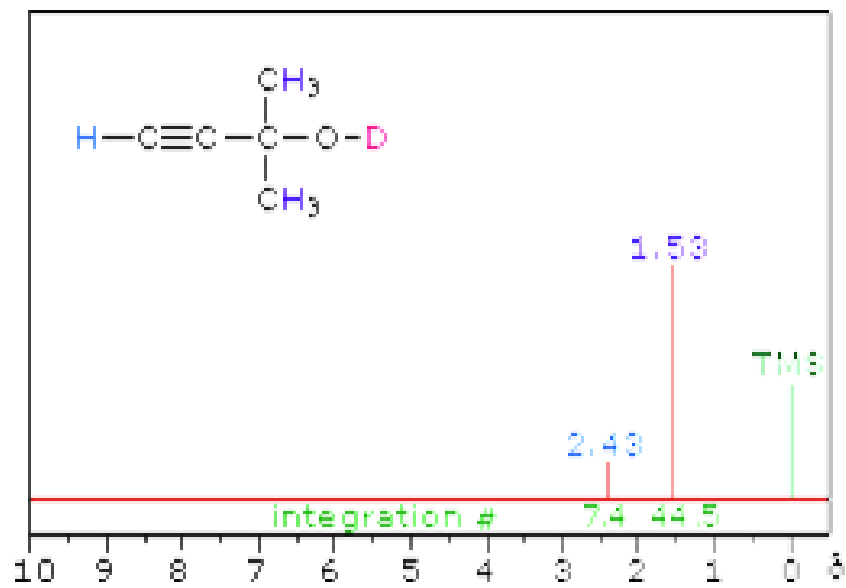
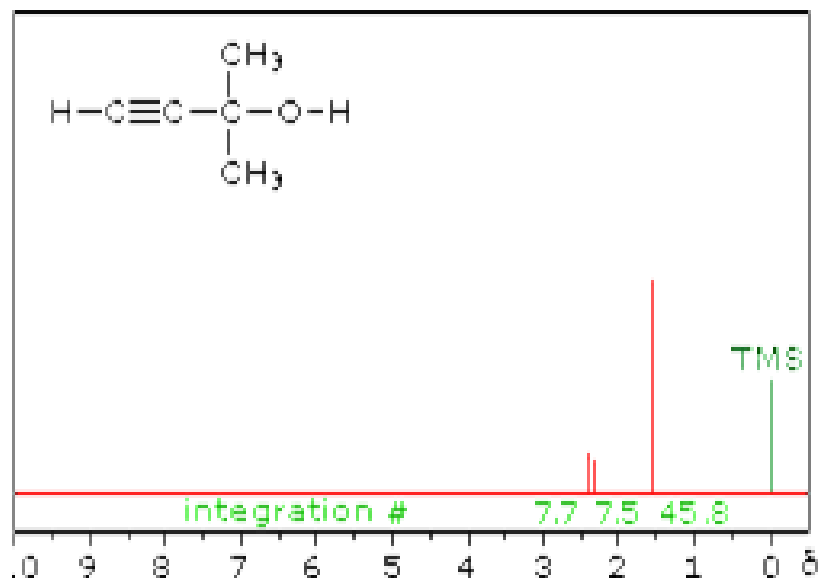
ppm ( $\delta$ )

Rozhodněte, které z následujících sloučenin odpovídá níže uvedené  $^1\text{H}$  NMR spektrum.



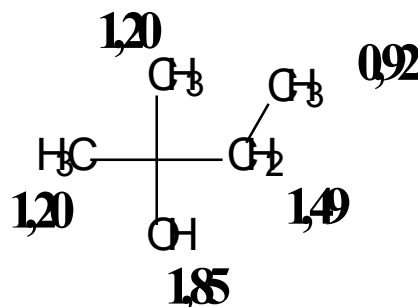
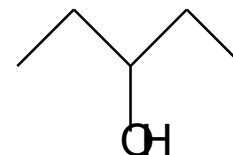
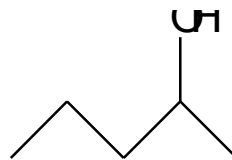
Rozhodněte, které z následujících sloučenin odpovídá níže uvedené  $^1\text{H}$  NMR spektrum.



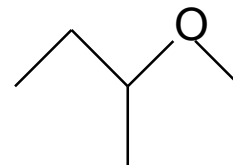
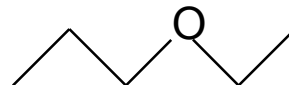
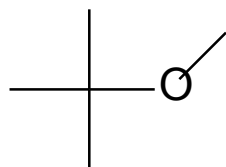


Pokuste se odhadnout, kterému z izomerních alkoholů sumárního vzorce  $C_5H_{12}O$  odpovídá následující  $^1H$  NMR spektrum.

- » 0,92 (t, 3H)
- » 1,20 (s, 6H)
- » 1,49 (k, 2H)
- » 1,85 (š. s, 1H)



Pokuste se odhadnout, jak byste na základě  $^1\text{H}$  NMR spekter rozlišili izomerní ethery sumárního vzorce  $\text{C}_5\text{H}_{12}\text{O}$ .

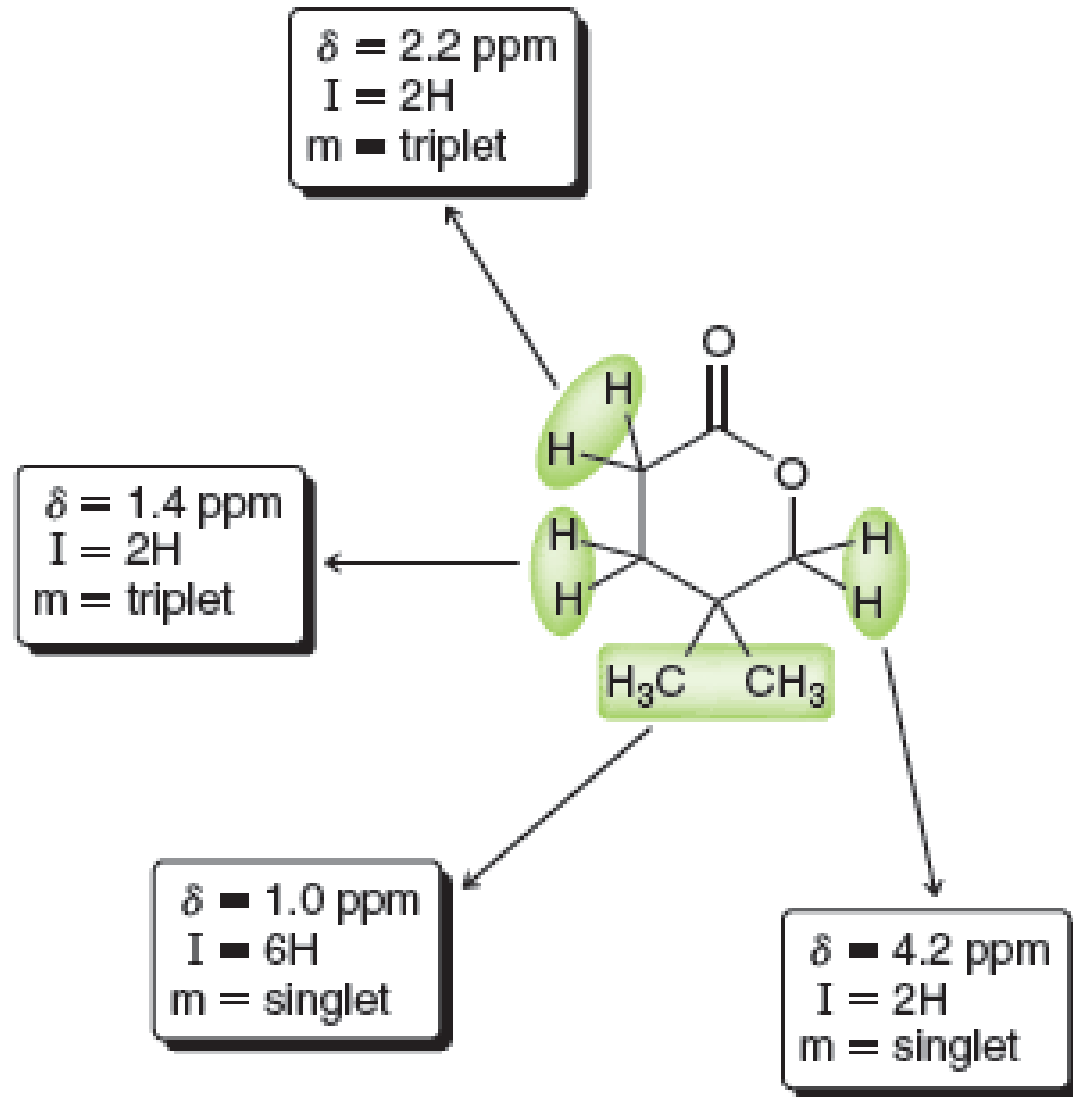


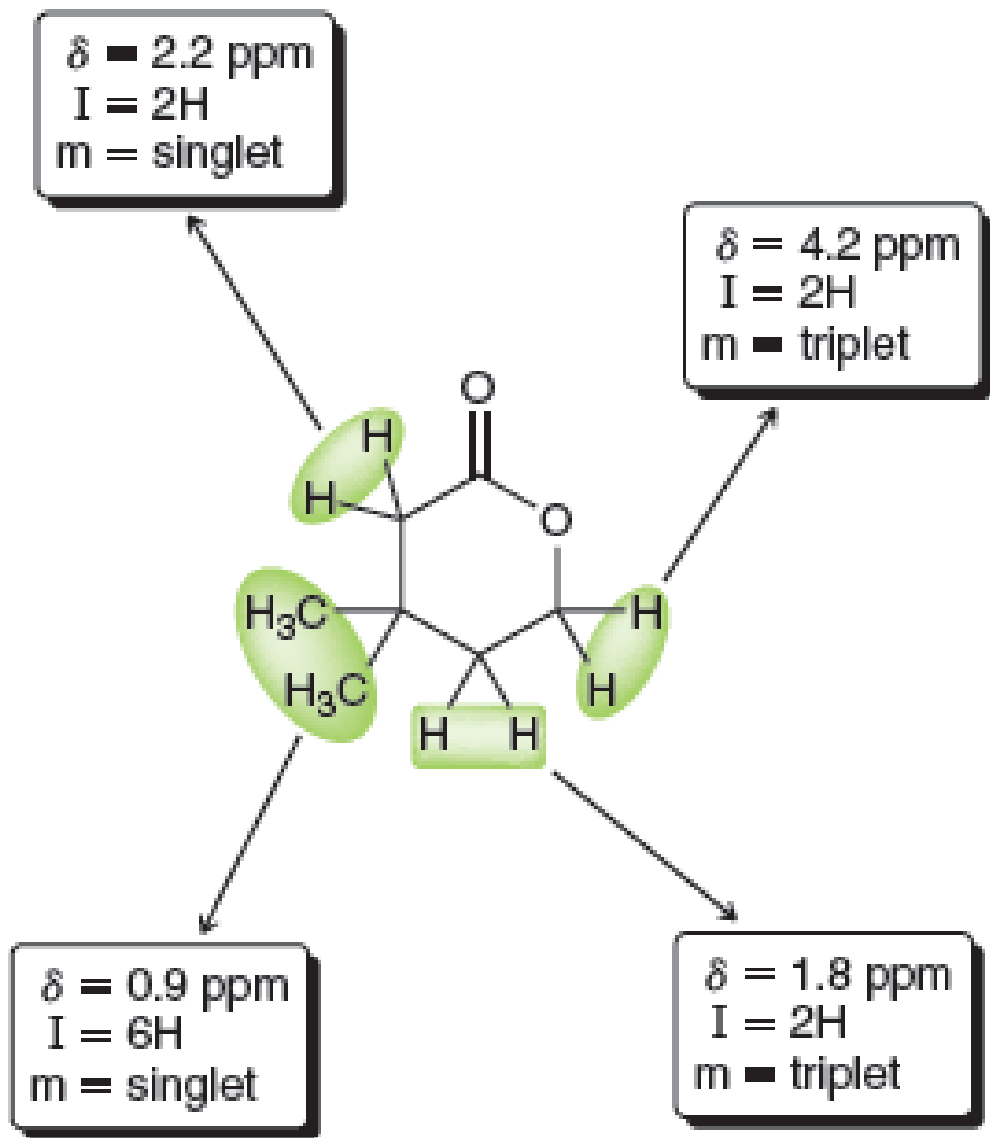
» 1,19 (s, 9H)

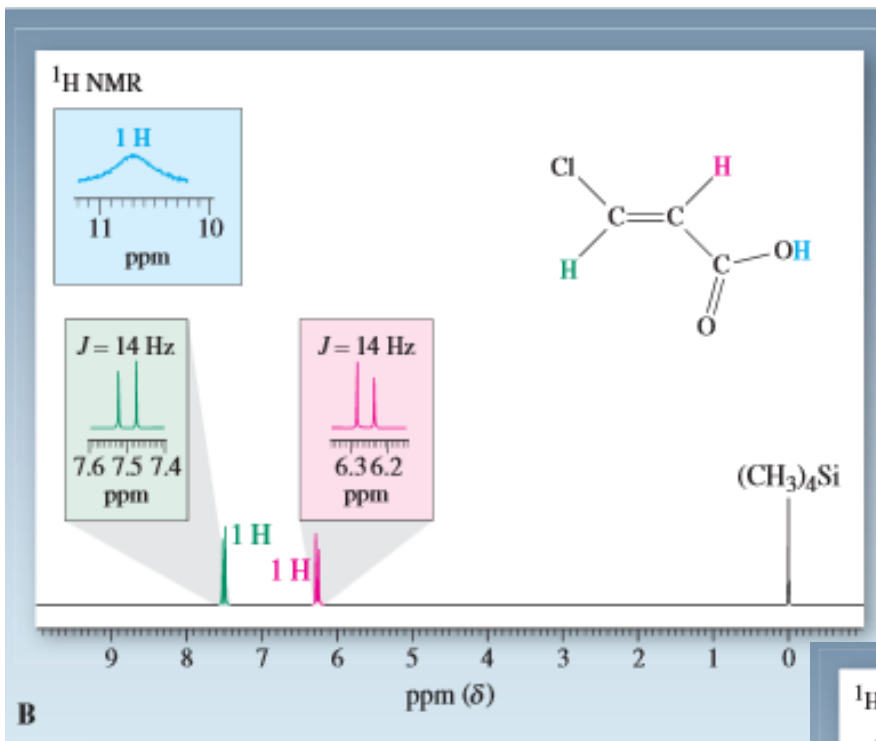
» 3,21 (s, 3H)



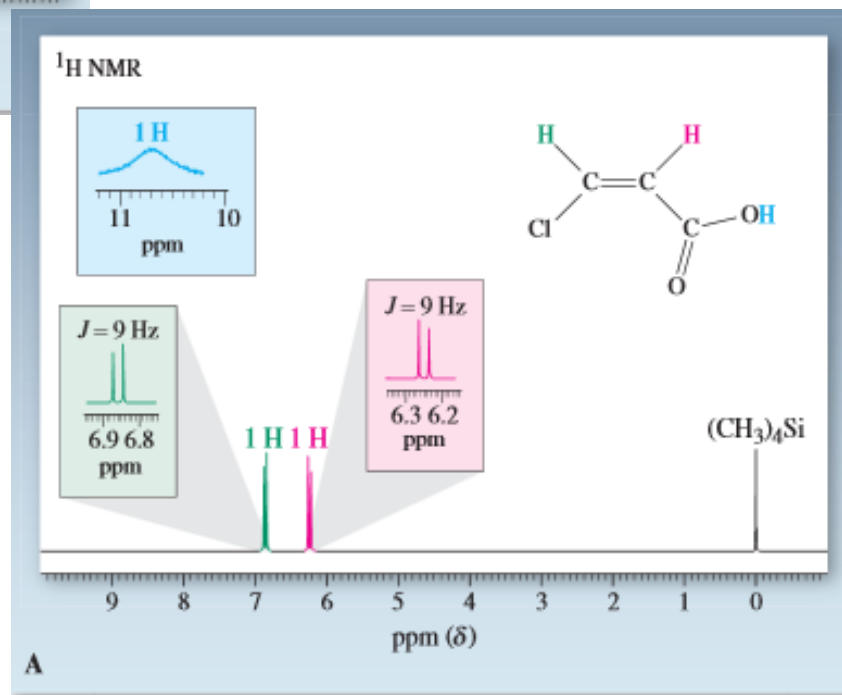








	Vicinal, cis	6-14	10
	Vicinal, trans	11-18	16
	Geminal	0-3	2
	None	4-10	6
	Allylic, (1,3)-cis or -trans	0.5-3.0	2
	(1,4)- or long-range	0.0-1.6	1



# $^{13}\text{C}$ NMR spektroskopie

Stejná jako v  $^1\text{H}$  NMR spektru, tj. odpovídá počtu ekvivalentních jader.

Ale značně závislá na způsobu měření neboť  $^{13}\text{C}$  jádra mají velmi rozdílné relaxační časy ...


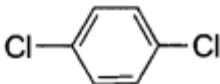
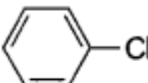
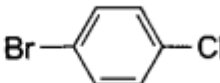
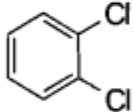
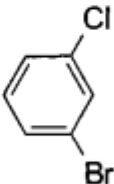
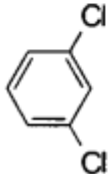
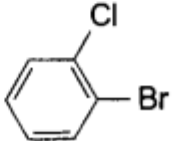
Obvykle tedy v  $^{13}\text{C}$  neintegrujeme ... Ale!

Mají-li uhlíky blízké relaxační časy, pak je lze integrovat: např. fenyl skupina, směsi rotačních či konfiguračních izomerů, atp.

