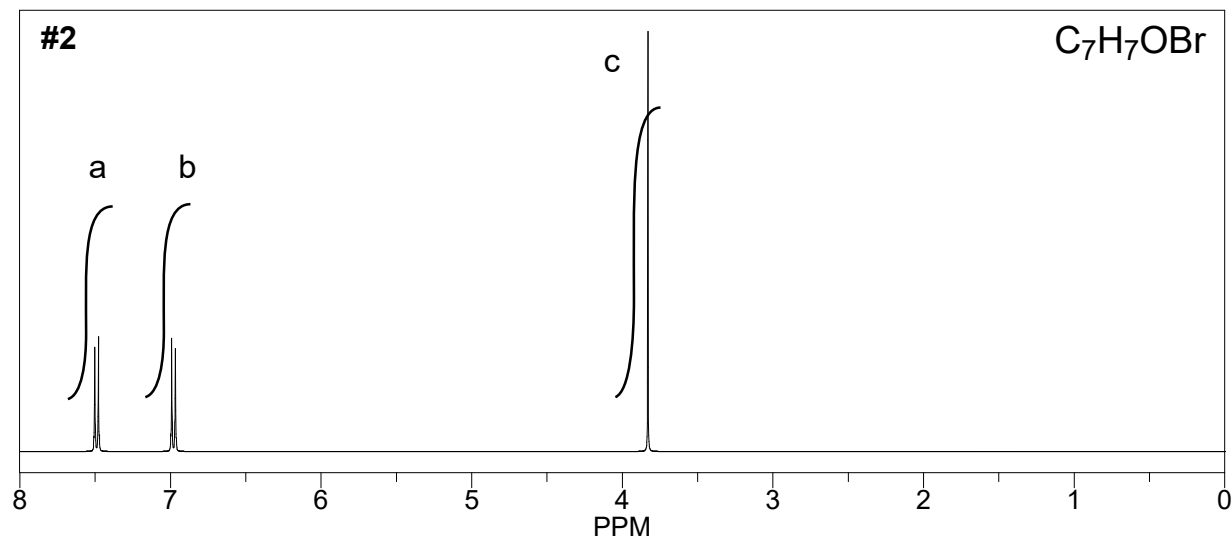
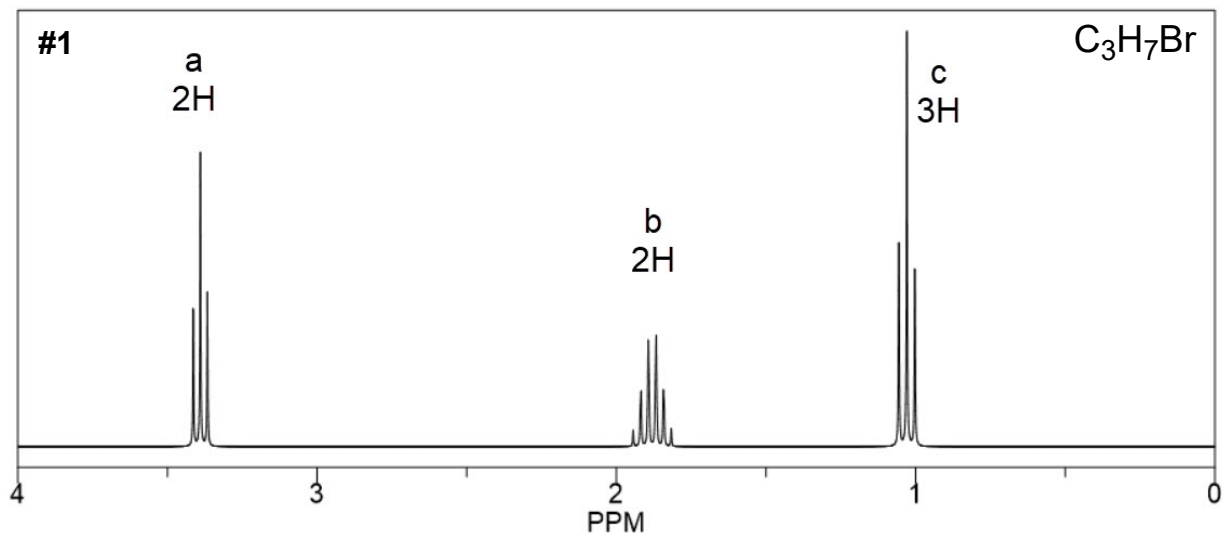
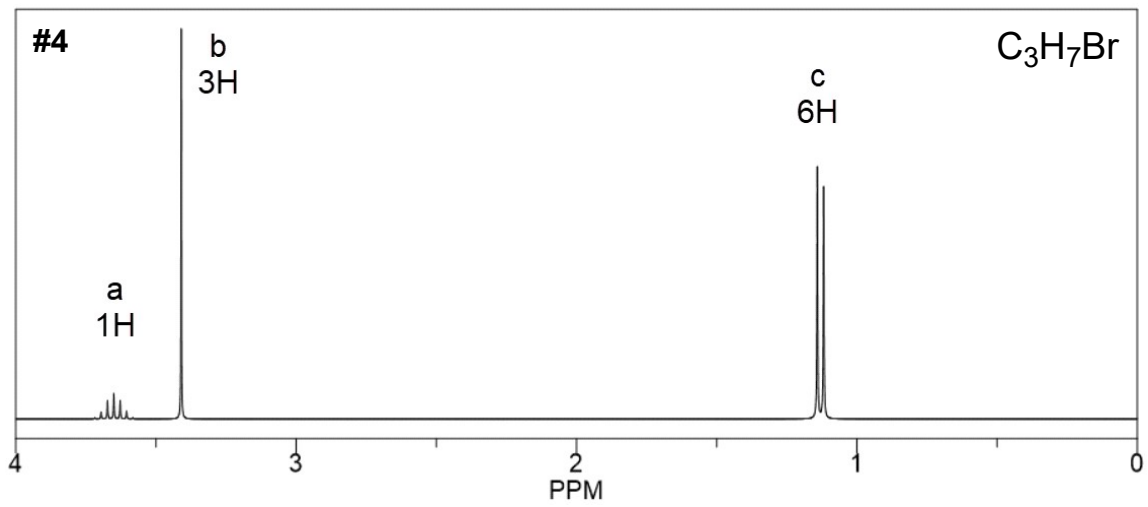
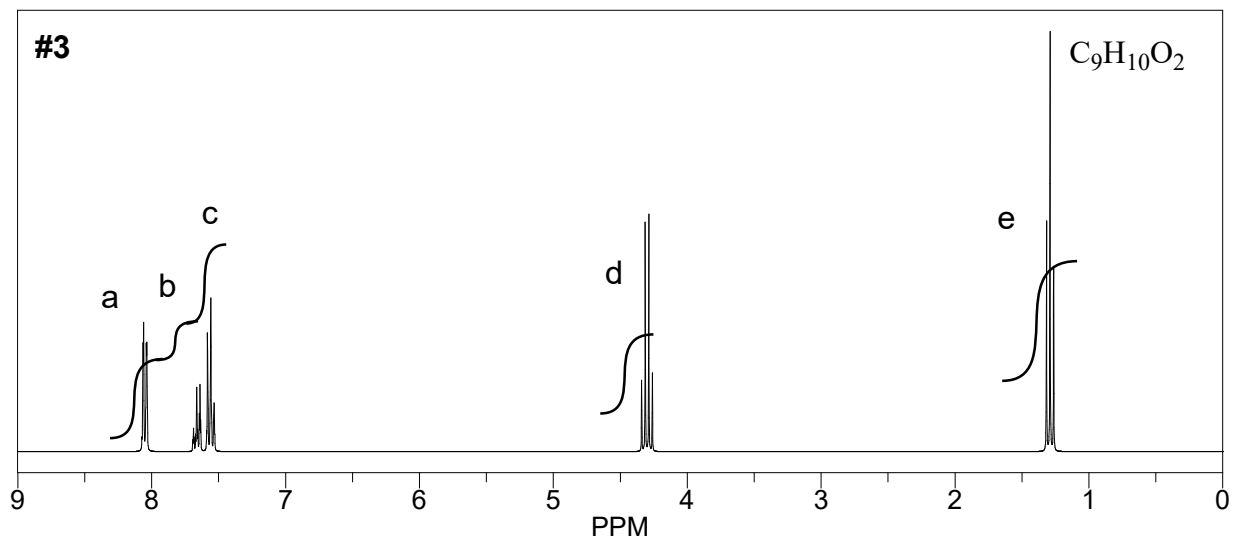


