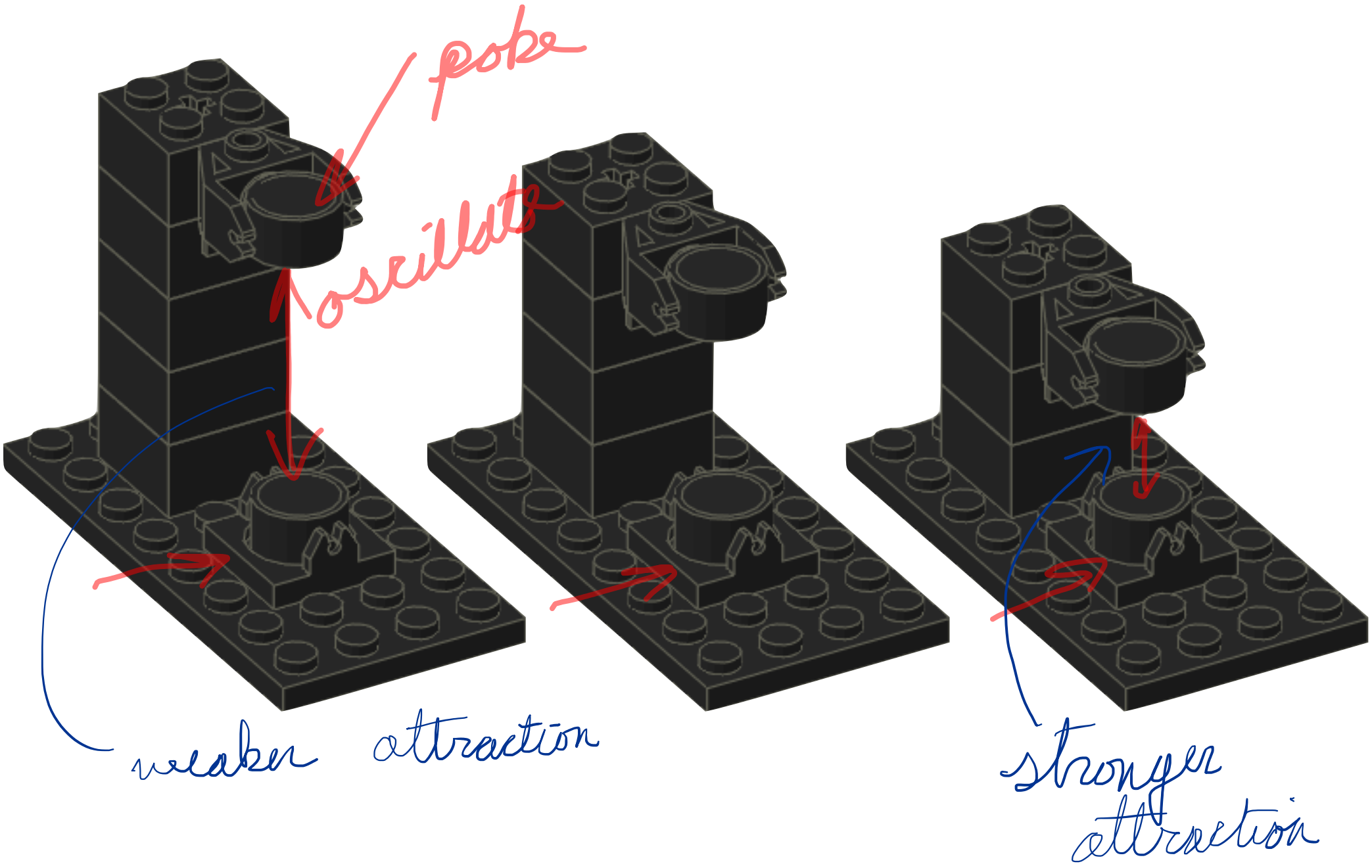
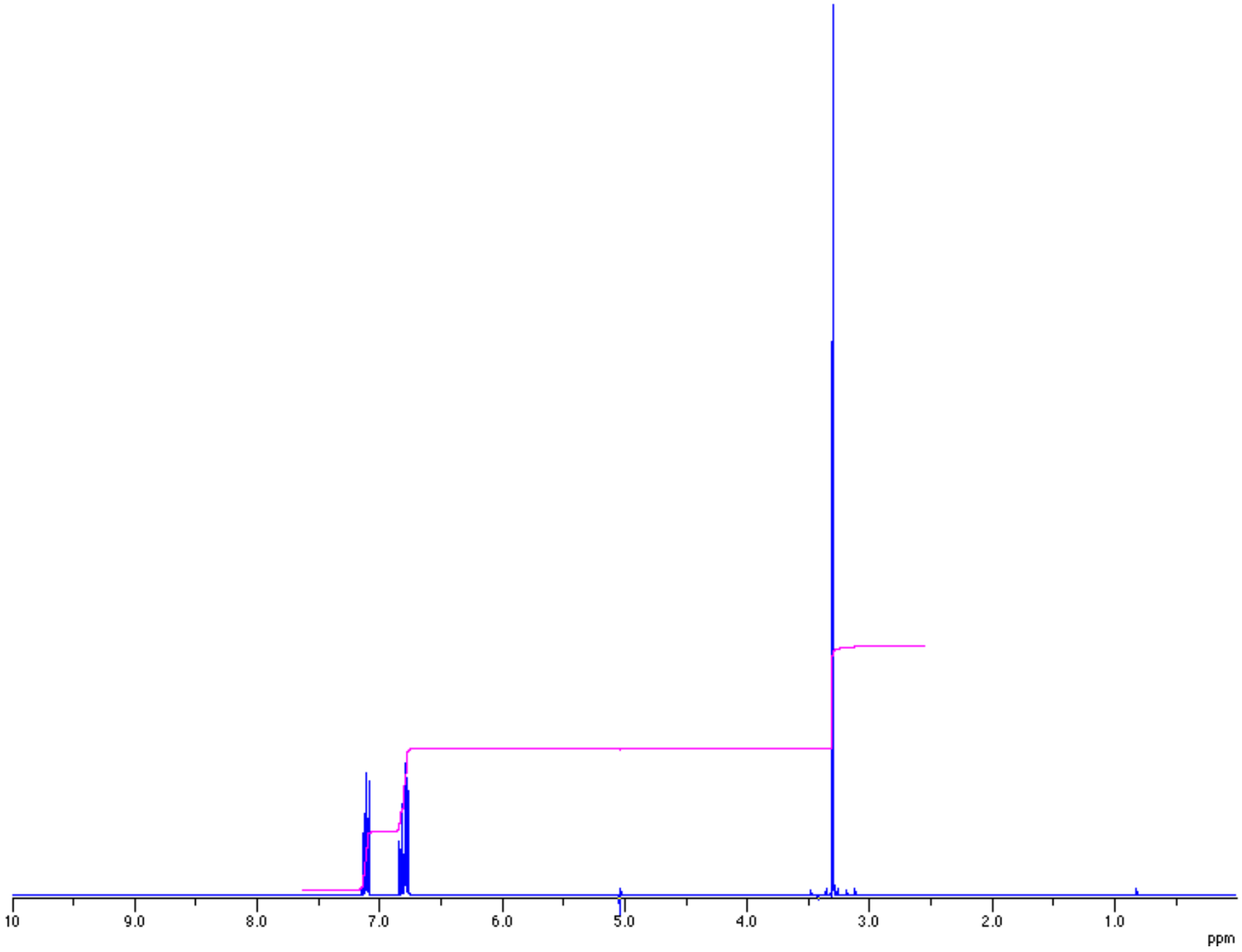