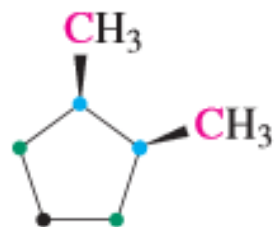
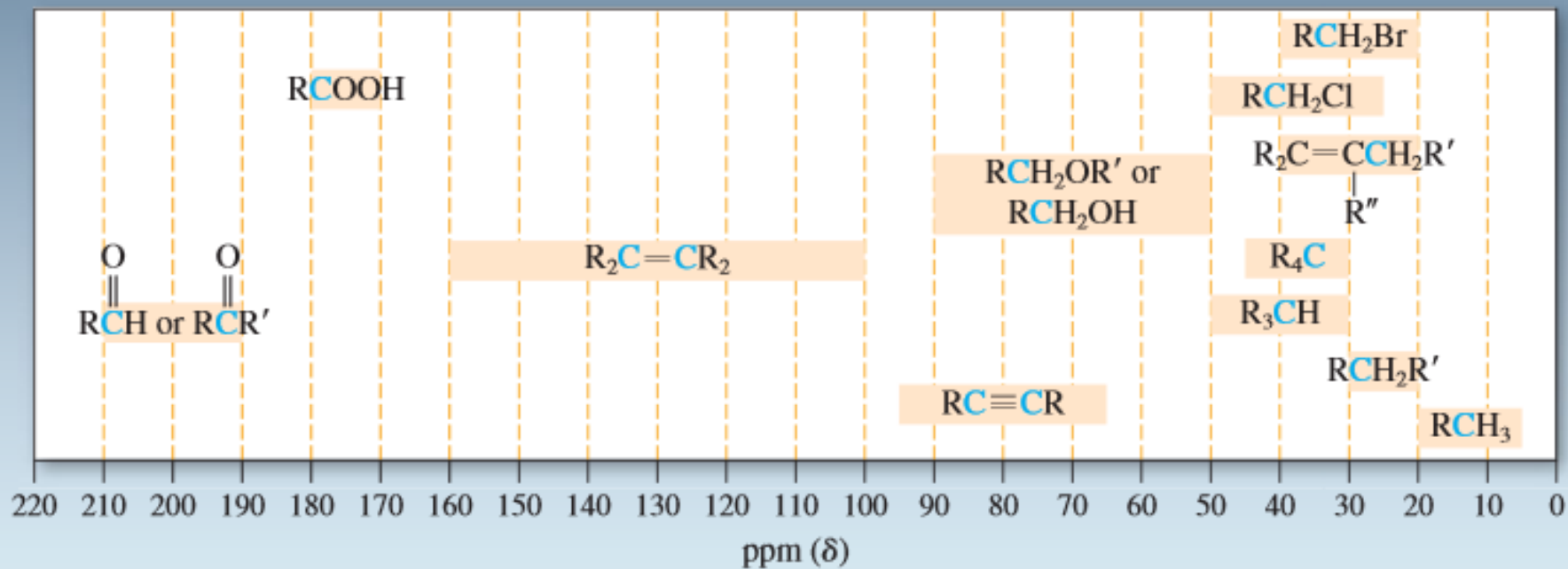
Počet vodíků, respektive množství spin-spin interakcí zrychluje relaxaci  $^{13}\text{C}$ .



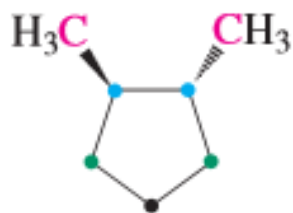
# $^{13}\text{C}$ NMR počet signálů

	1		2
	4		4
	3		6
	4		6

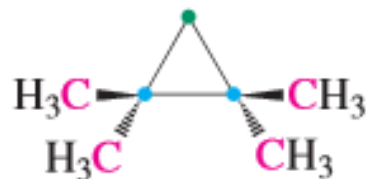




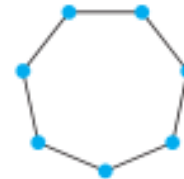
Four peaks



Four peaks



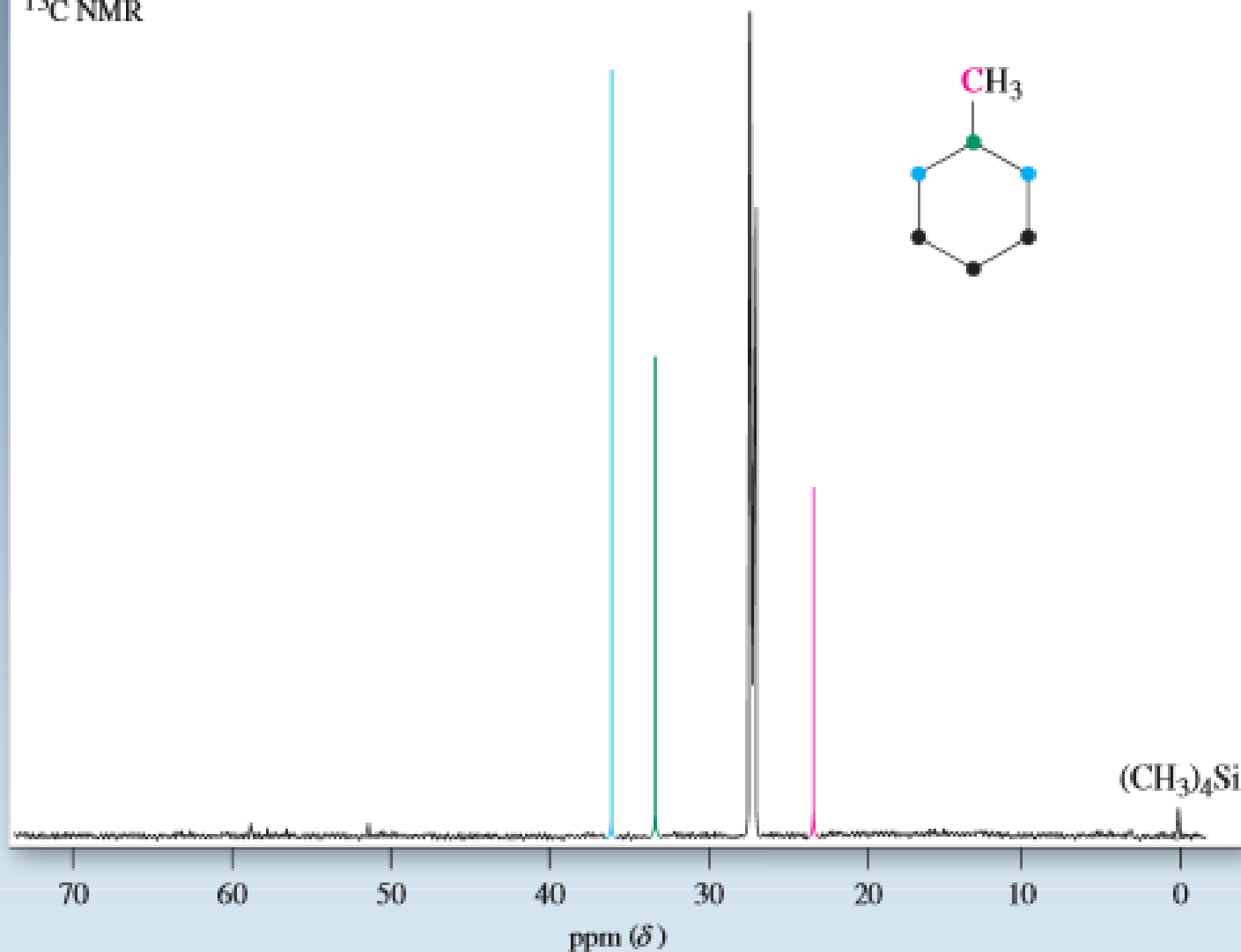
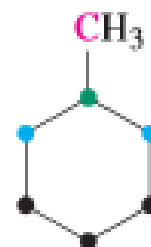
Three peaks

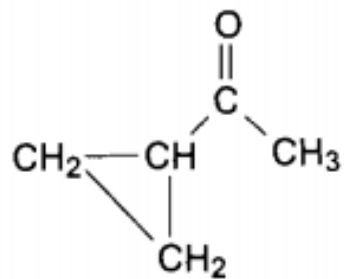


One peak

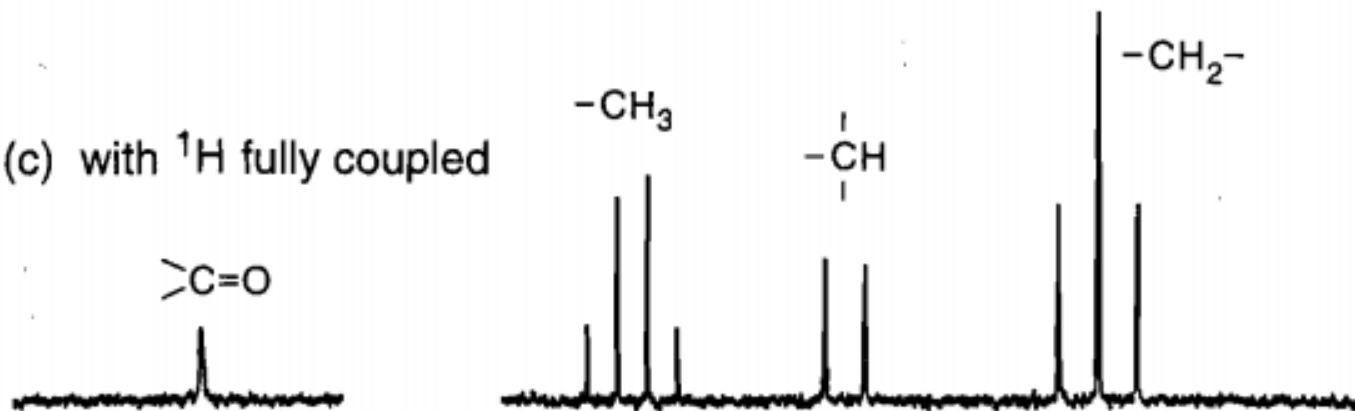


$^{13}\text{C}$  NMR

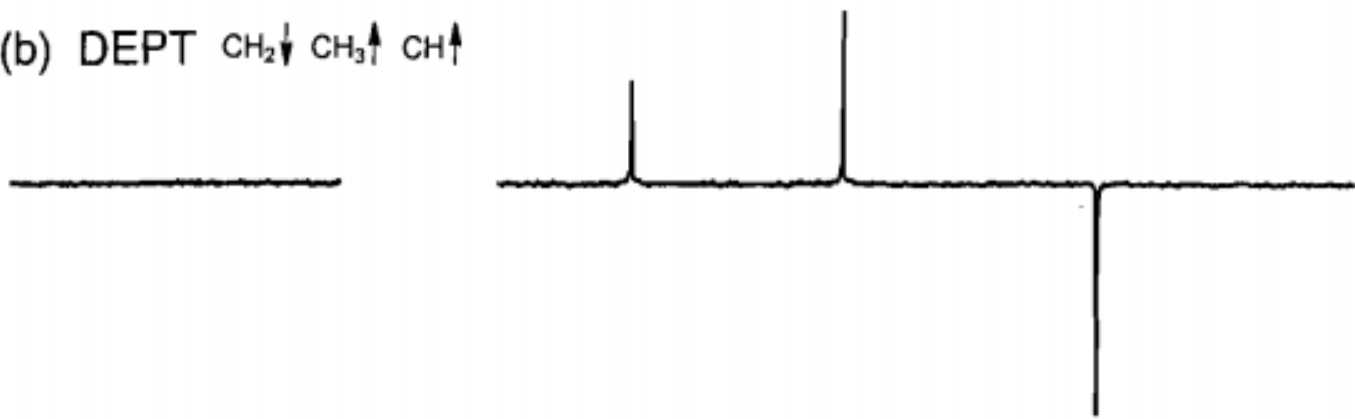




(c) with  $^1\text{H}$  fully coupled



(b) DEPT  $\text{CH}_2 \downarrow$   $\text{CH}_3 \uparrow$   $\text{CH} \uparrow$







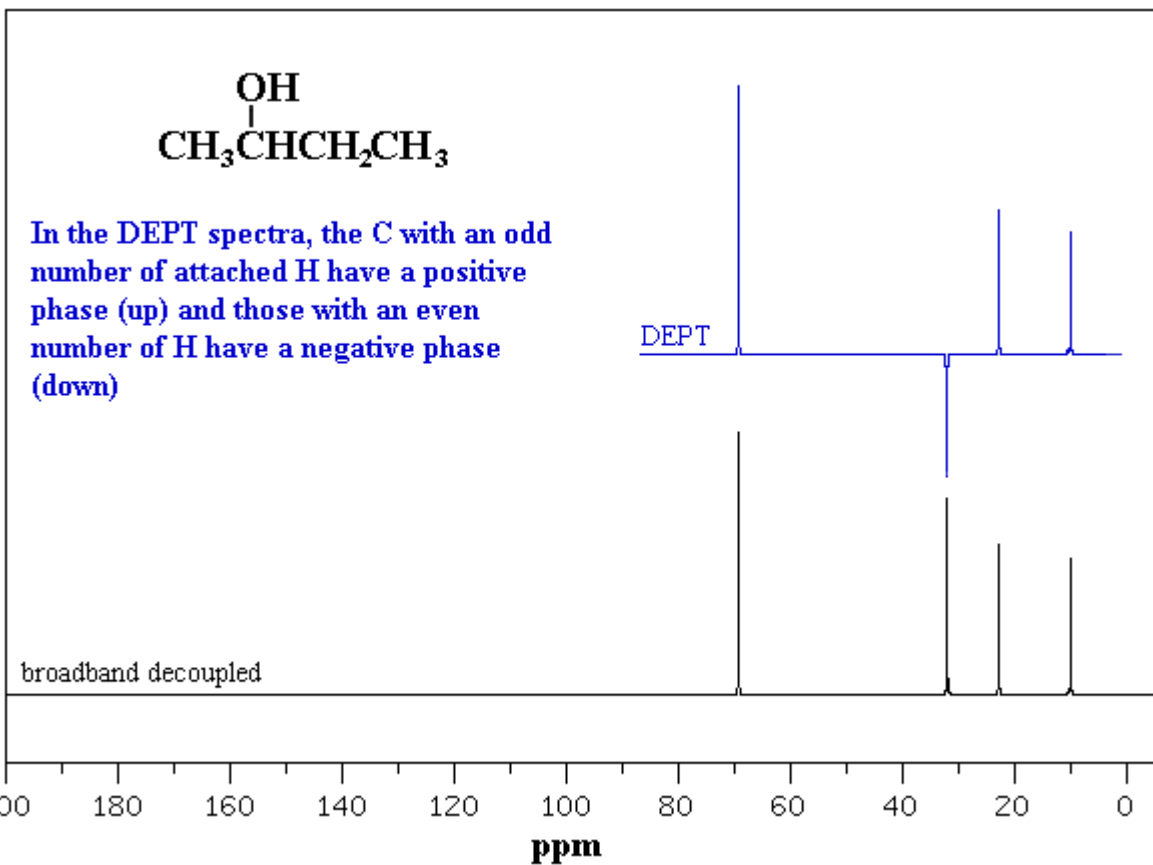
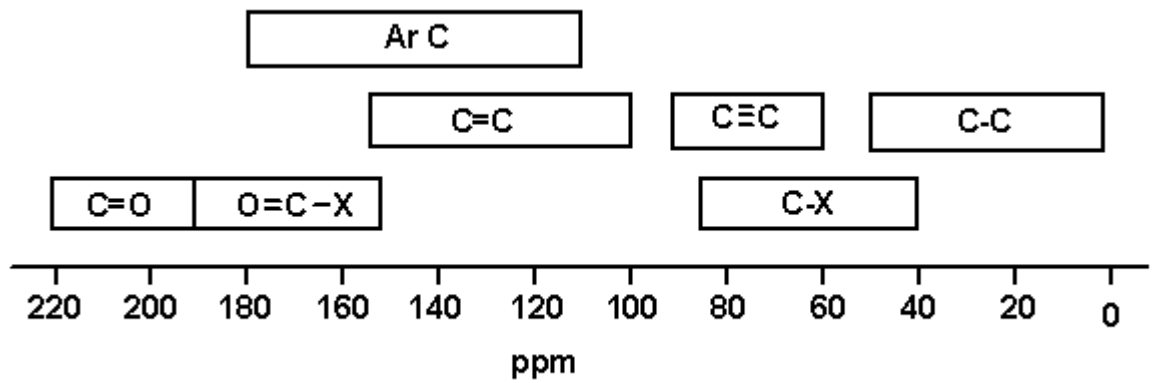
**A** Normal  $^{13}\text{C}$  NMR spectrum

**B** Spectrum showing only  $\text{CH}_3$  peaks

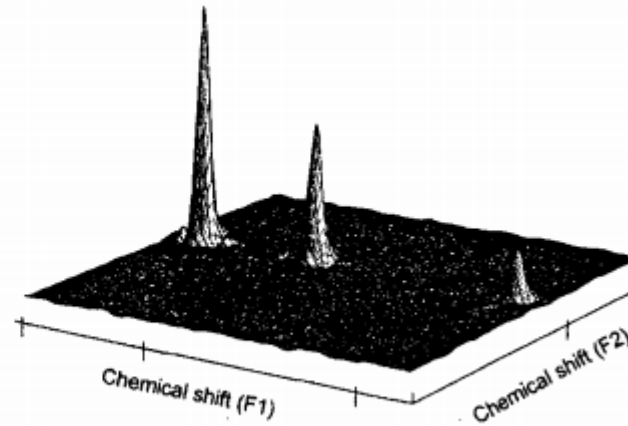
**C** Spectrum showing only  $\text{CH}_2$  peaks