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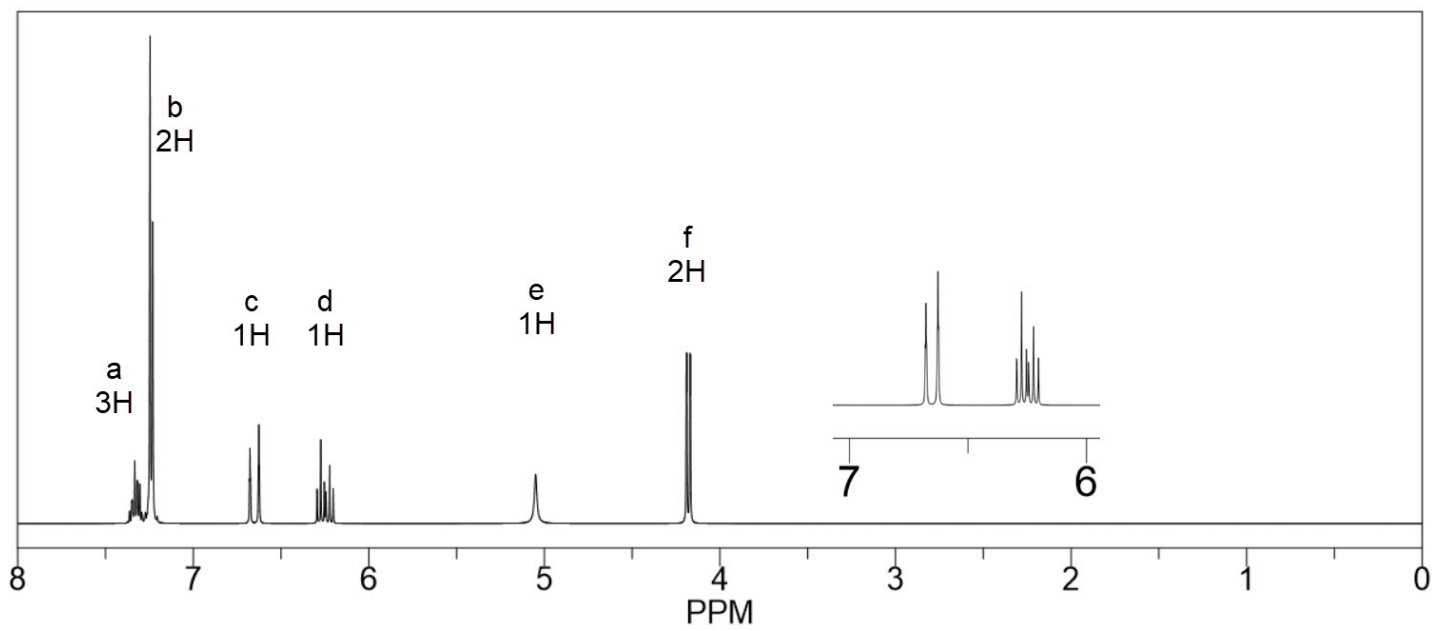
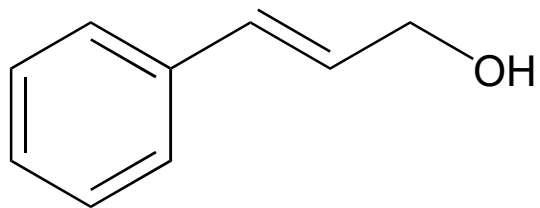