poke
oscillate
weaken attraction
stronger attraction
slower oscillation
faster oscillation

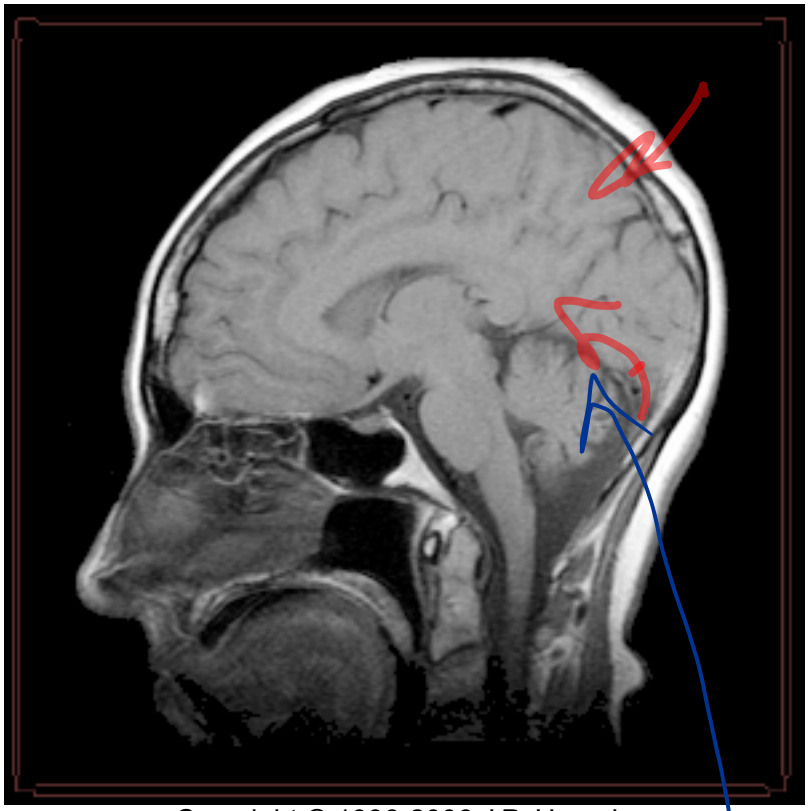
^1H is a tiny magnet

ring of superconductive material

900 MHz, (21.2 T) NMR Magnet at HWB-NMR, Birmingham, UK
https://en.wikipedia.org/wiki/Nuclear_magnetic_resonance#/media/File:HWB-NMR_-_900MHz_-_21.2_Tesla.jpg