**D** Spectrum showing only  $\text{CH}$  peaks

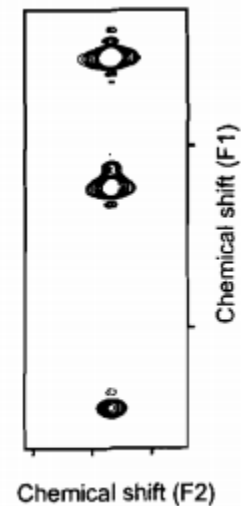


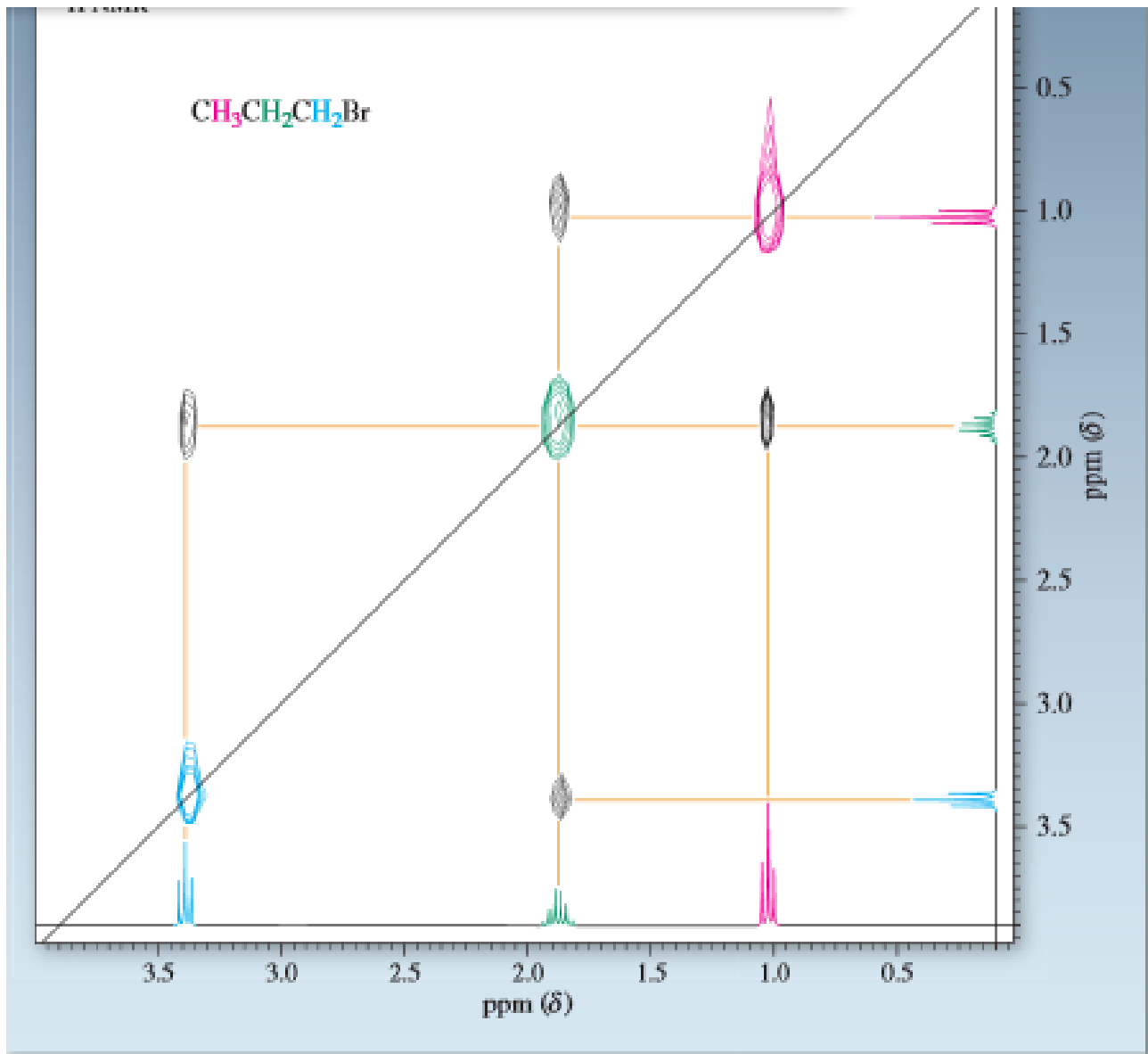


Two-dimensional spectra have the appearance of surfaces, generally with two axes corresponding to chemical shift and the third (vertical) axis corresponding to signal intensity.



It is usually more useful to plot two-dimensional spectra viewed directly from above (a **contour plot** of the surface) in order to make measurements and assignments.





<http://www.vscht.cz/nmr/predmet/lekce/NMR-lekce6.pdf> (26.2.2014)

<http://www.nmrdb.org/predictornew> (Simulace NMR spekter)

[http://www.vscht.cz/anl/dolensky/technmr/soubory/2013\\_Techniky\\_MereniInterpretaceNMR\\_INTRO.pdf](http://www.vscht.cz/anl/dolensky/technmr/soubory/2013_Techniky_MereniInterpretaceNMR_INTRO.pdf)

**Použitá literatura**

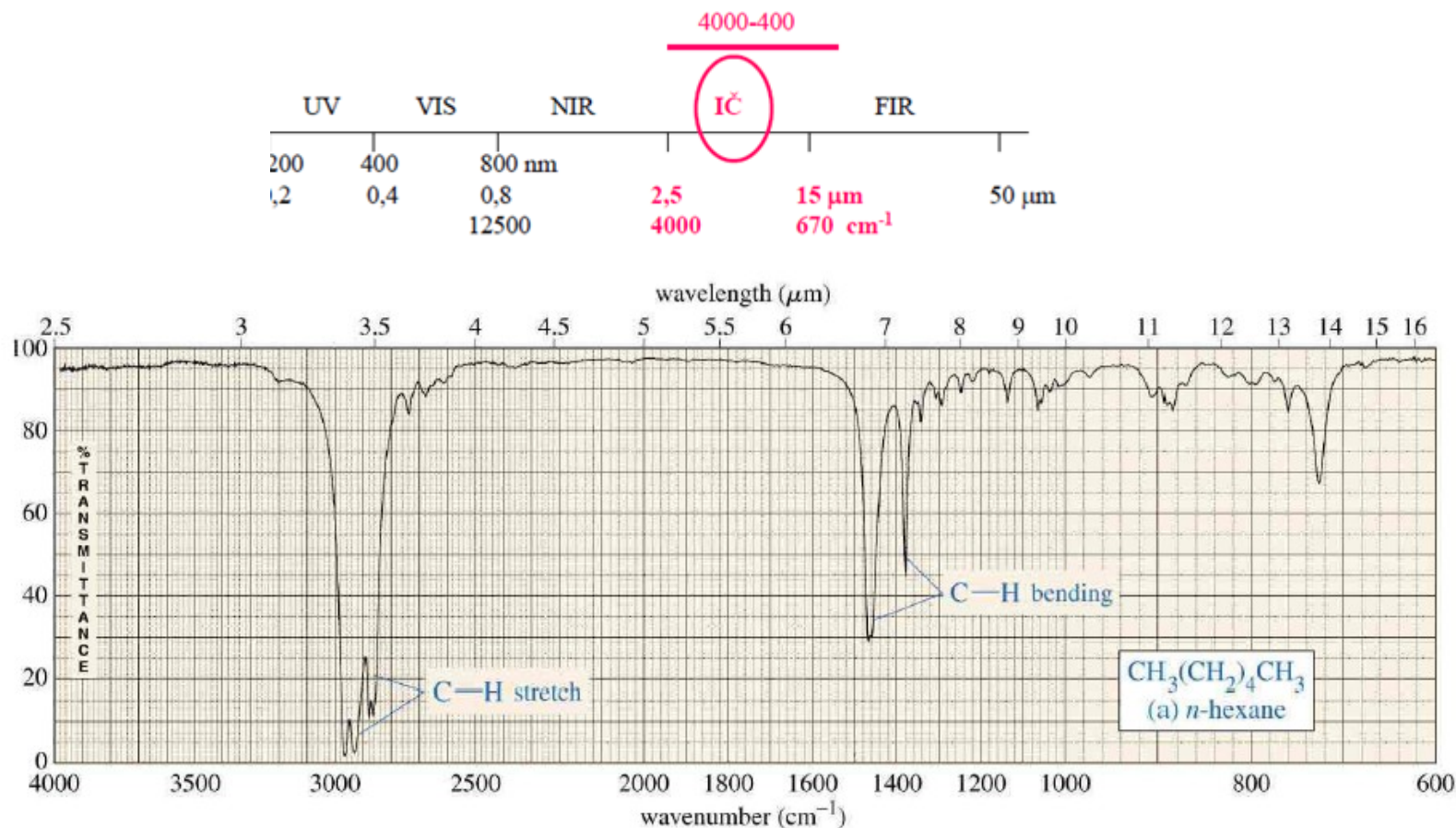




# Infračervená spektroskopie

vibračně – rotační spektroskopie

v organické chemii – důkaz přítomnosti funkčních skupin



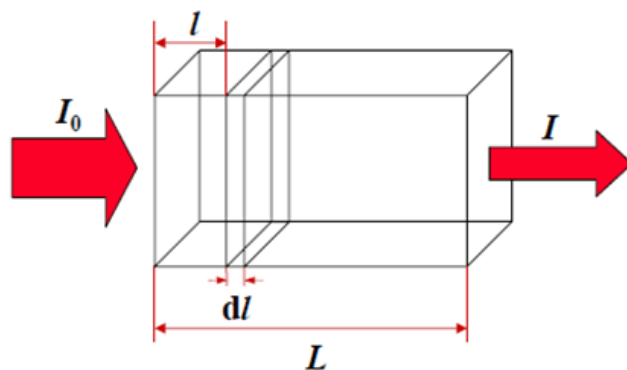


**Transmittance T (propustnost) hodnoty 0 – 1 (0 – 100%)**

$$T = I / I_0$$

**T = 0 prostředí světlo nepropouští vůbec**

**T = 1 prostředí propouští všechno světlo**



**Absorbance**

$$A = -\log T$$

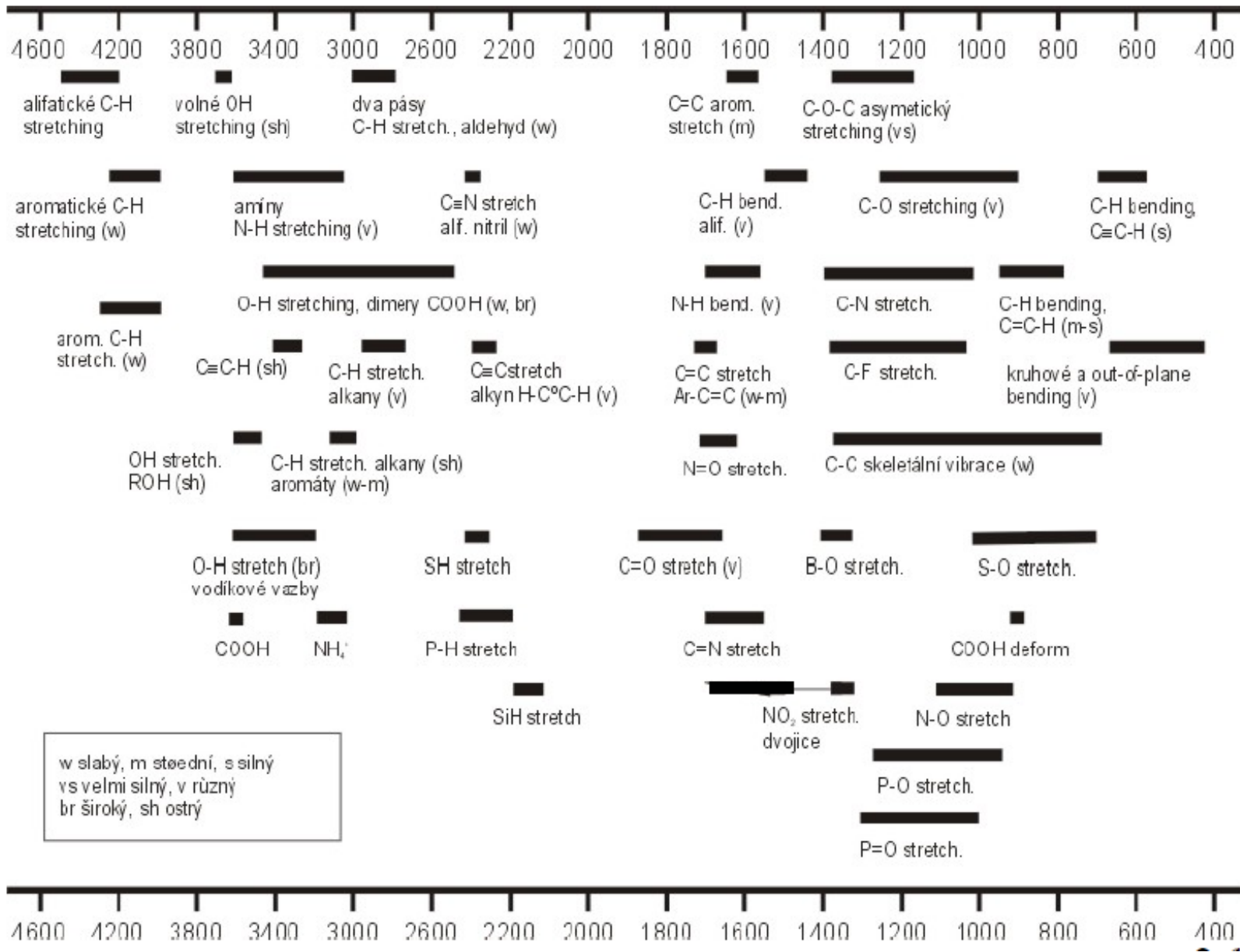
$$A = \varepsilon \cdot l \cdot c$$





# » Charakteristické vibrace

cm<sup>-1</sup>



### A Simplified Infrared Correlation Chart

	Type of Vibration	Frequency (cm <sup>-1</sup> )	Intensity
<b>C-H</b>	Alkanes (stretch)	3000-2850	s
	-CH <sub>3</sub> (bend)	1450 and 1375	m
	-CH <sub>2</sub> - (bend)	1465	m
	Alkenes (stretch)	3100-3000	m
	(out-of-plane bend)	1000-650	s
	Aromatics (stretch)	3150-3050	s
	(out-of-plane bend)	900-690	s
	Alkyne (stretch)	~3300	s
	Aldehyde	2900-2800	w
		2800-2700	w
<b>C-C</b>	Alkane not interpretatively useful		
<b>C=C</b>	Alkene	1680-1600	m-w
	Aromatic	1600 and 1475	m-w
<b>C≡C</b>	Alkyne	2250-2100	m-w
<b>C=O</b>	Aldehyde	1740-1720	s
	Ketone	1725-1705	s
	Carboxylic Acid	1725-1700	s
	Ester	1750-1730	s
	Amide	1670-1640	s
	Anhydride	1810 and 1760	s
	Acid Chloride	1800	s
<b>C-O</b>	Alcohols, Ethers, Esters, Carboxylic Acids, Anhydrides	1300-1000	s
<b>O-H</b>	Alcohols, Phenols		
	Free	3650-3600	m
	H-bonded	3500-3200	m
	Carboxylic Acids	3400-2400	m
<b>N-H</b>	Primary and Secondary Amines and Amides		
	(stretch)	3500-3100	m
	(bend)	1640-1550	m-s
<b>C-N</b>	Amines	1350-1000	m-s
<b>C=N</b>	Imines and Oximes	1690-1640	w-s
<b>C≡N</b>	Nitriles	2260-2240	m
<b>X=C=Y</b>	Allenes, Ketenes, Isocyanates, Isothiocyanates	2270-1950	m-s
<b>N=O</b>	Nitro (R-NO <sub>2</sub> )	1550 and 1350	s
<b>S-H</b>	Mercaptans	2550	w
<b>S=O</b>	Sulfoxides	1050	s
	Sulfones, Sulfonyl Chlorides, Sulfates, Sulfonamides	1375-1300 and 1200-1140	s s
<b>C-X</b>	Fluoride	1400-1000	s
	Chloride	800-600	s
	Bromide, Iodide	<667	s



# Hookův zákon

$$\tilde{\nu} = \left( \frac{1}{2\pi C} \right) \left( \frac{f}{m_{\text{red}}} \right)^{\frac{1}{2}}$$

force constant (bond strength)

