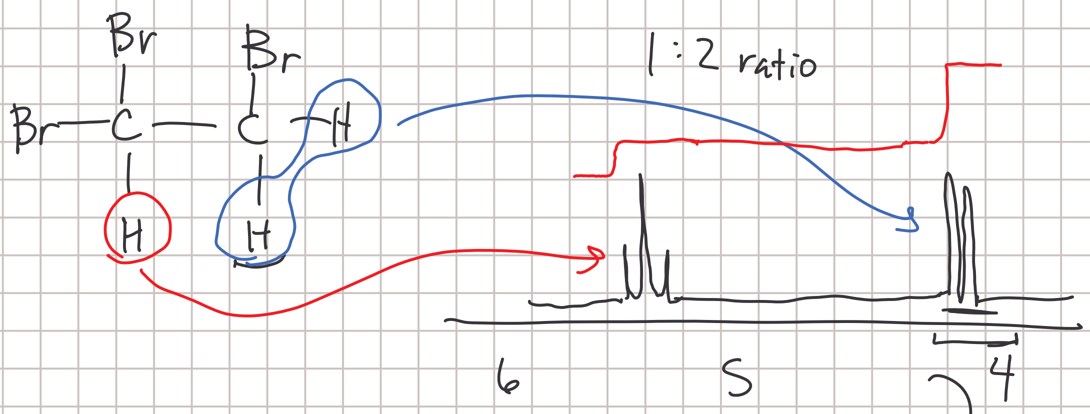
Ch 13

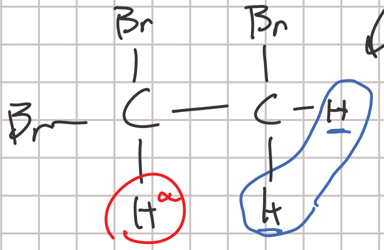
Note Title 10/26/2005

Spin-spin splitting

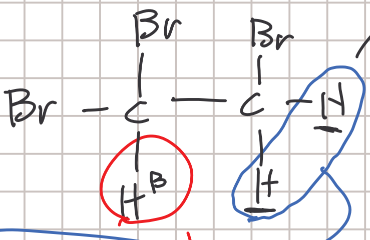


α = ↑ spin

β = ↓ spin



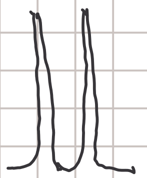
- or -



since there's 1 nearby H, this resonance is a doublet

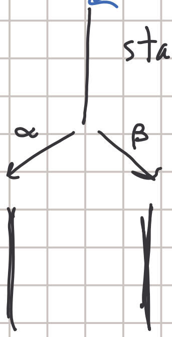
- α spin nearby reinforces applied field
- β spin nearby opposes applied field

(a single peak = singlet)



doublet

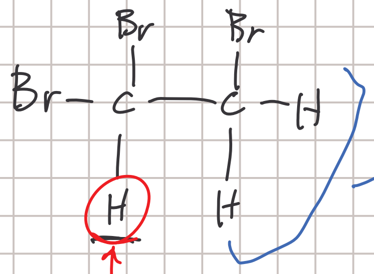
=



start w/ single peak

1 nearby H

now have 2 peaks!



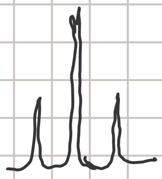
has
2 nearby protons

Could be any of 4 combinations

$\underbrace{H^{\alpha}, H^{\alpha}}_{\text{reinforce field}}$ $\underbrace{\begin{matrix}-H^{\alpha}, H^{\beta} \\ -H^{\beta}, H^{\alpha}\end{matrix}}_{\text{field unchanged}}$ $\underbrace{H^{\beta}, H^{\beta}}_{\text{oppose field}}$

3 peaks =

this resonance is a triplet



1:2:1

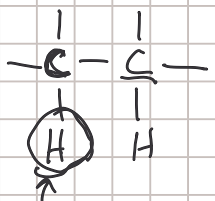
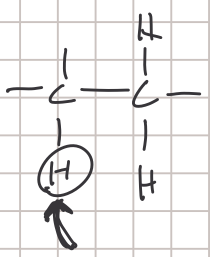
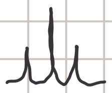
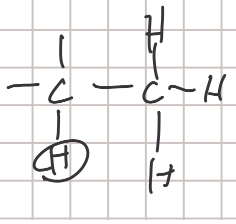
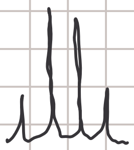
triplet

middle peak is twice the intensity

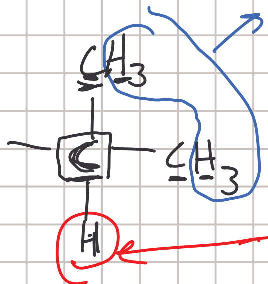
the N+1 rule

if a resonance is split by N equiv. H's, the resonance will have N+1 peaks.