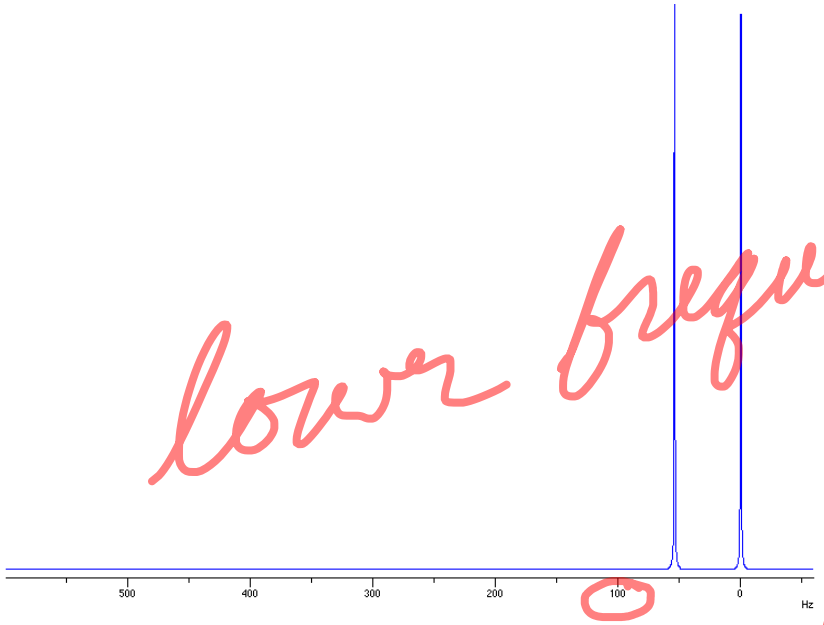

10
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
ppm

www.radiologyinfo.org



move the magnetic field through a person and map the response on a 3-D model

H_2O

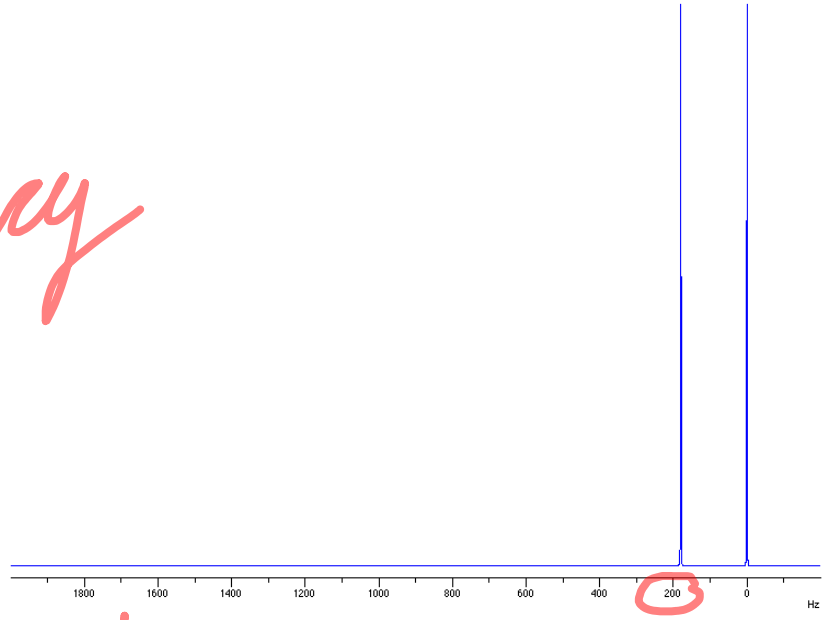


lower frequency

+ 60,000,000 Hz (60 MHz)

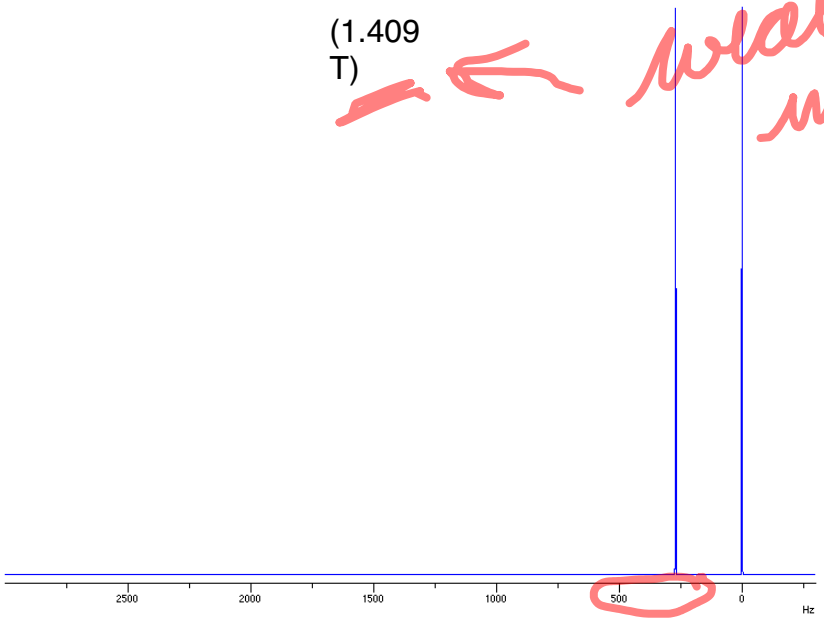
(1.409 T)

← weaker magnet



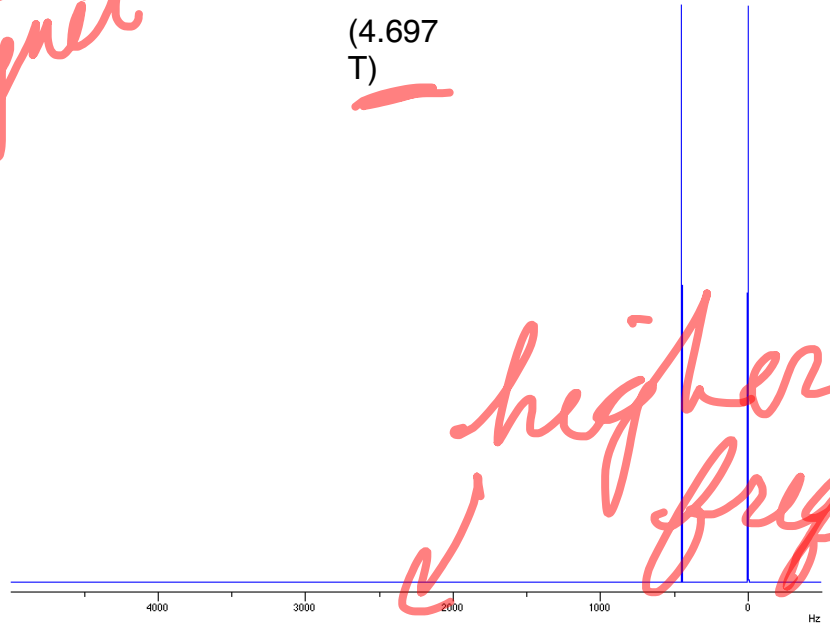
+ 200,000,000 (200 MHz)

(4.697 T)



+300,000,000 Hz (300 MHz)

(7.046 T)



higher freq

+ 500,000,000 Hz (500 MHz)