reduced mass =  $\left( \frac{m_1 m_2}{m_1 + m_2} \right)$



~3000 cm<sup>-1</sup>



~2200 cm<sup>-1</sup>



~1100 cm<sup>-1</sup>



~700 cm<sup>-1</sup>



~2200 cm<sup>-1</sup>



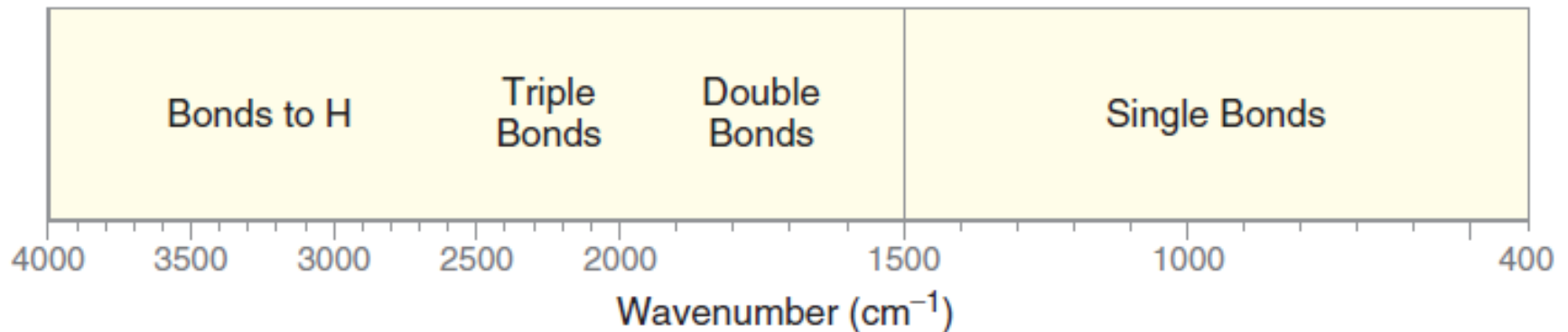
~1600 cm<sup>-1</sup>

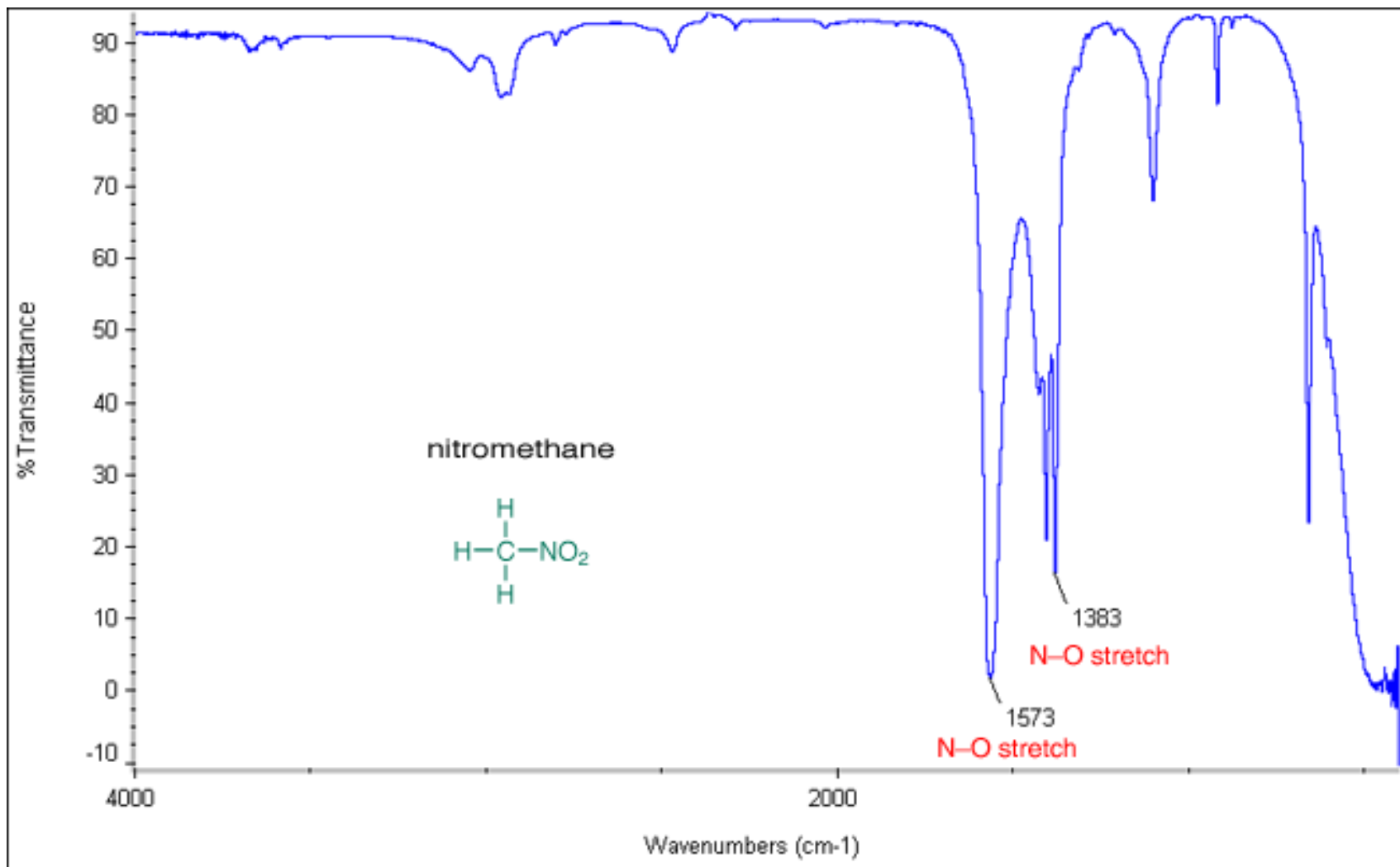


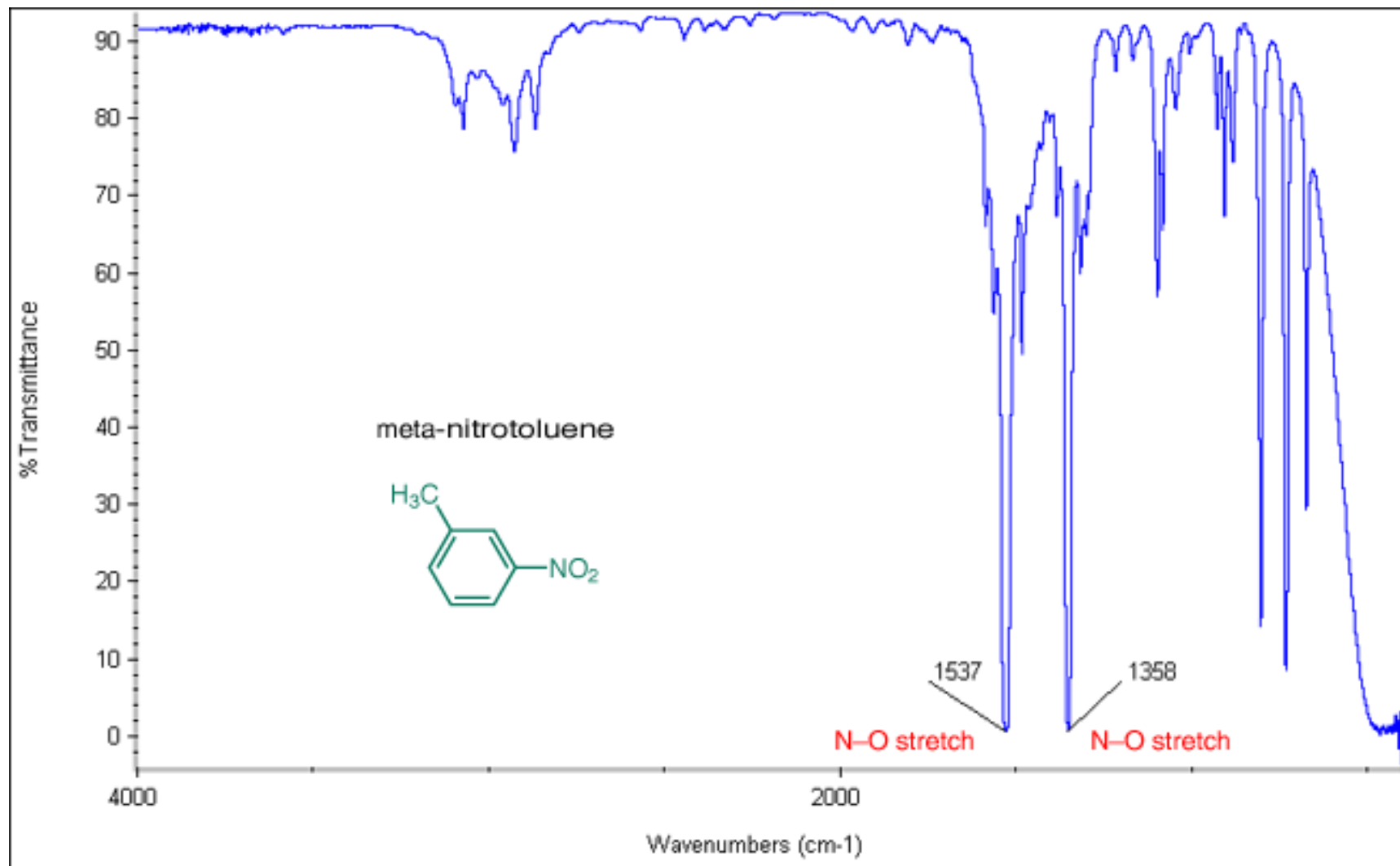
~1100 cm<sup>-1</sup>

Diagnostic Region

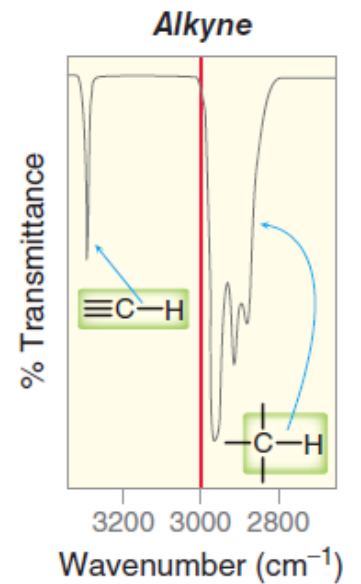
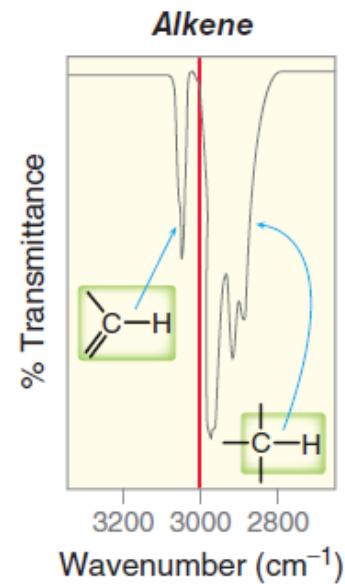
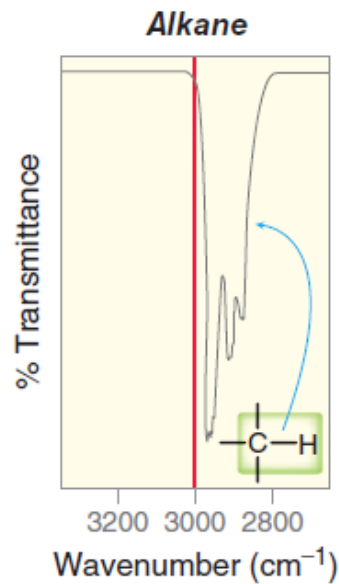
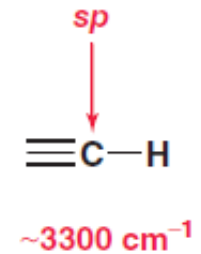
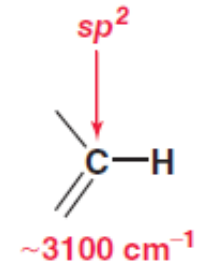
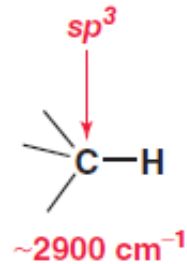
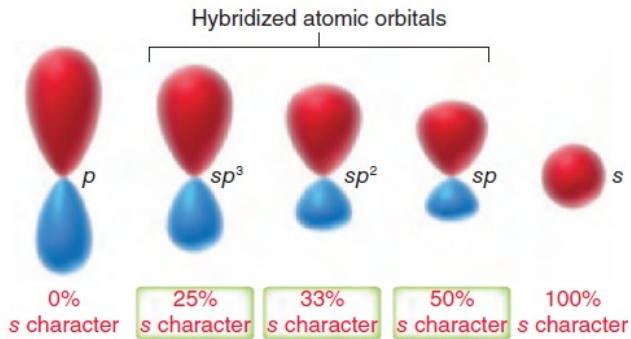
Fingerprint Region