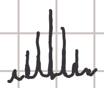
usually occurs on H's on adjacent carbons

	# H on adj. C's	resonance	
 this resonance	1	doublet	 1:1
	2	triplet	 1:2:1
	3	quartet	 1:3:3:1

# peaks	intensities	name
1	1	singlet (s)
2	1 : 1	doublet (d)
3	1 : 2 : 1	triplet (t)
4	1 : 3 : 3 : 1	quartet (q)
5	1 : 4 : 6 : 4 : 1	quintet (qu)
6	1 : 5 : 10 : 10 : 5 : 1	sextet (s)
7	1 : 6 : 15 : 20 : 15 : 6 : 1	septet (sept)
8	1 : 7 : 21 : 35 : 35 : 21 : 7 : 1	octet (o)



1 H on adj C's N+1 = 2 peaks = doublet



isopropyl group

6 H's on adjacent carbons

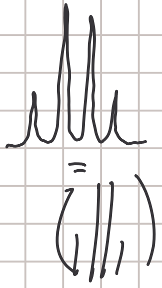
N+1 = 7 peaks in its resonance = septet

2 = N+1
N = 1 H on adj. C's

1 : 6 integral ratio

7 peaks
7 = N+1
N = 6 H on adj C's

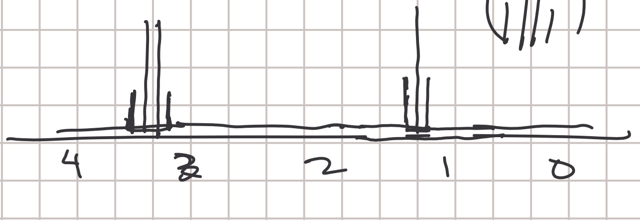
sept & d isopropyl pattern



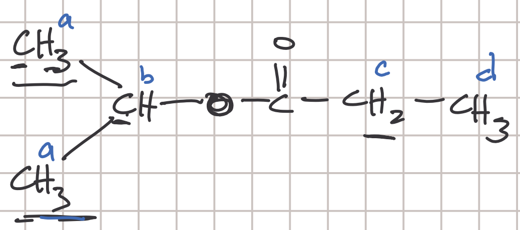
Ethyl group $Cl-CH_2-CH_3$ → triplet (t)

quartet (q)

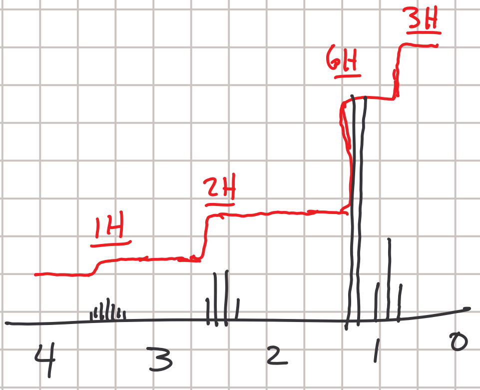
δ 3-4 1-2

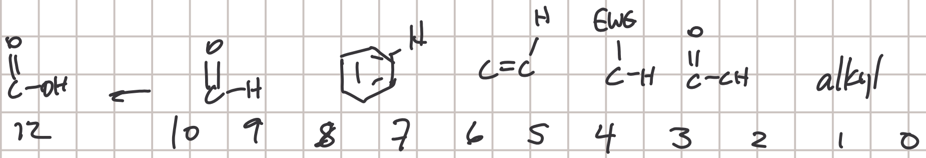


Draw the NMR spc of



H	integral ratio	δ	(#H on adj C's)	m → multiplicity (s, d, t, etc)
a	6	1-2	1	d
b	1	3-4	6	sept
c	2	2-3	3	q
d	3	~1	2	t



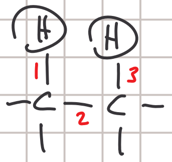


Spin-spin splitting happens most often between H's on adjacent C's

Vicinal Protons

att. to adj. C's

3 bonds apart



CH_3-CH_3

- not see 2 quartets

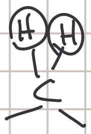
actually see 1 singlet

equivalent H's don't split eachother!

Protons on same Carbon

are usually equivalent and do not split e/o

geminal protons



but if 2 geminal H's are inequivalent they do split e/o!