(11.743 T) ← stronger magnet

chemical shift

$$\delta \text{ ppm} = \frac{\nu_{(peak)}\text{Hz} - \nu_{(TMS)}\text{Hz}}{\nu_{(TMS)}\text{MHz}}$$

how far from the standard.

tells us where a peak is relative to a standard

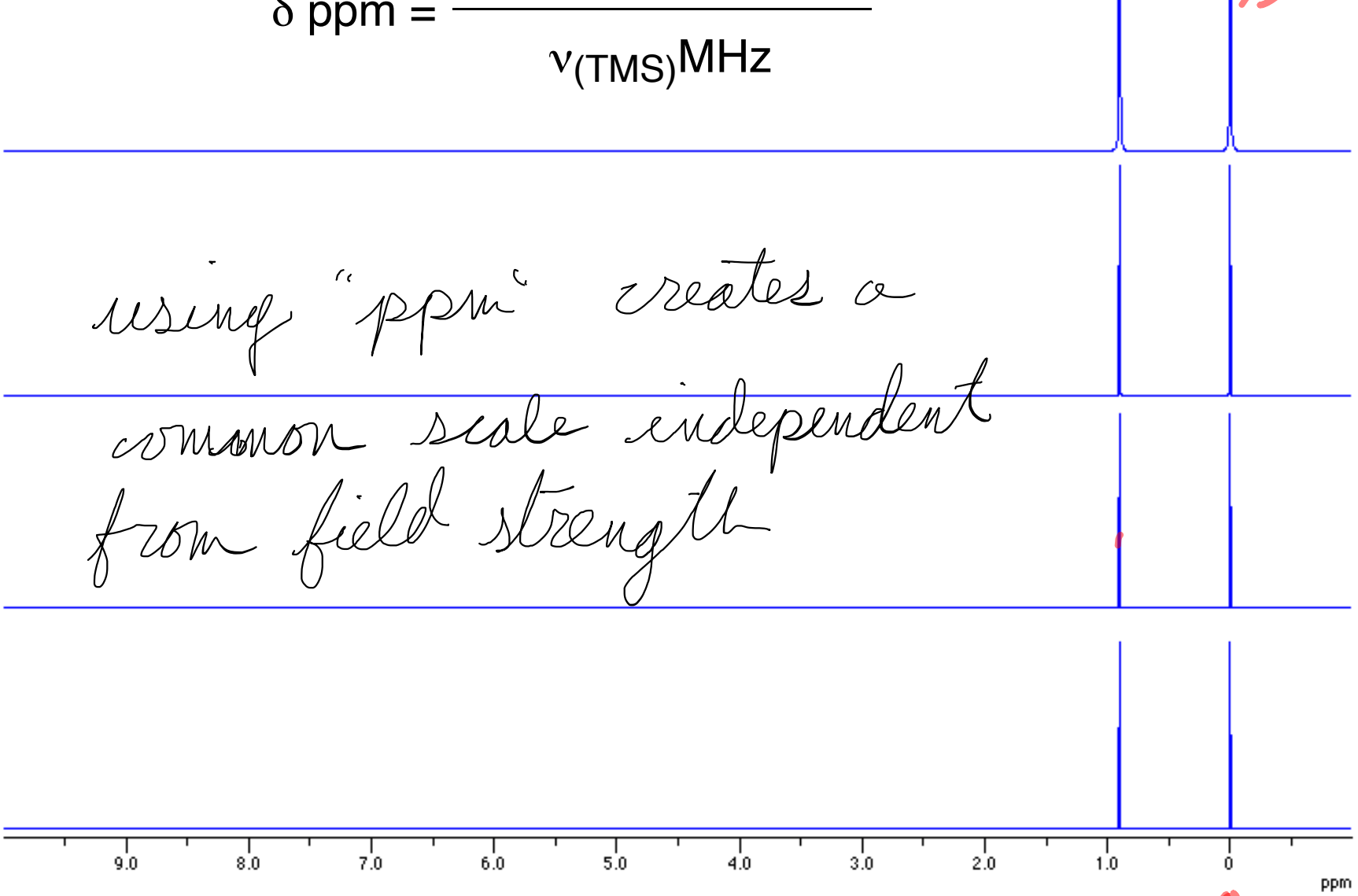
resonance frequency of the standard

$$\delta \text{ ppm} = \frac{\nu_{(peak)}\text{Hz} - \nu_{(TMS)}\text{Hz}}{\nu_{(TMS)}\text{MHz}}$$