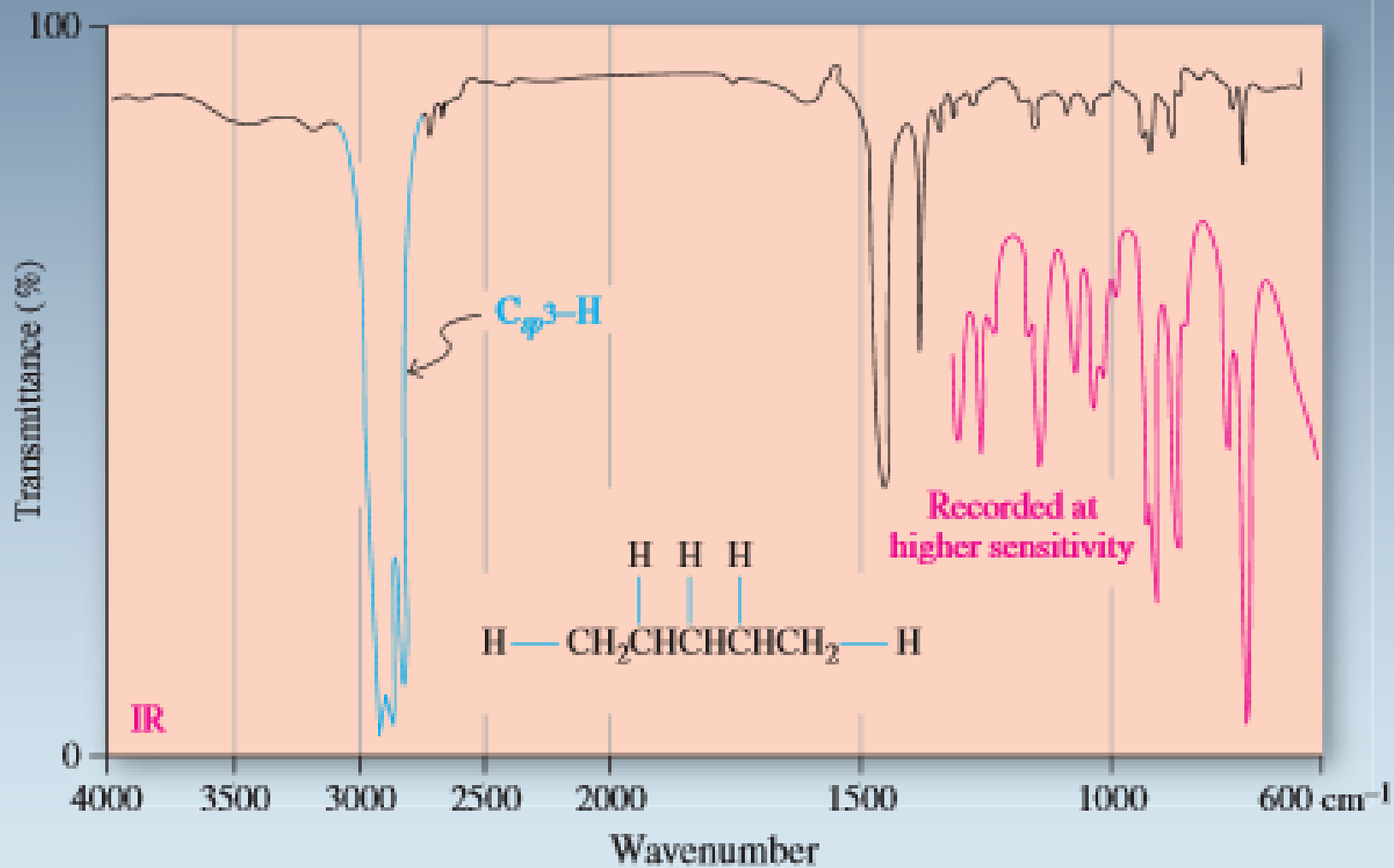


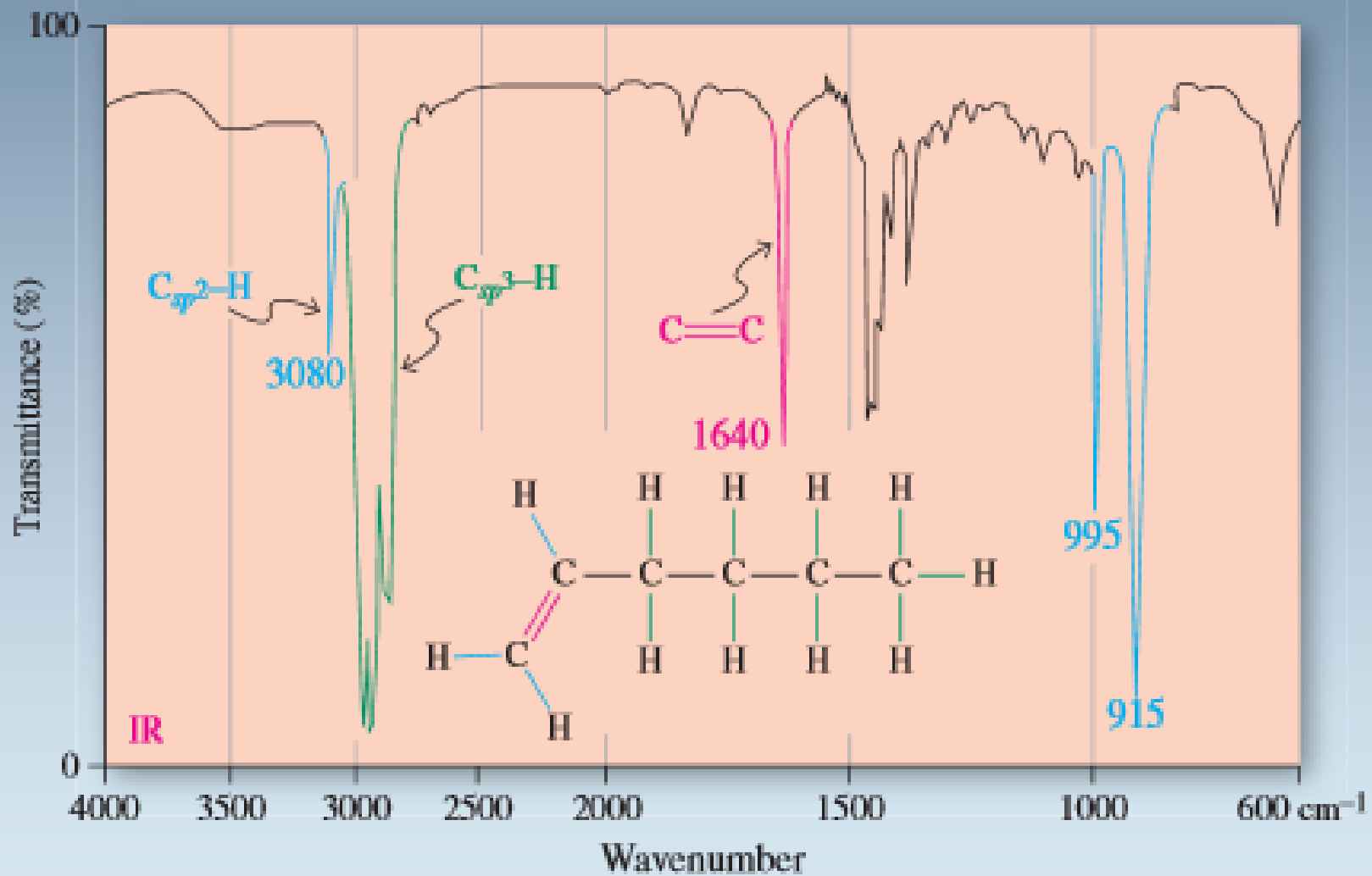




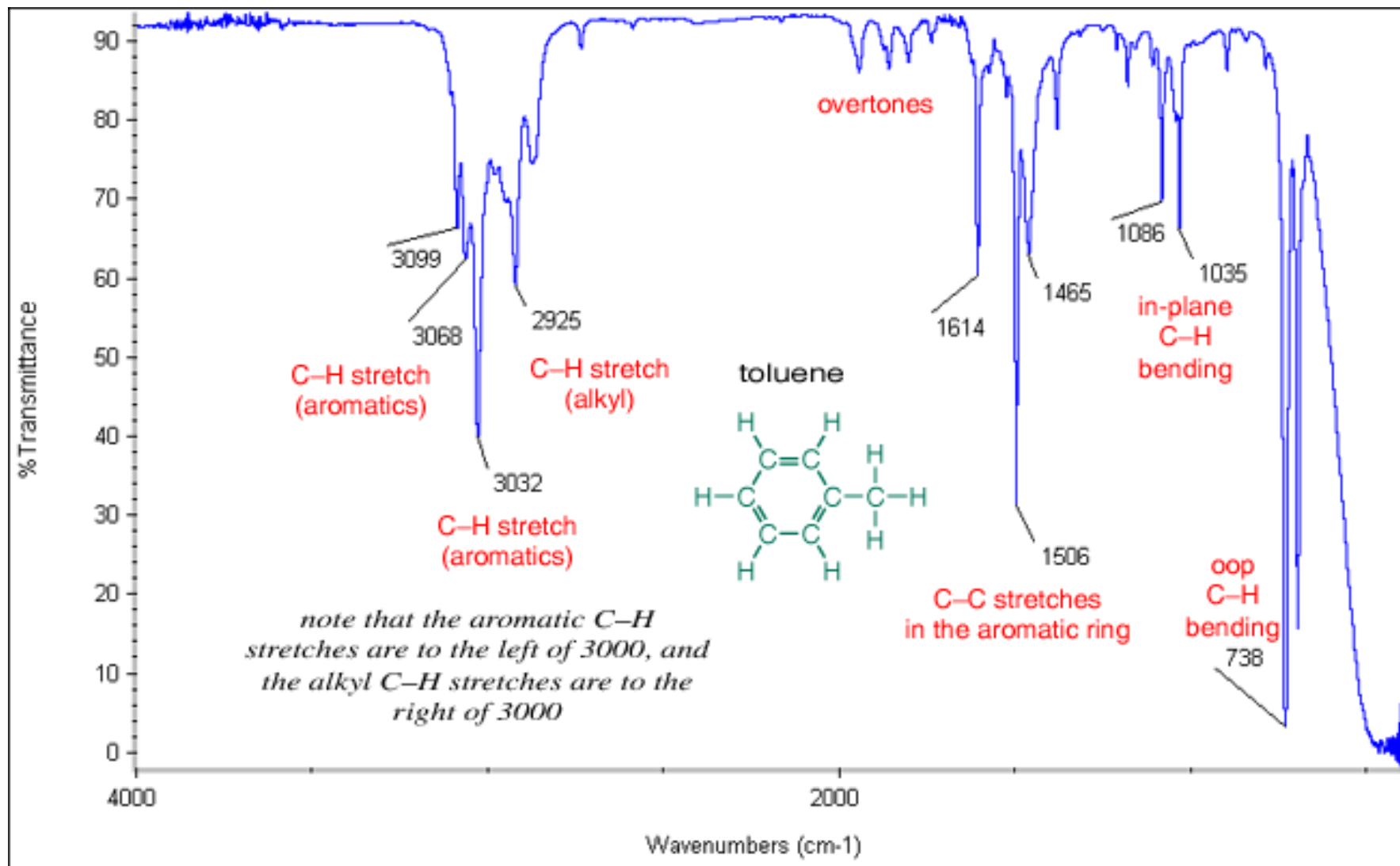
# Efekt hybridizace

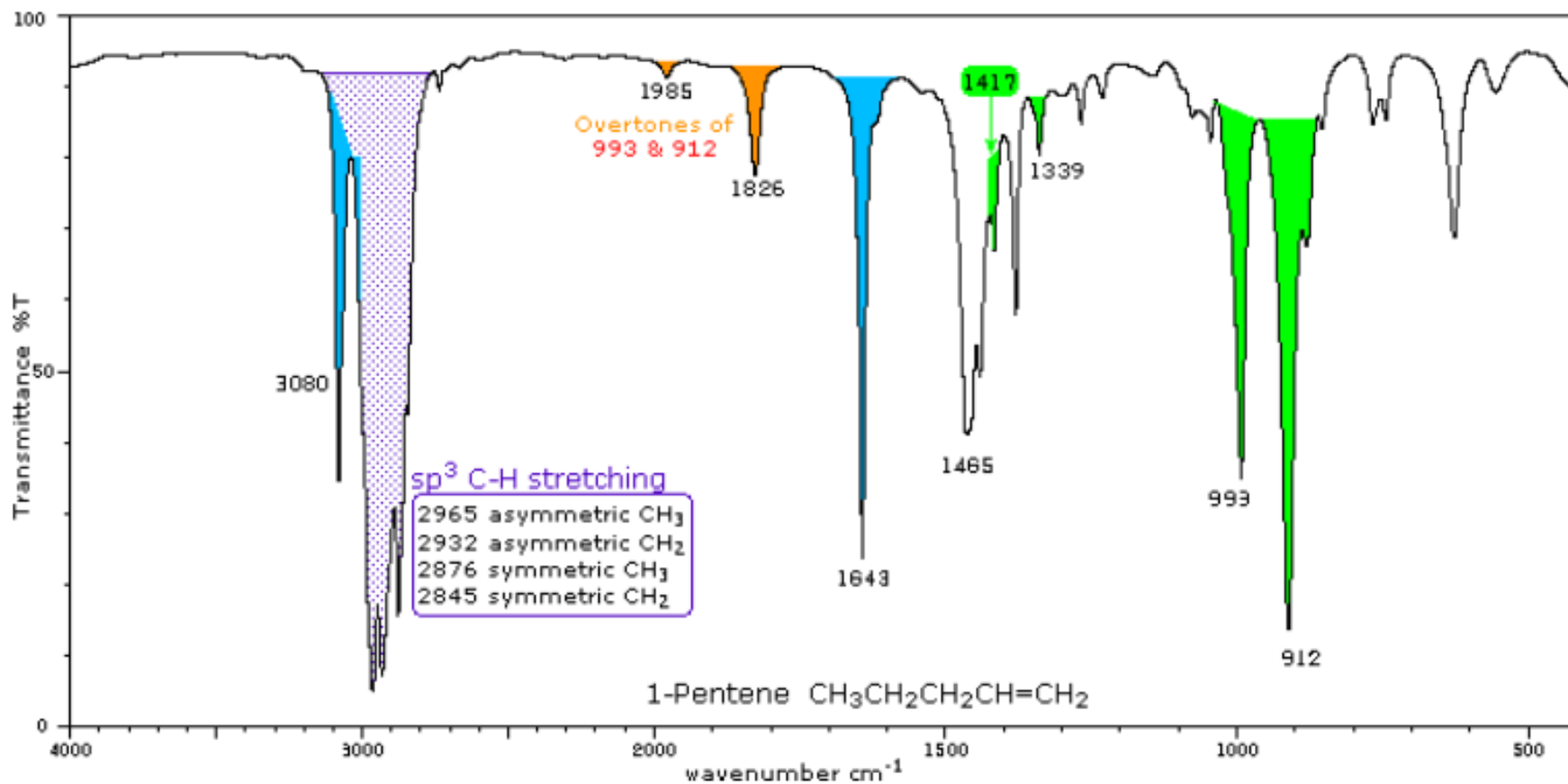




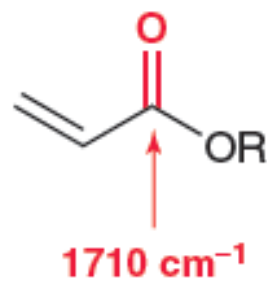
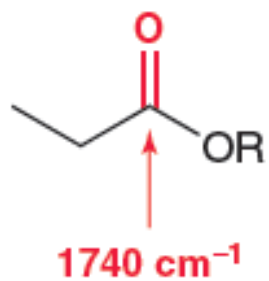
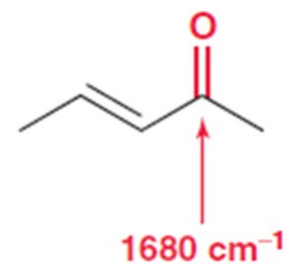
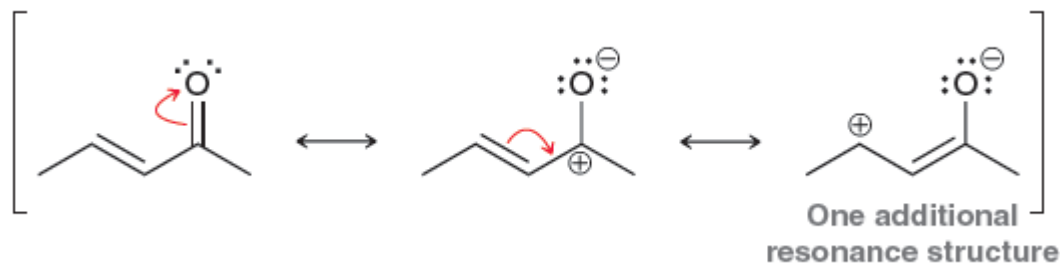
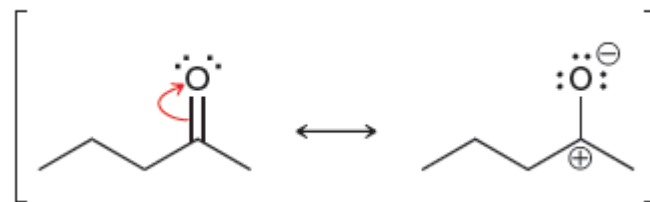
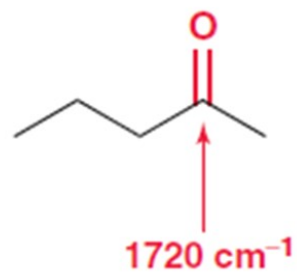




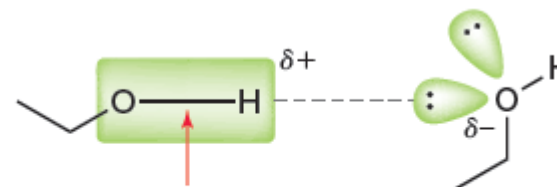




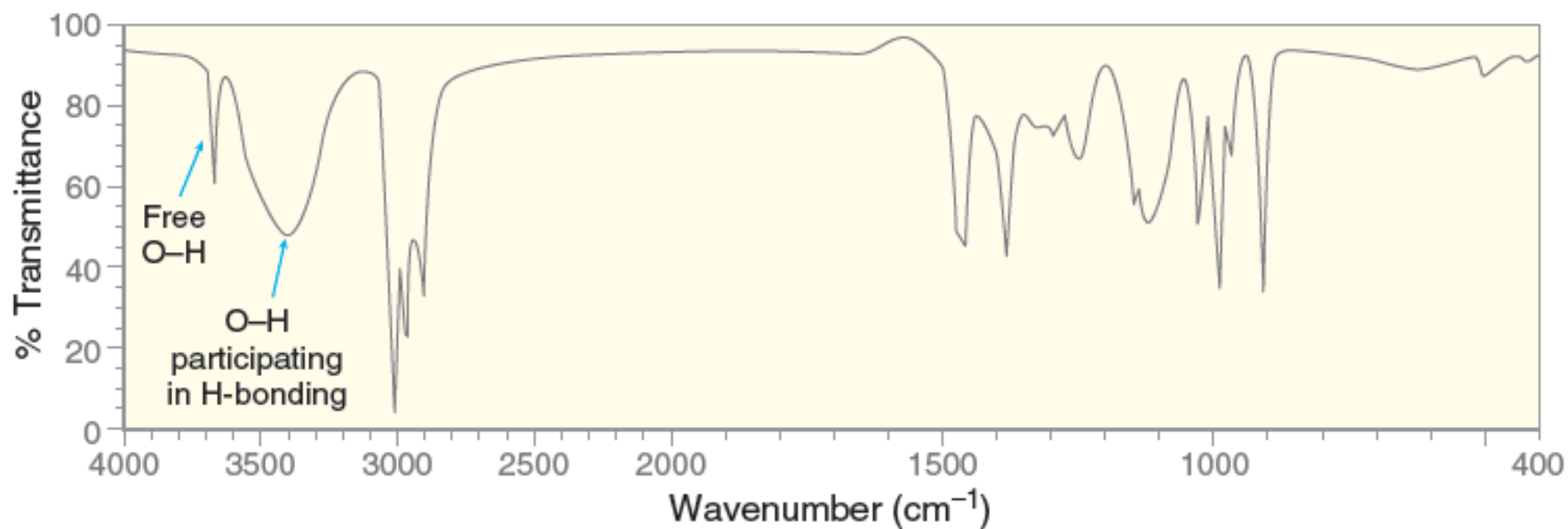
## Efekt rezonance

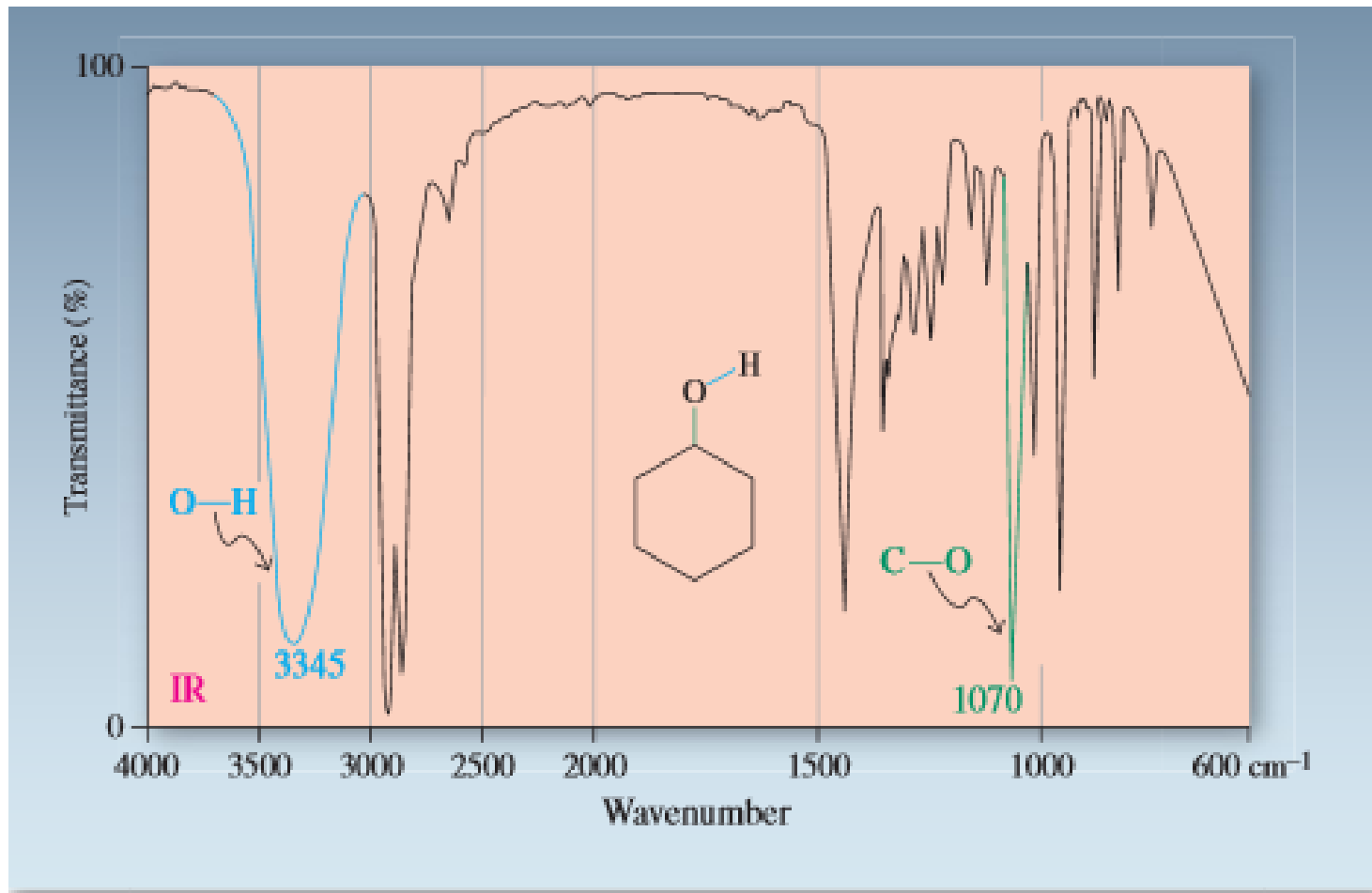


# Efekt vodíkových vazeb



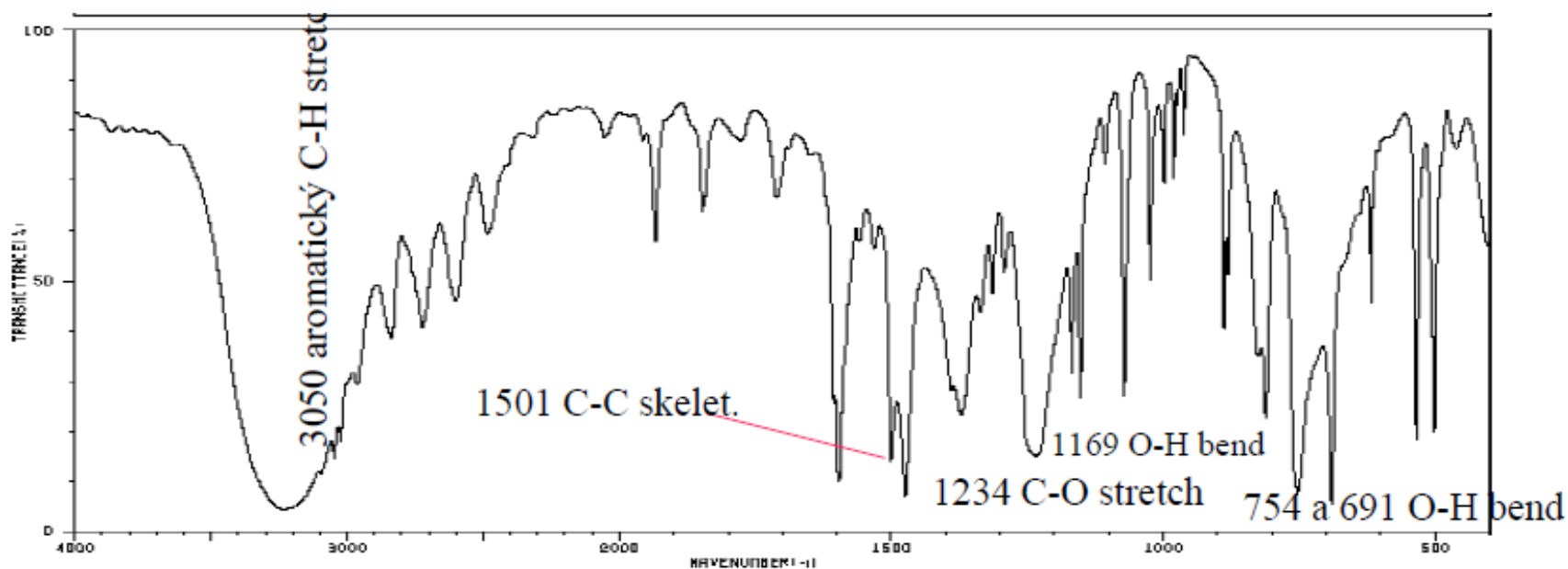
This bond is weakened as a result of H bonding