Organic Chemistry I, CHM 3140
Dr. Laurie S. Starkey, Cal Poly Pomona
Chapter 15 NMR, Part 2 – Practice Problems



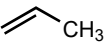
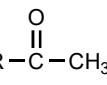
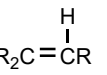
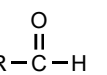


Label all the protons a/b/c/etc. to match the corresponding signals in the ^1H NMR spectrum.

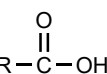
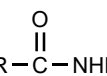


Cal Poly Pomona, Dr. L. S. Starkey
¹H and ¹³C NMR - General Chemical Shifts

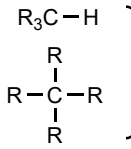

¹H NMR: Protons on Carbon

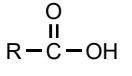
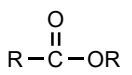
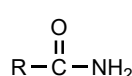
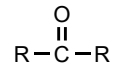
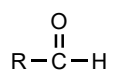
Type of C-H	δ (ppm)	Description
R-CH ₃	0.9	alkyl (methyl)
R-CH ₂ -R	1.3	alkyl (methylene)
R ₃ C-H	1.5-2	alkyl (methine)
	1.8	allylic
	2-2.3	α to carbonyl
Ar-CH ₃	2.3	benzylic
RC≡C-H	2.5	alkynyl
R ₂ N-CH ₃	2-3	α to nitrogen
R-CH ₂ -X	3-3.5	α to halogen
RO-CH ₃	3.8	α to oxygen
R-CH ₂ -F	4.5	α to fluorine
	5-5.3	vinyl
Ar-H	7.3	aromatic
	9.7	aldehyde

¹H NMR: Protons on Oxygen/Nitrogen

Type of H	δ (ppm)	Description
ROH	0.5-5	alcohol
ArOH	4-7	phenol
	10-13	carb. acid
RNH ₂	0.5-5	amine
ArNH ₂	3-5	aniline
	5-9	amide

¹³C NMR: Carbons

Type of carbon	δ (ppm)	Description
R-CH ₃	10-30	methyl
R-CH ₂ -R	15-55	methylene
	20-60	methine or quaternary
C-I	0-40	
C-Br	25-65	
C-N	40-60	
C-Cl	35-80	
C-O	40-80	
RC≡CR	65-90	alkynyl
R ₂ C=CR ₂	100-150	alkenyl
	110-170	aromatic

	165-185	C=O, carboxylic acid, ester, amide
		
		
	185-220	C=O, ketone or aldehyde
		

R = alkyl group
 Ar = aromatic ring, such as phenyl (Ph)