sample

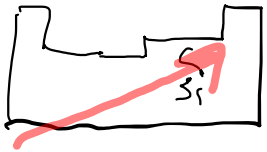
standard

using "ppm" creates a common scale independent from field strength



0.9 ppm

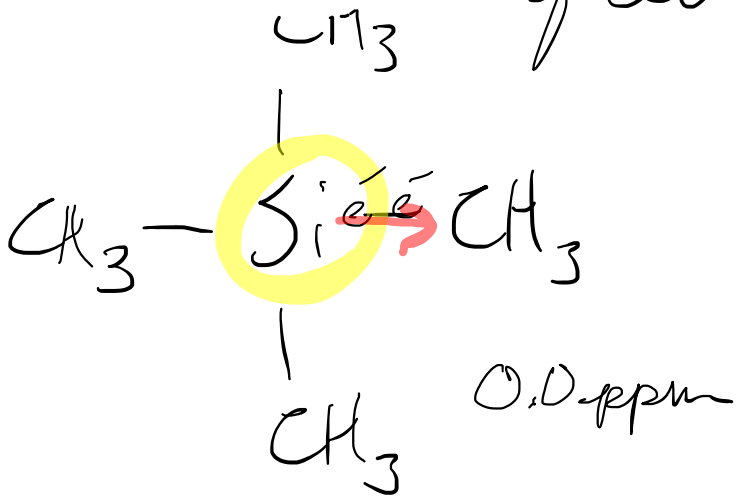
0 ppm

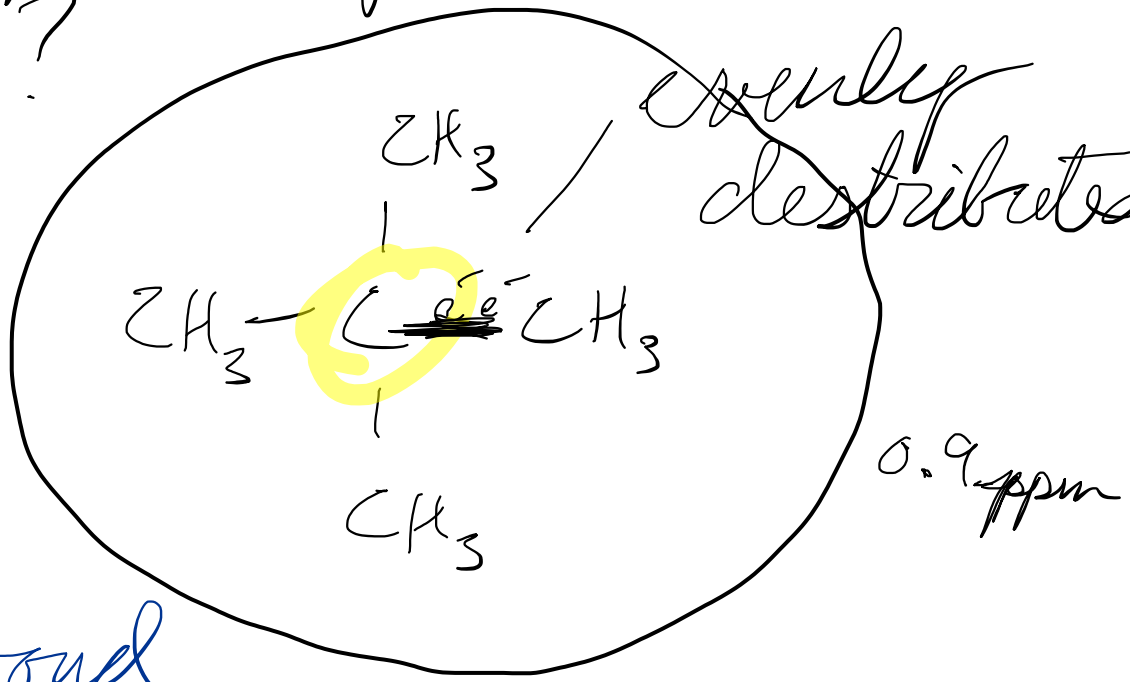


What gives rise to differences in chemical shift?

Why do the H's of tetramethylsilane resonate at a different frequency than 2,2-dimethylpropane?

which is experiencing the stronger field?





e⁻ in Si to C bond are drawn towards C.

The H's on the C are shielded by the e⁻'s. Thus the magnetic field is weaker... lower freq.