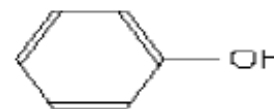


» 1500 - 400  $\text{cm}^{-1}$

fingerprint

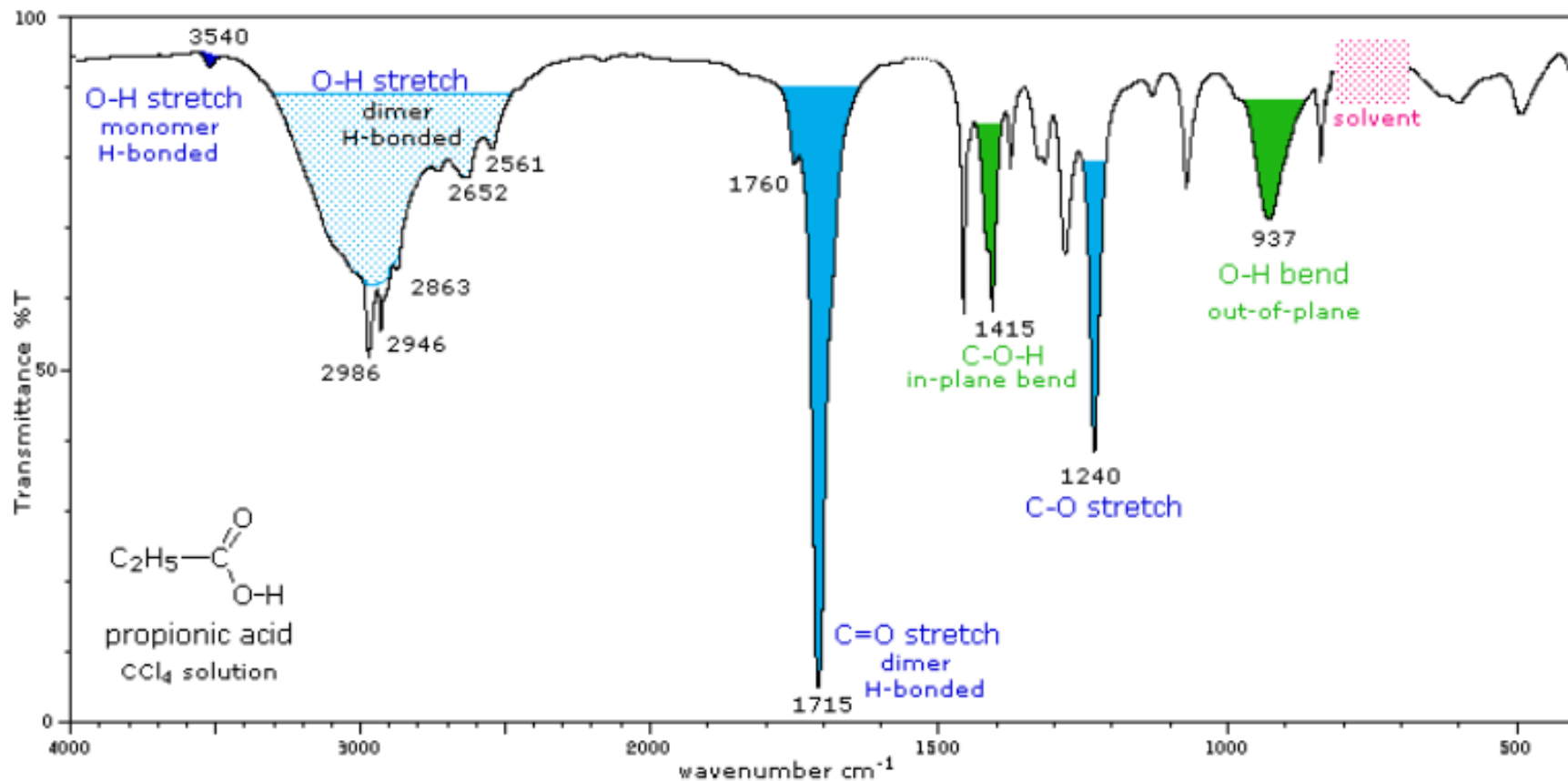
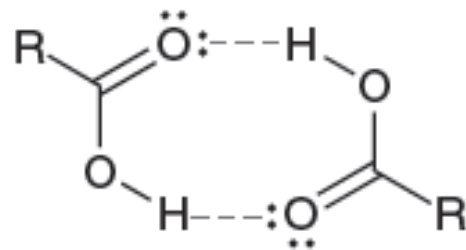


3229	4	2484	68	1632	66	1234	16	826	36
3048	15	1933	57	1501	14	1169	31	812	23
3023	18	1847	62	1474	7	1153	26	754	8
2962	29	1711	64	1372	23	1072	27	691	6
2837	38	1606	26	1336	43	1024	40	617	44
2723	41	1600	10	1316	47	889	41	636	18
2699	46	1569	67	1293	60	881	60	602	20



2-24

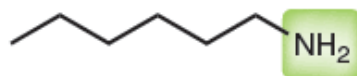




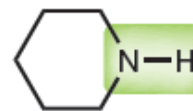
[http://www.vscht.cz/anl/lach1/7\\_IC.pdf](http://www.vscht.cz/anl/lach1/7_IC.pdf)



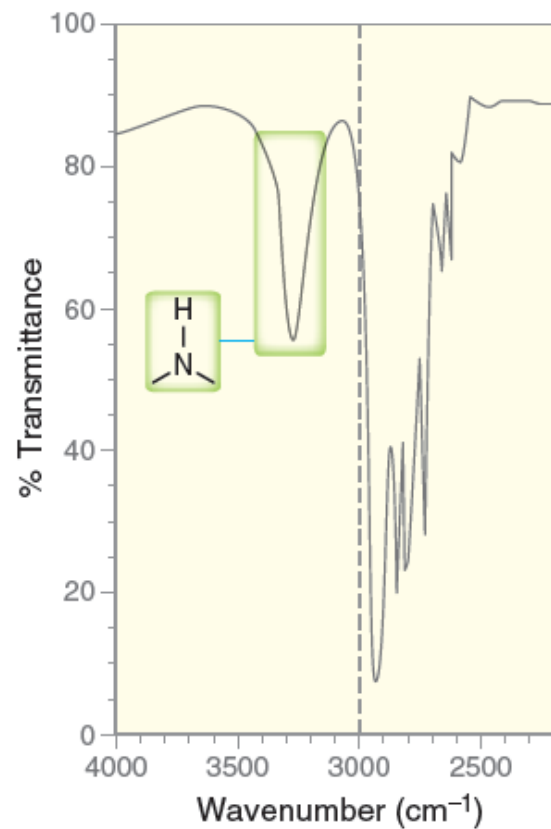
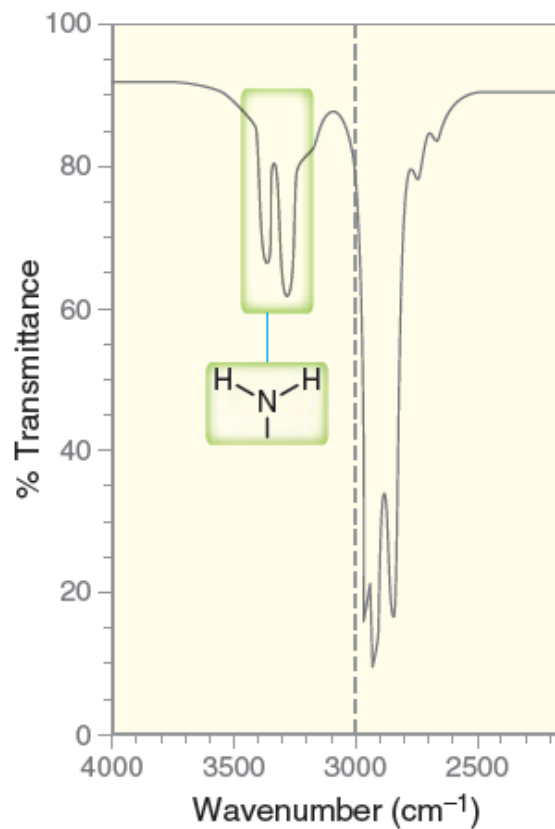
# Aminy



Hexylamine  
(a primary amine)



Piperidine  
(a secondary amine)



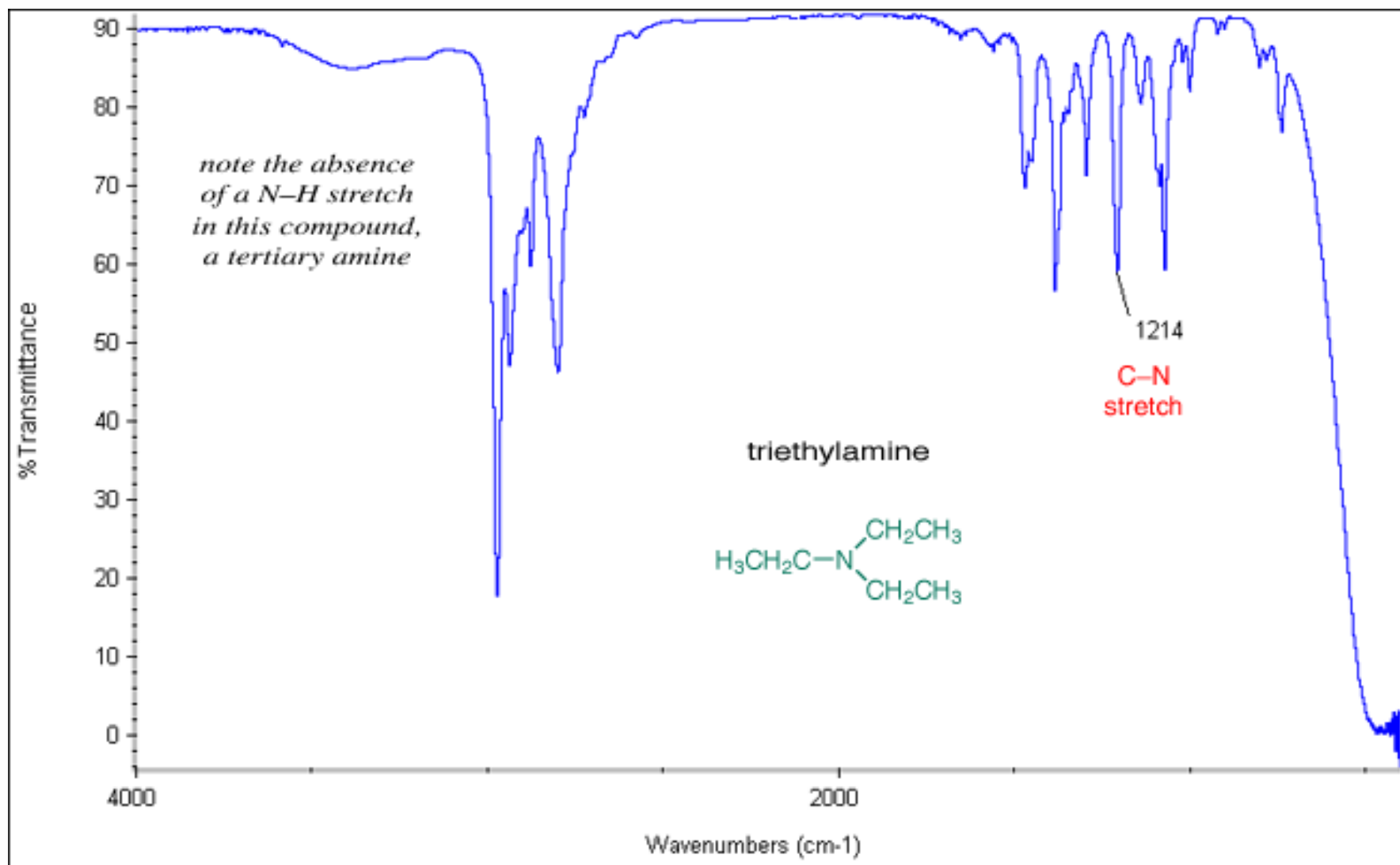
Symmetric stretching

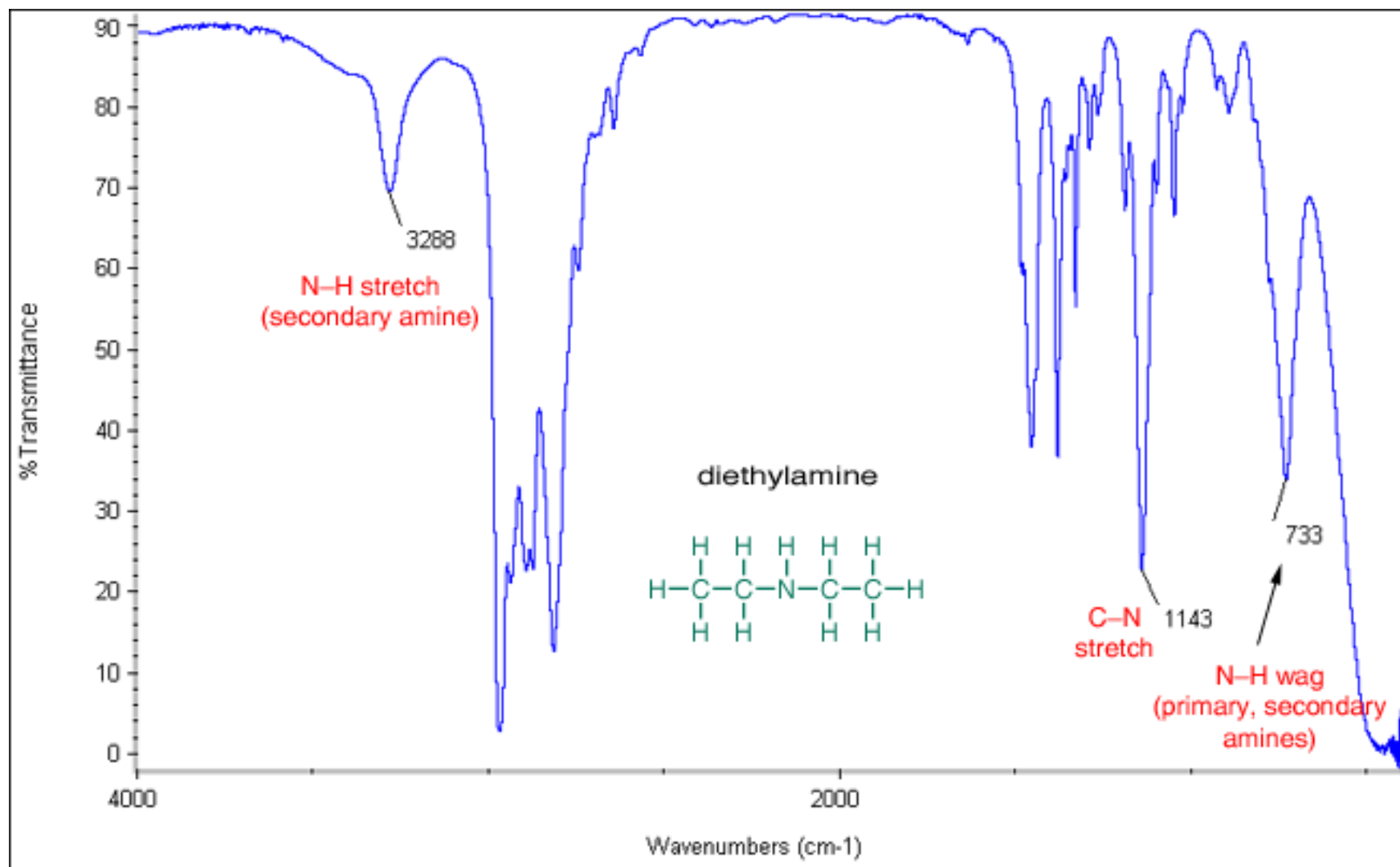


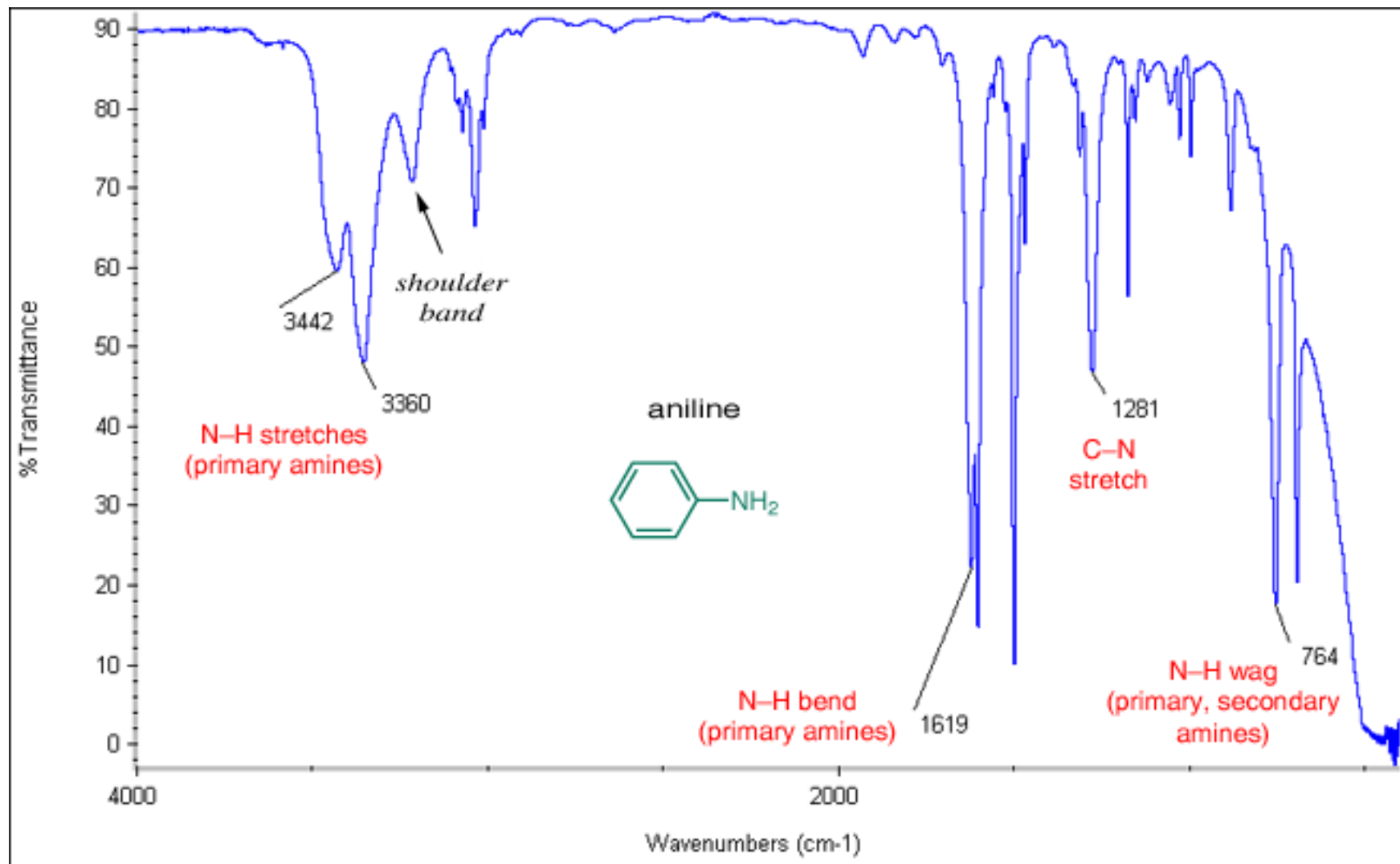
Asymmetric stretching

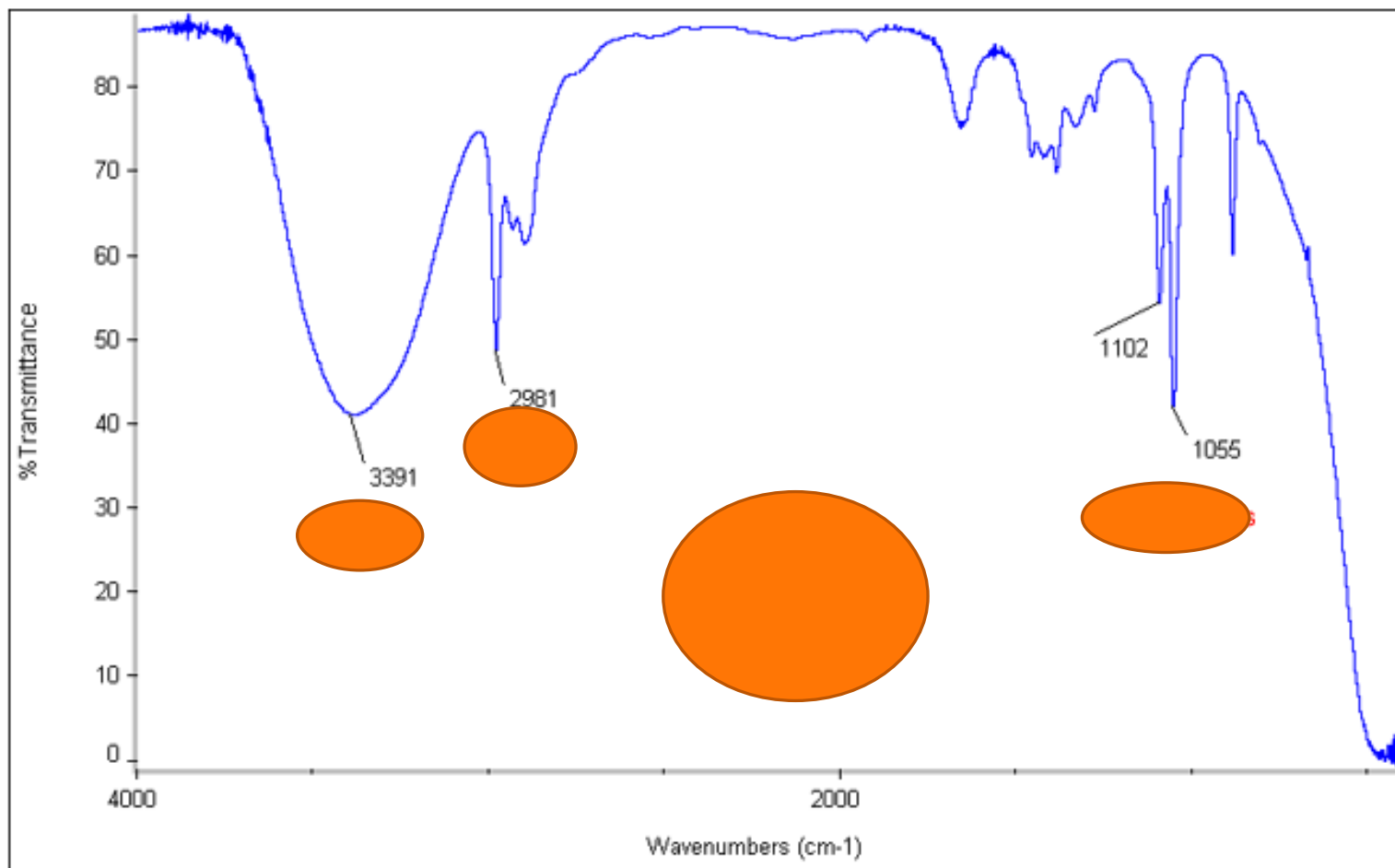


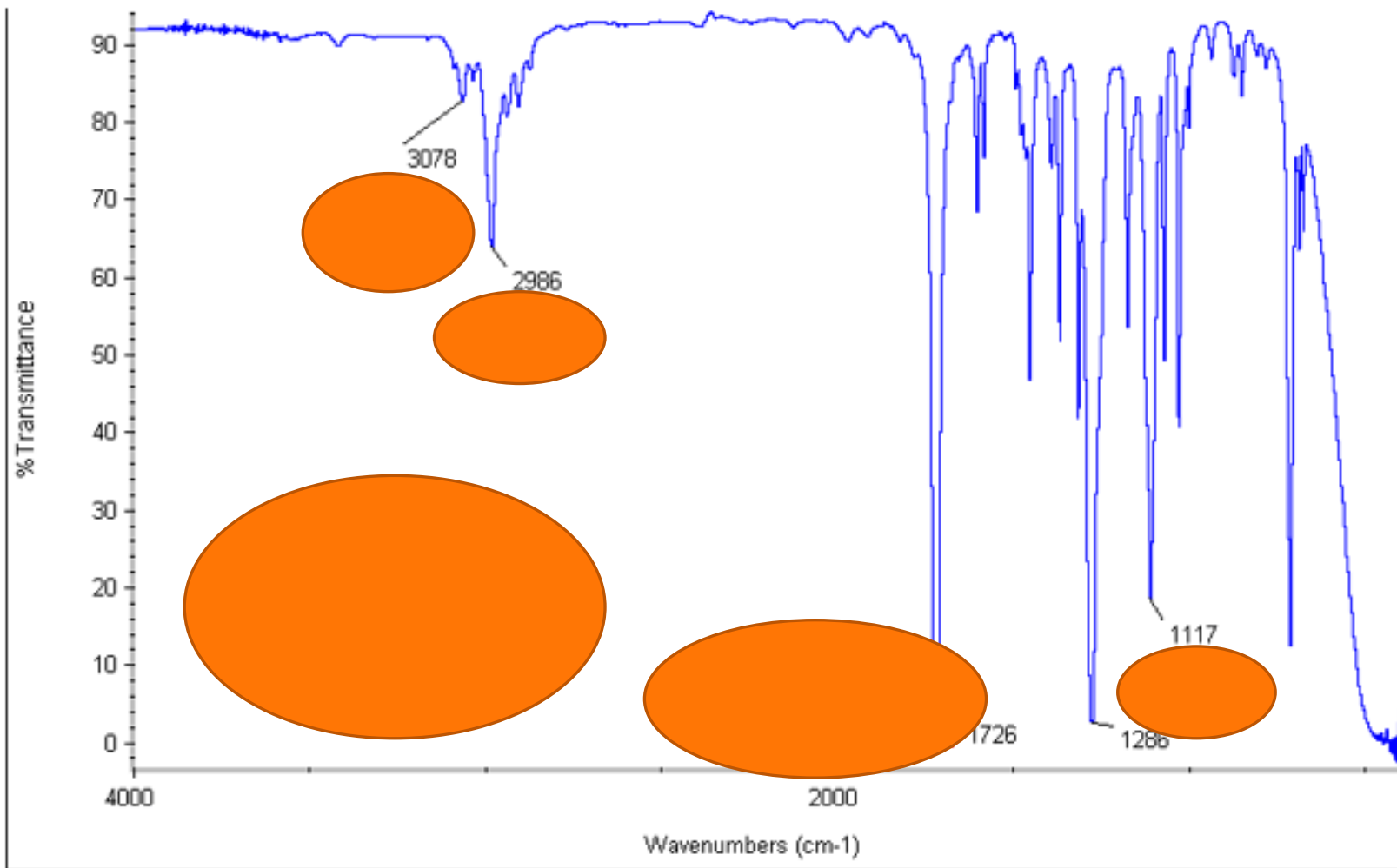


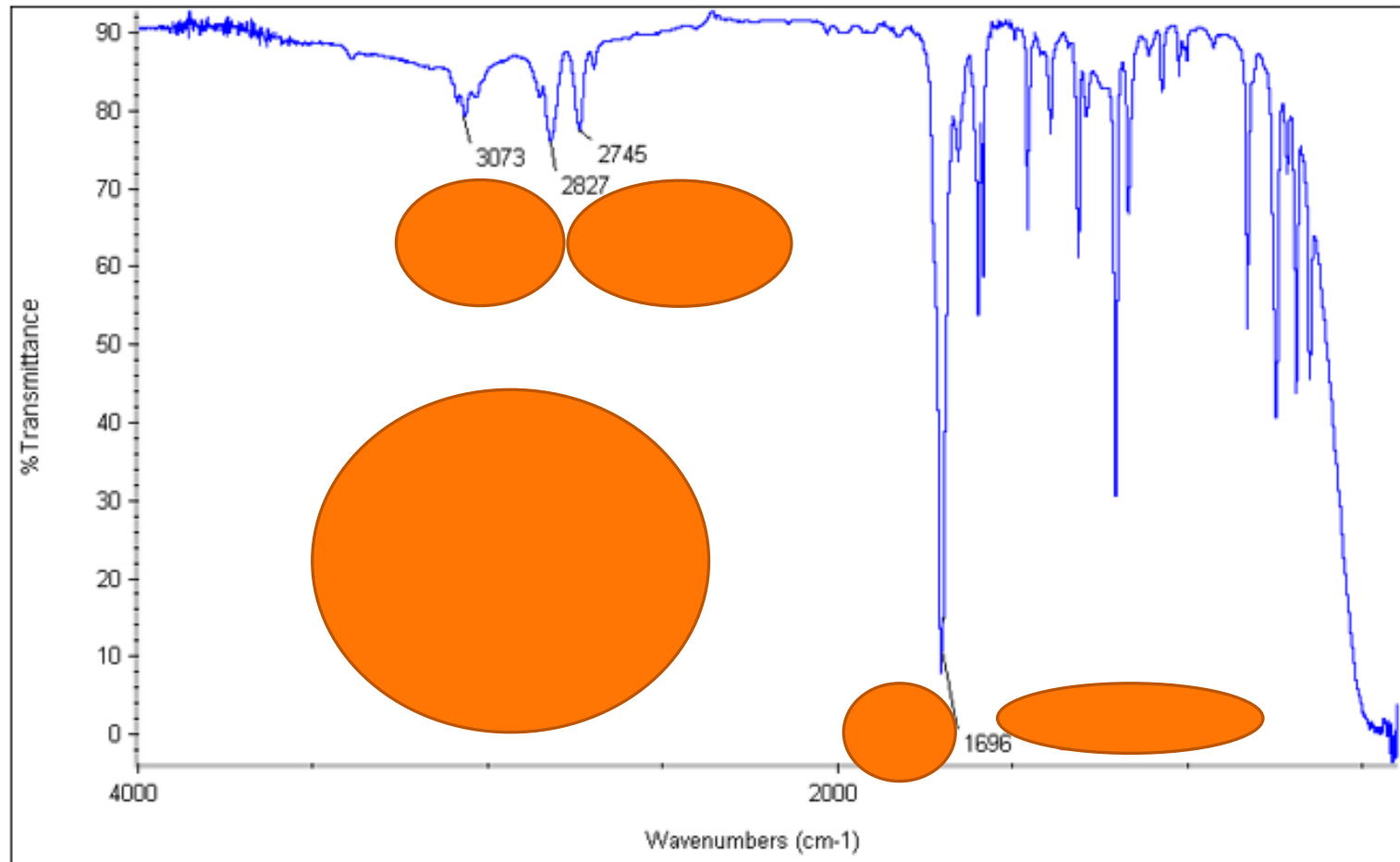


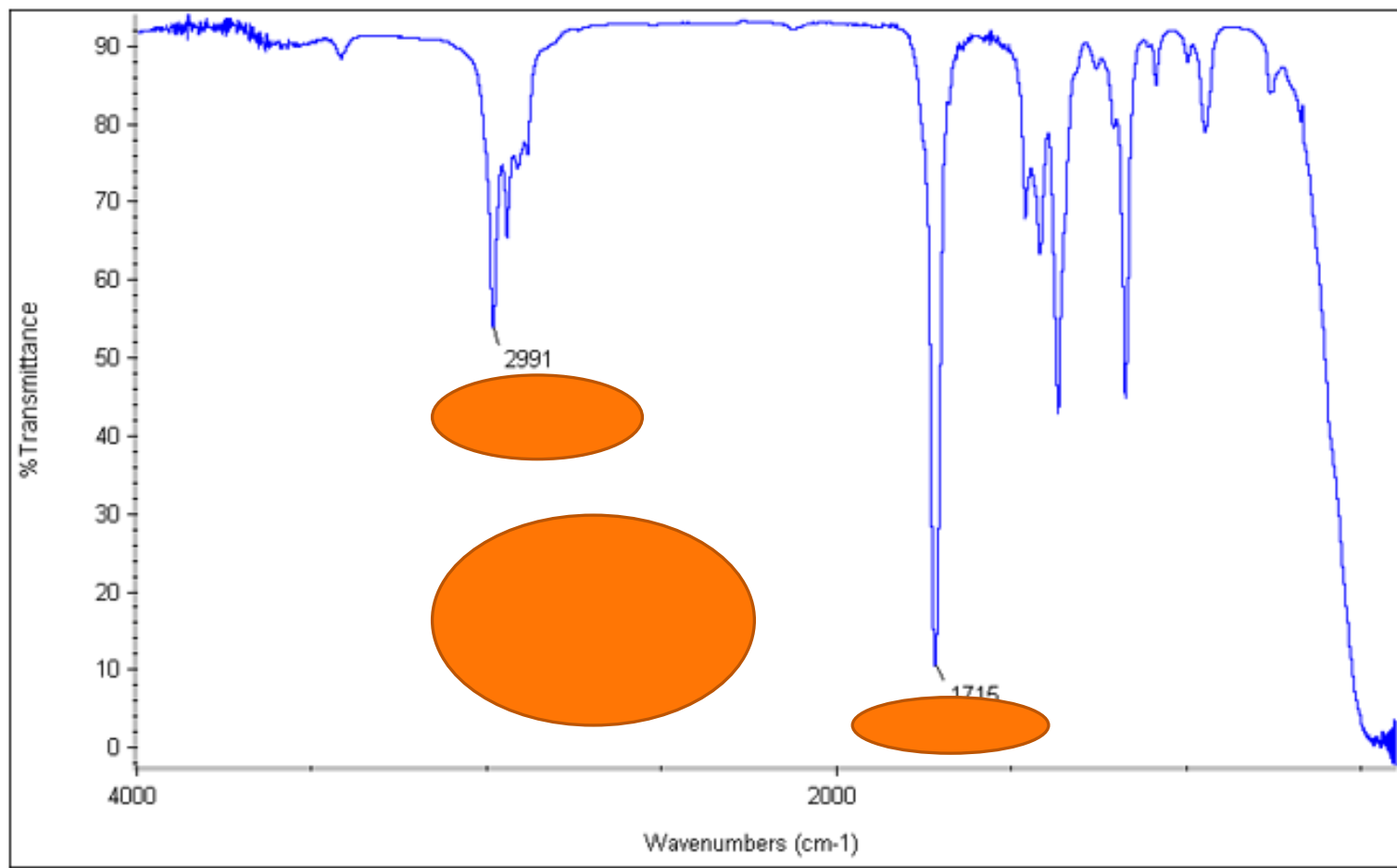


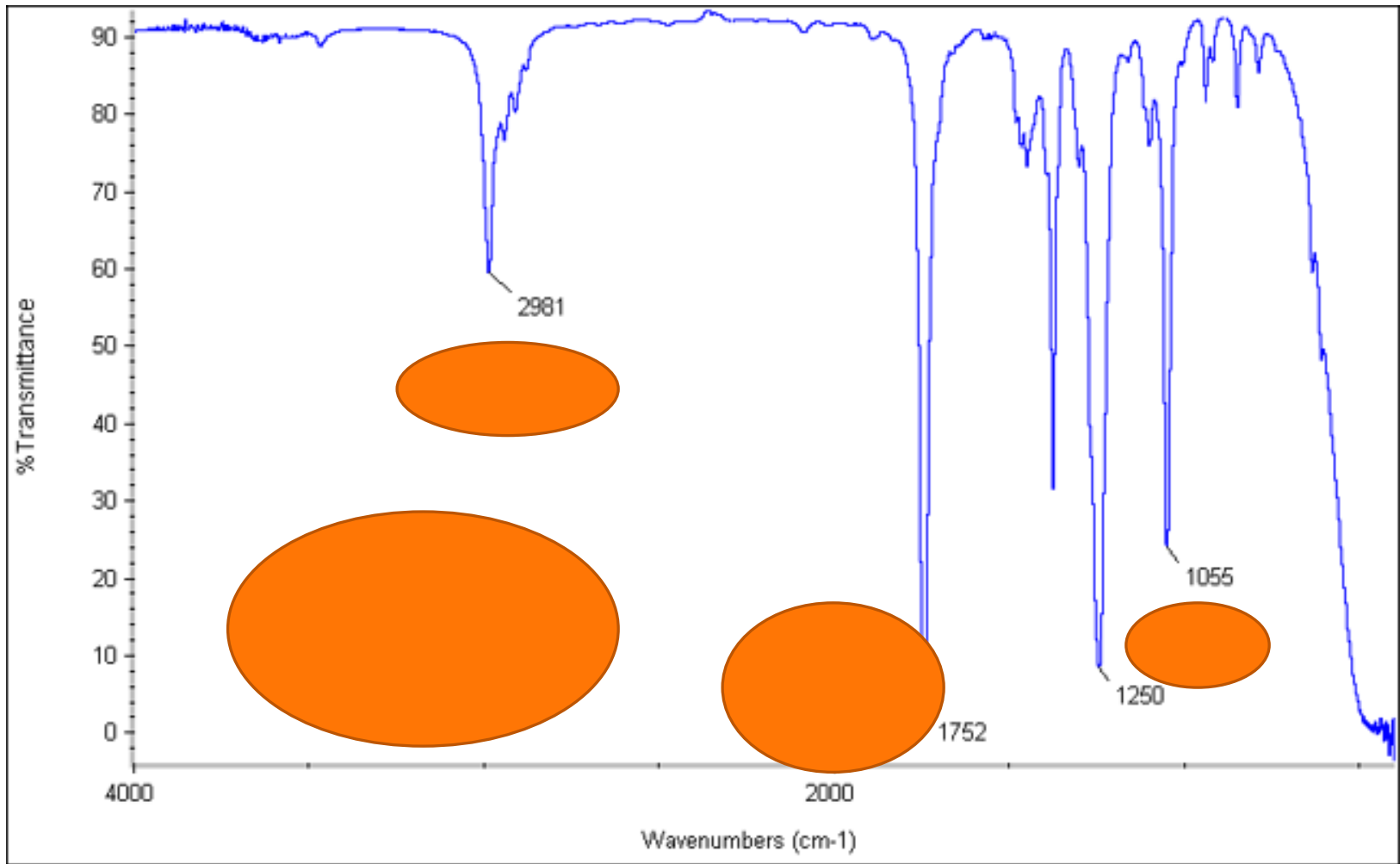








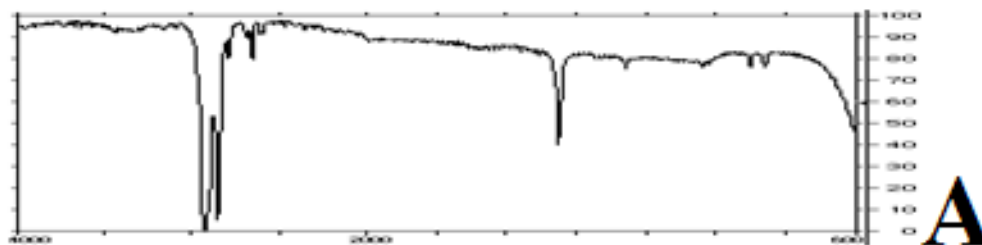




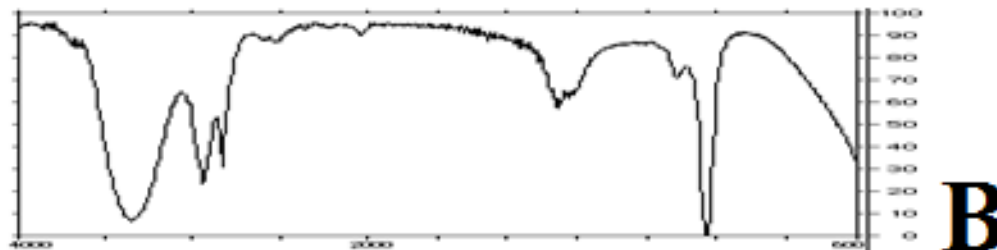


Přiřadte spektra těmto látkám: methanol, cyklohexan, oktanal

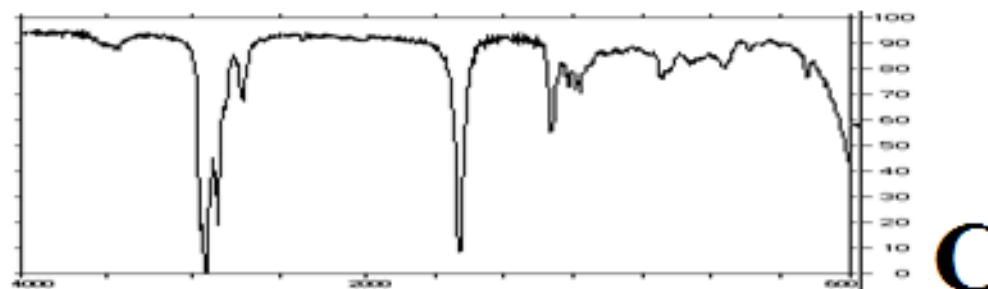
cyklohexan



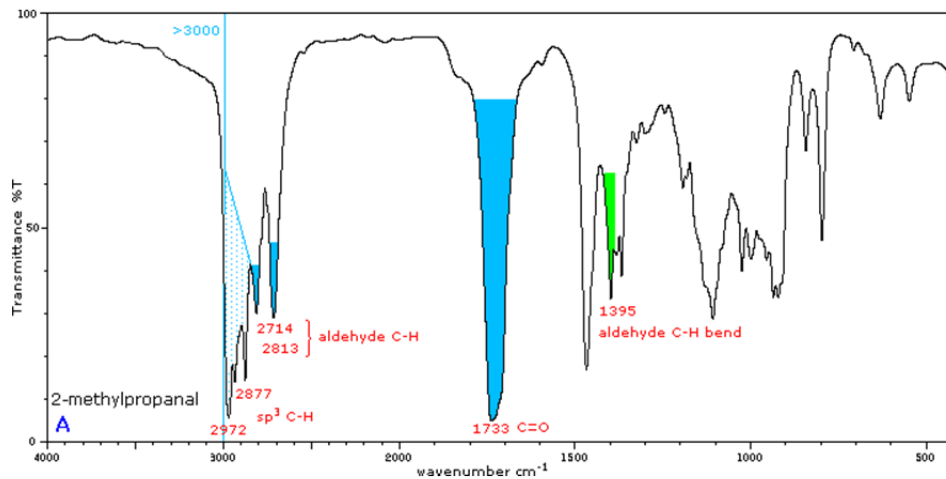
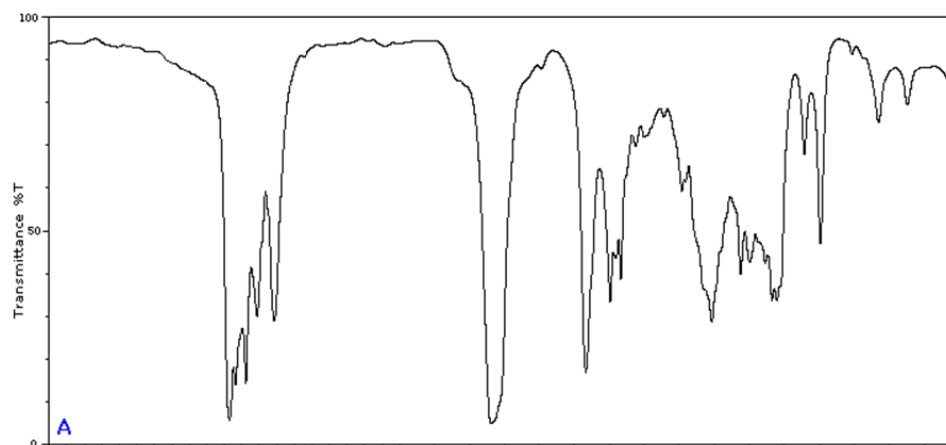
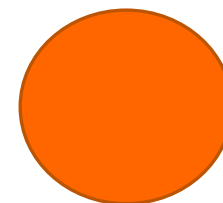
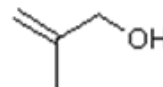
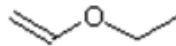
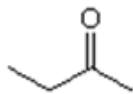
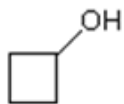
methanol



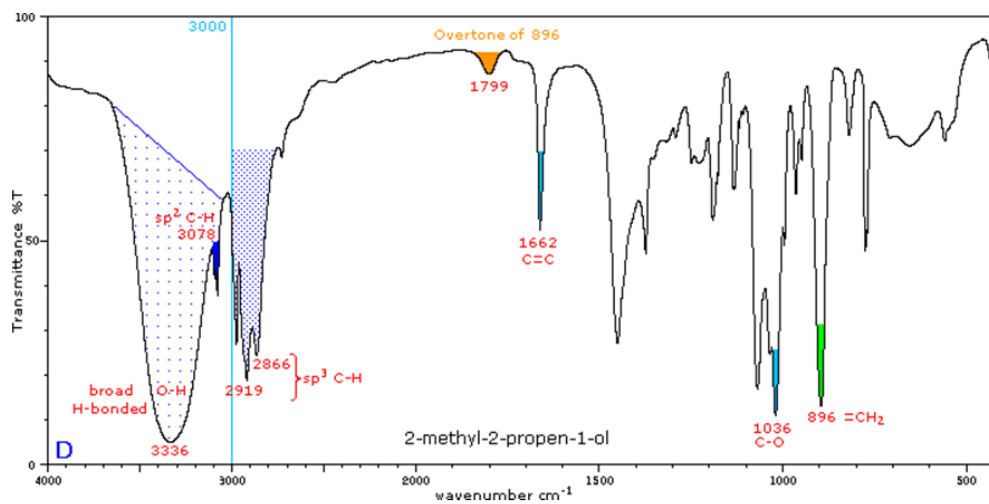
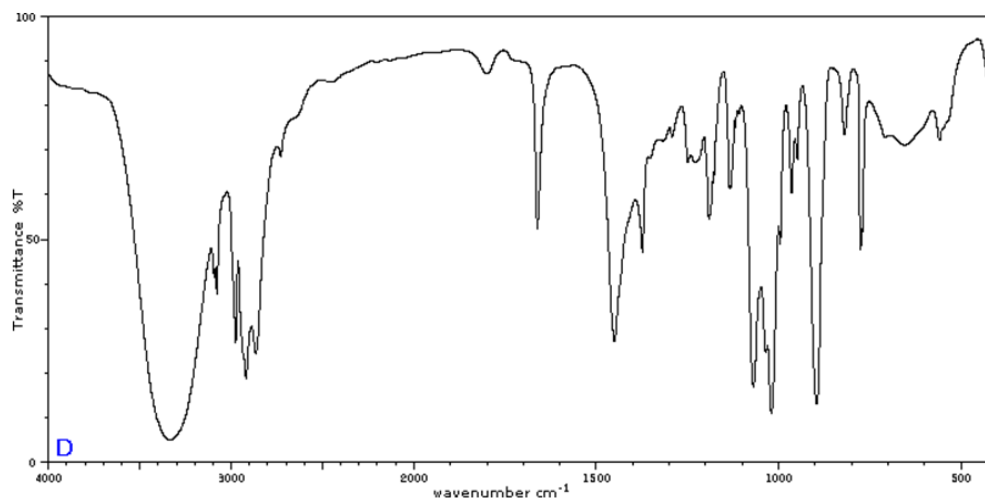
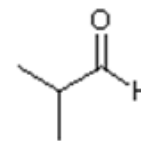