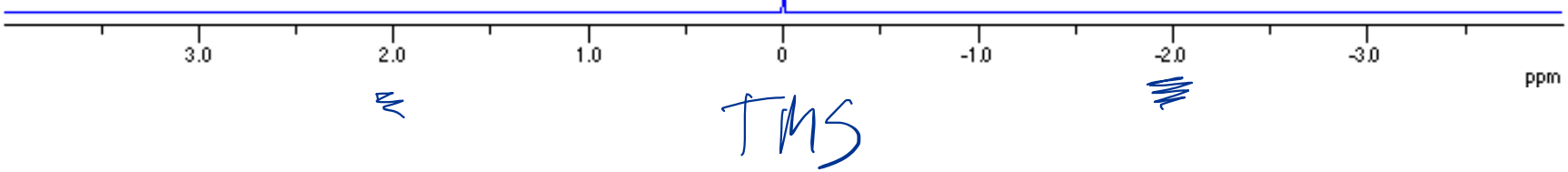
higher frq

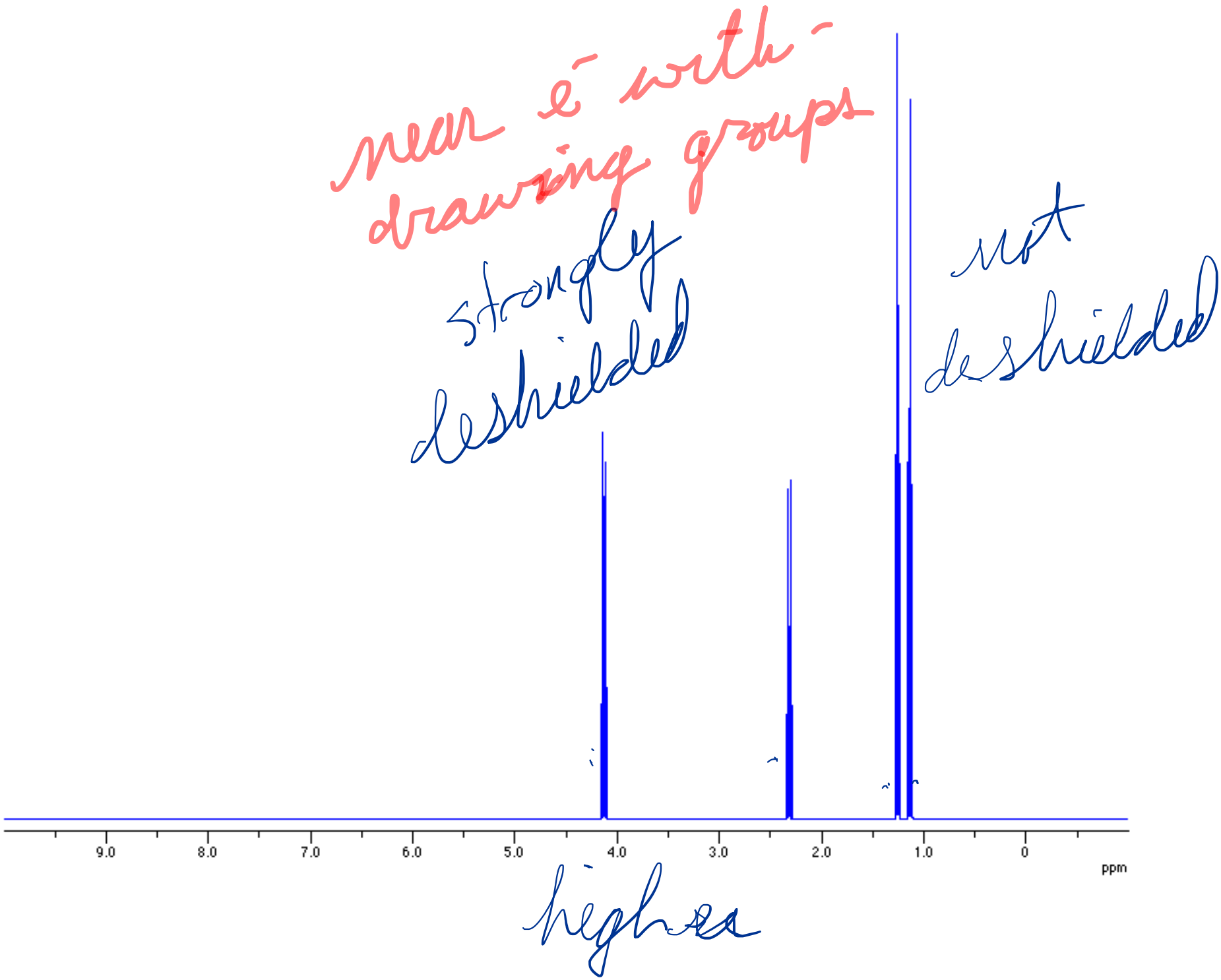
deshielded

lower frq

shielded

not much down here in organic molecules




near e⁻ with
drawing groups
strongly
deshielded
not
deshielded
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
ppm
higher

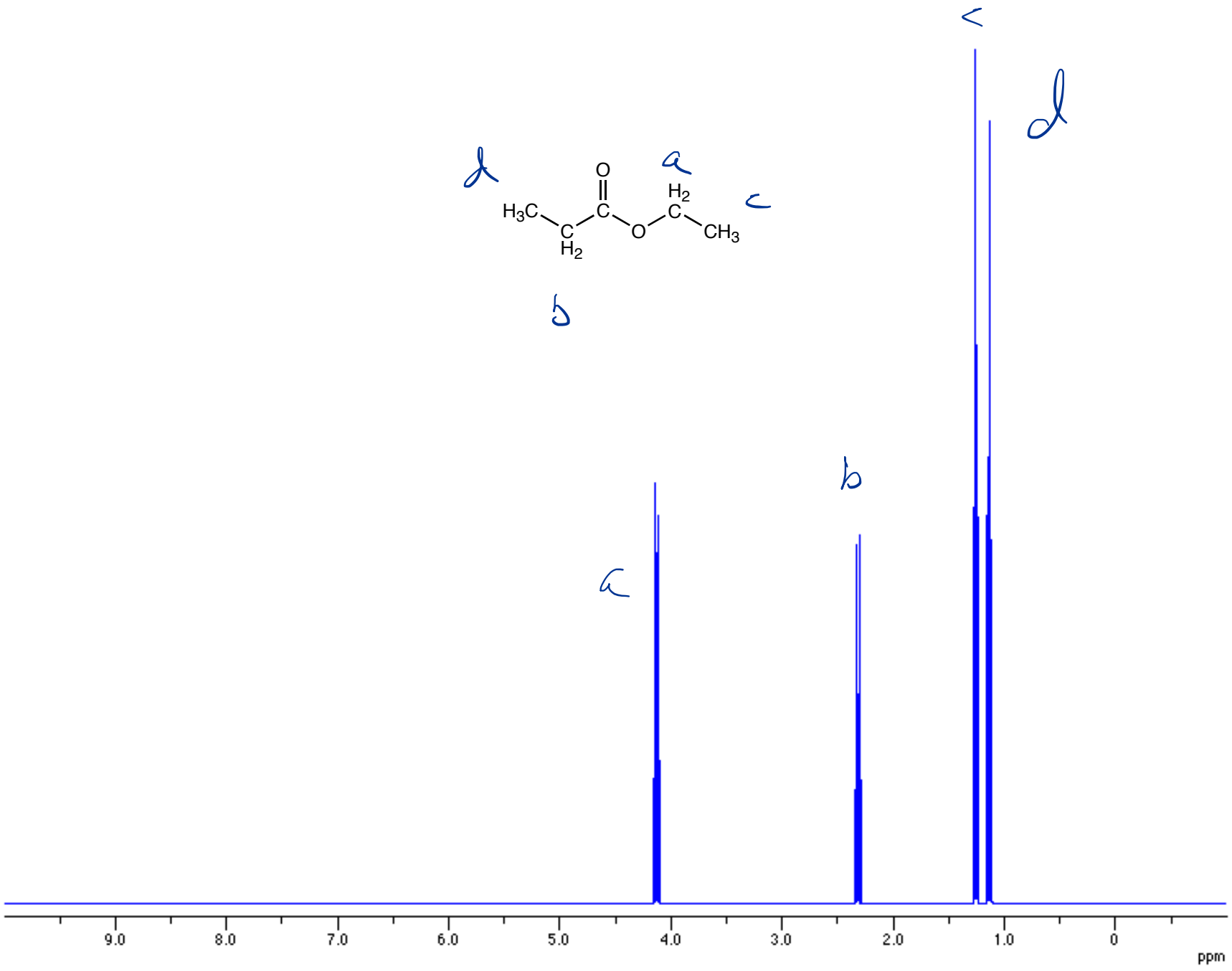
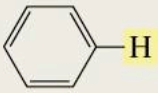
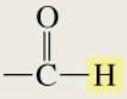
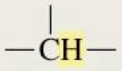
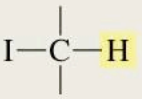
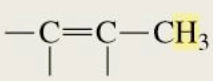
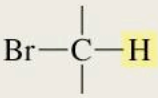
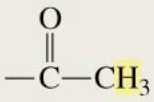
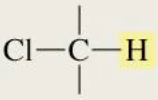
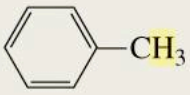
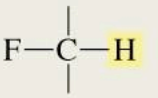
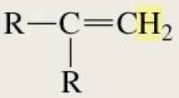
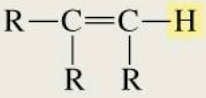
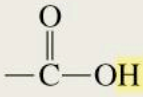
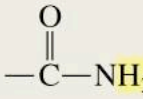
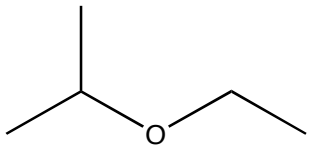
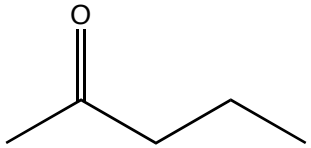