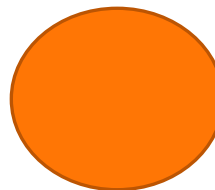
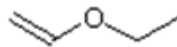
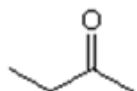
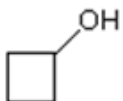
oktanal



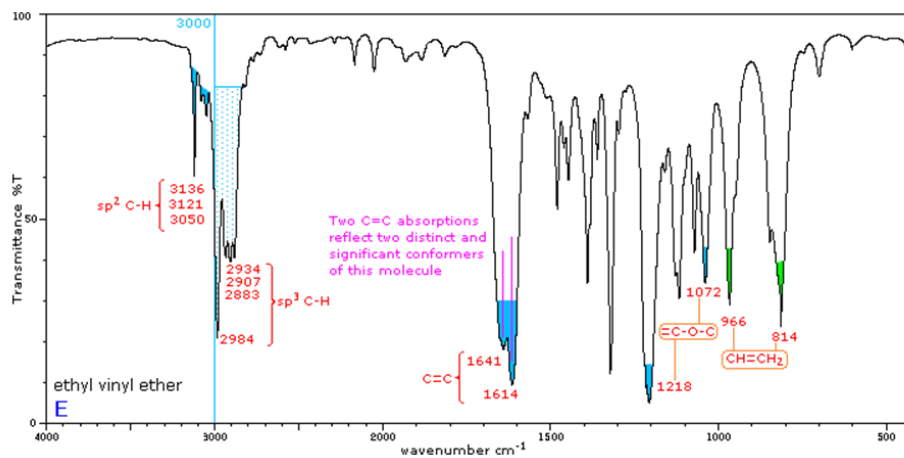
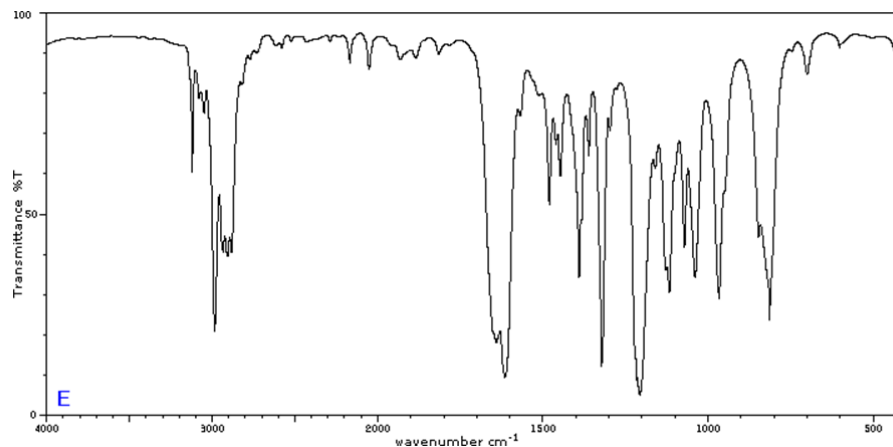
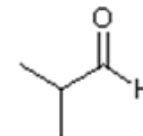
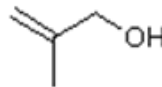
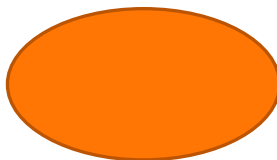
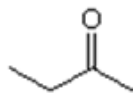
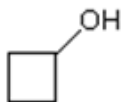
# Vyberte, které ze sloučenin náleží uvedené IČ spektrum



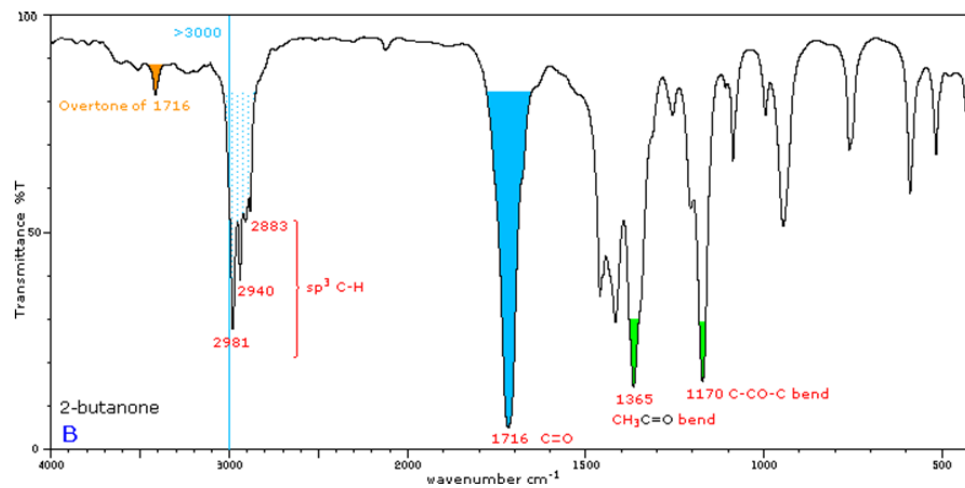
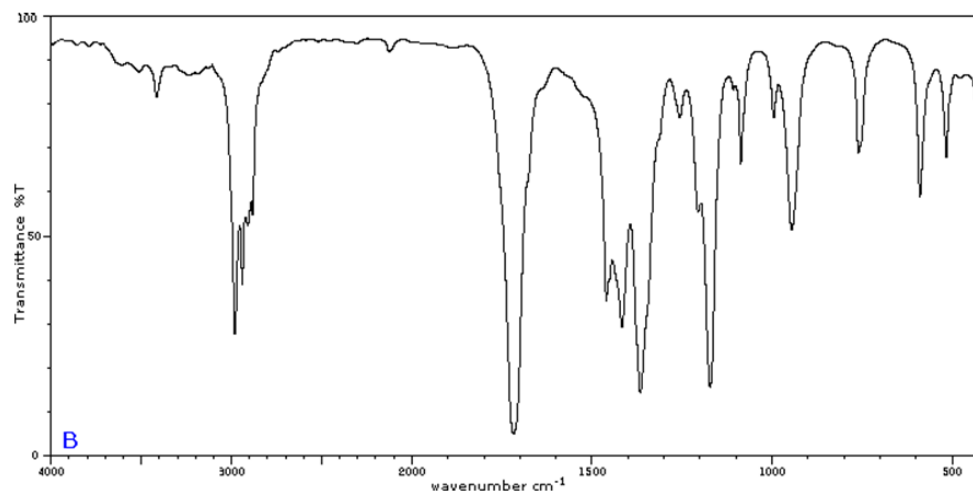
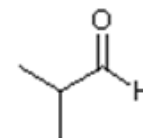
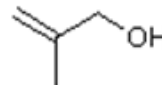
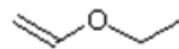
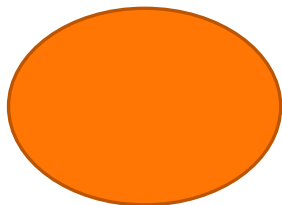
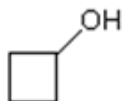
# Vyberte, které ze sloučenin náleží uvedené IČ spektrum



# Vyberte, které ze sloučenin náleží uvedené IČ spektrum



# Vyberte, které ze sloučenin náleží uvedené IČ spektrum



# Vyberte, které ze sloučenin náleží uvedené IČ spektrum