d
a
c
b
d
a
b
c
O
H3C
C
H2
C
O
H2
C
CH3
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
ppm

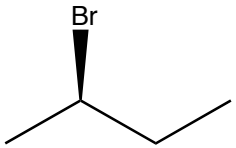
Table 14.1 Approximate Values of Chemical Shifts for ^{1}H NMR[a]

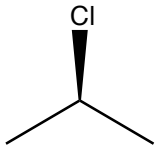
Type of proton	Approximate chemical shift (ppm)	Type of proton	Approximate chemical shift (ppm)
$(CH_3)_4Si$	0		6.5–8
$-CH_3$	0.9		
$-CH_2-$	1.3		9.0–10
	1.4		2.5–4
	1.7		
			2.5–4
	2.1		
			3–4
	2.3		
			4–4.5
$-C\equiv C-H$	2.4		
$R-O-CH_3$	3.3	RNH_2	Variable, 1.5–4
	4.7	ROH	Variable, 2–5
		ArOH	Variable, 4–7
	5.3		Variable, 10–12
			Variable, 5–8

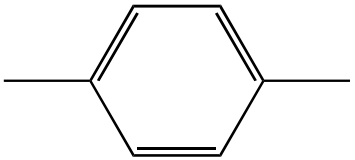
[a]The values are approximate because they are affected by neighboring substituents.

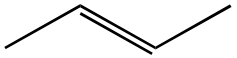

O


O


Br

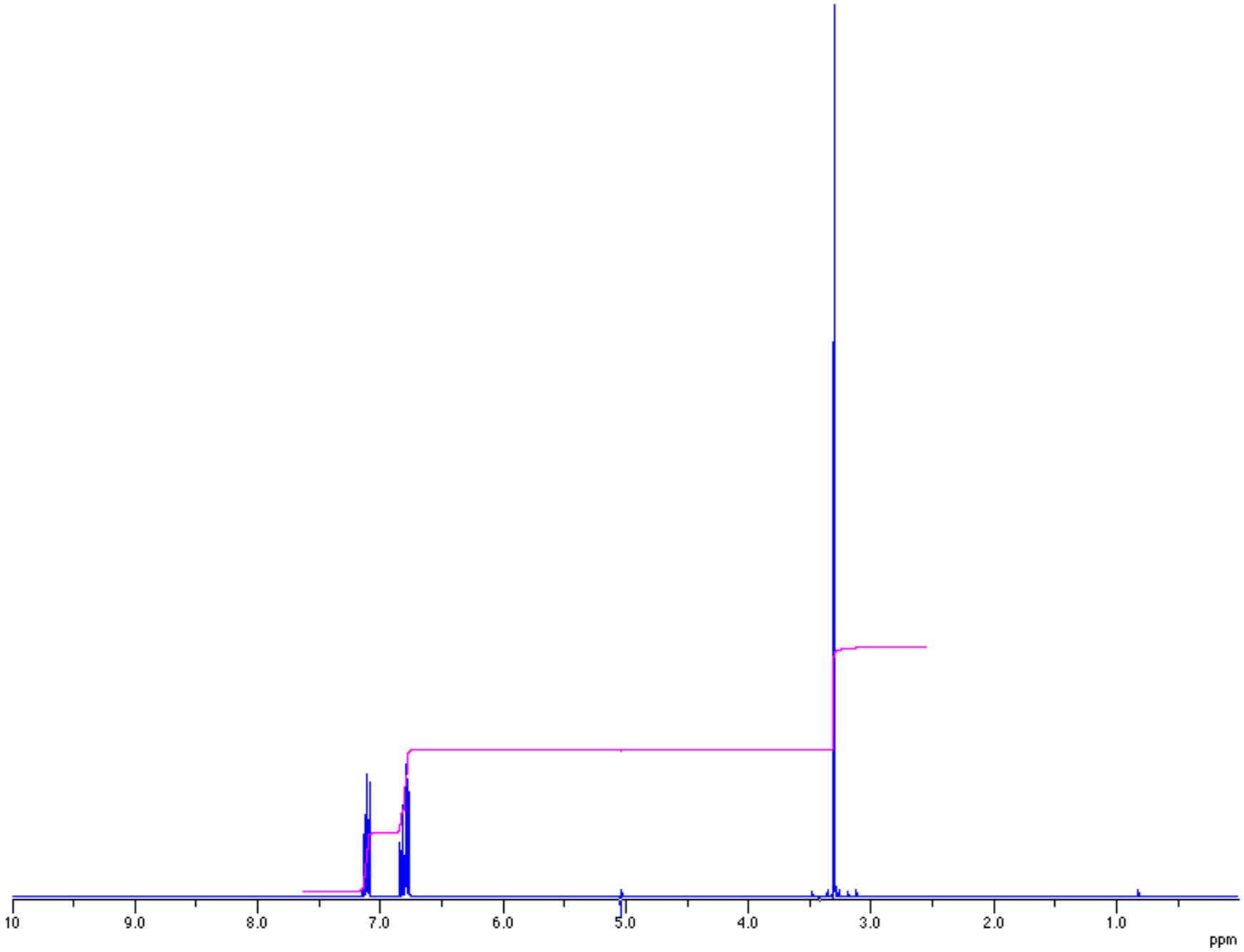

Cl

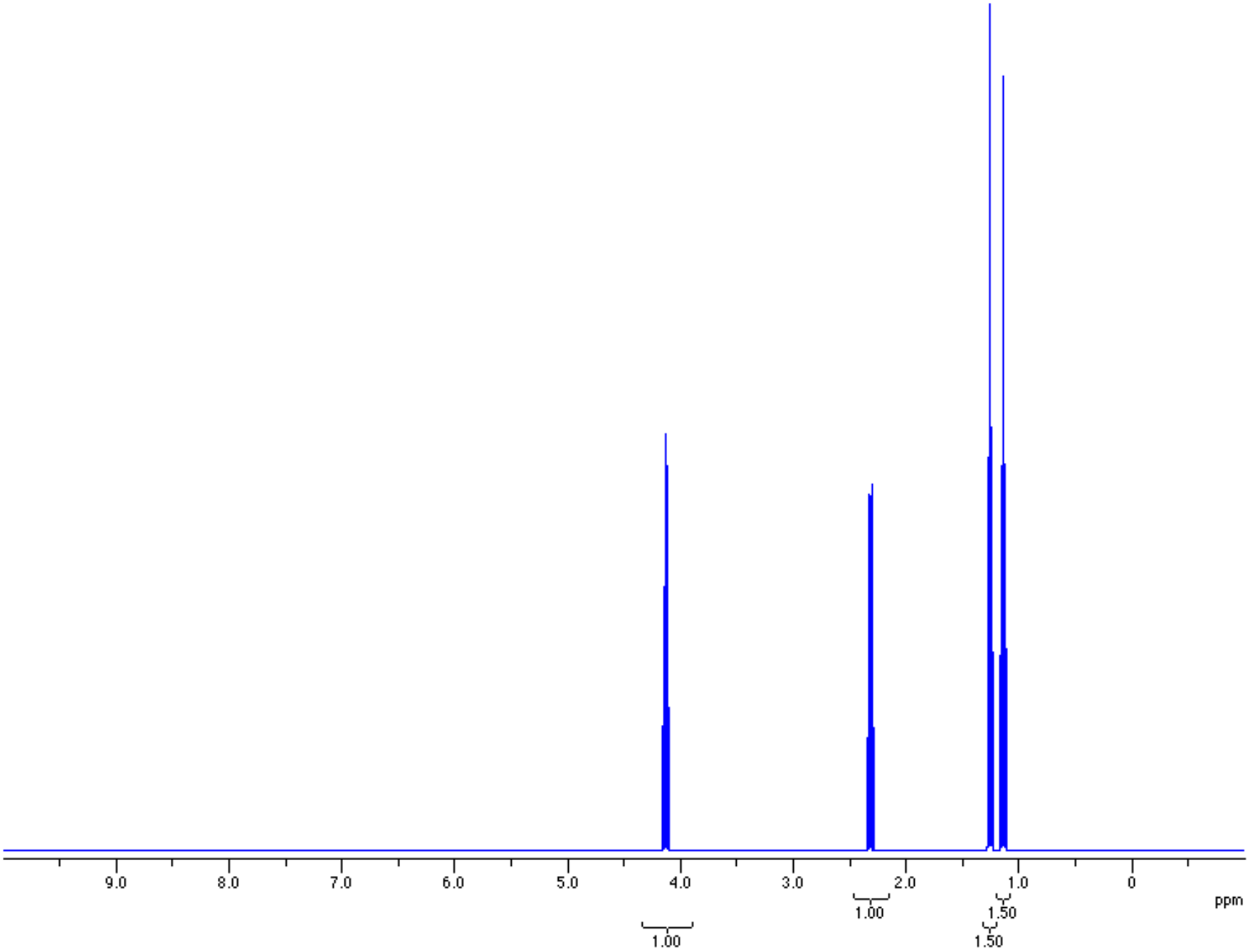




Number of different types of H atoms

Chemical environments of the H atoms

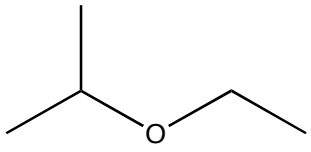

10
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
ppm

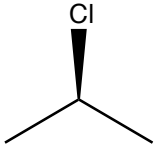

9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
ppm
1.00
1.00
1.50
1.50

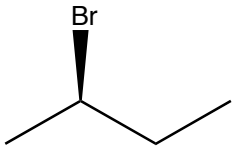
Number of different types of H atoms

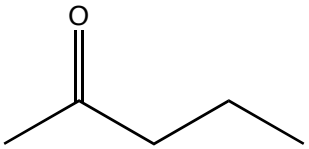
Chemical environments of the H atoms

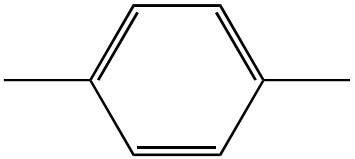
How many of each type of H atom

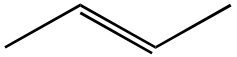

O


Cl


Br


O





Number of different types of H atoms

Chemical environments of the H atoms

How many of each type of H atom

How many H atoms neighbor each different type of H atom