


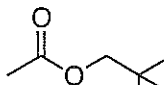

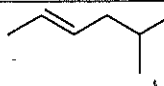
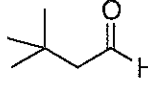
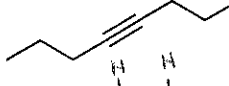
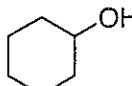


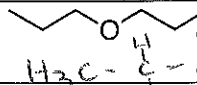
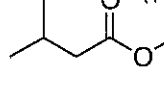
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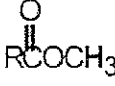
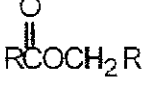

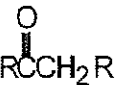
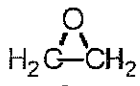


splitting patterns abbrev's
 s = singlet
 d = doublet
 t = triplet
 q = quartet
 m = multiplet (> q)

CH320N Problem Solving Session

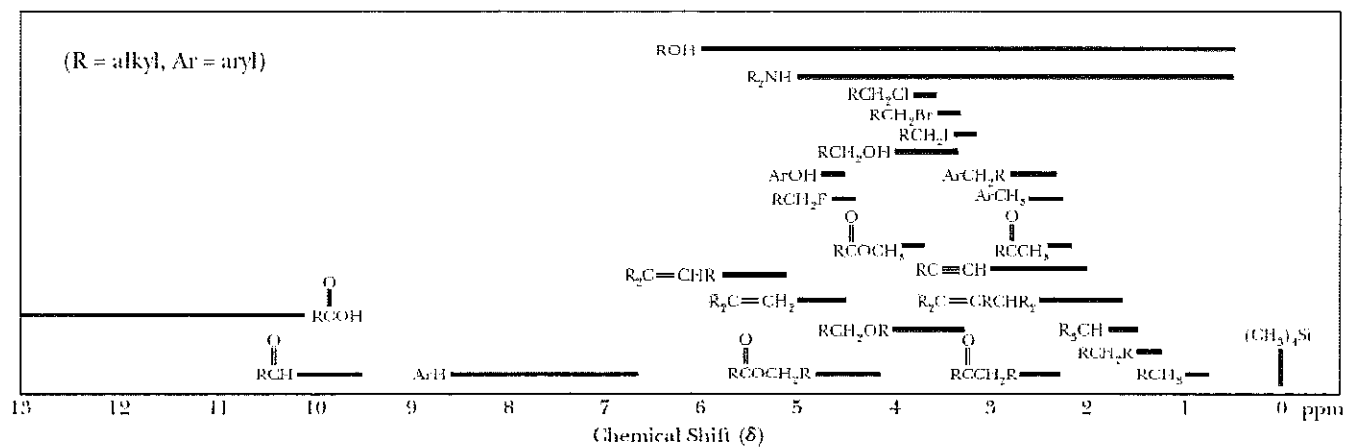
¹H NMR Problems

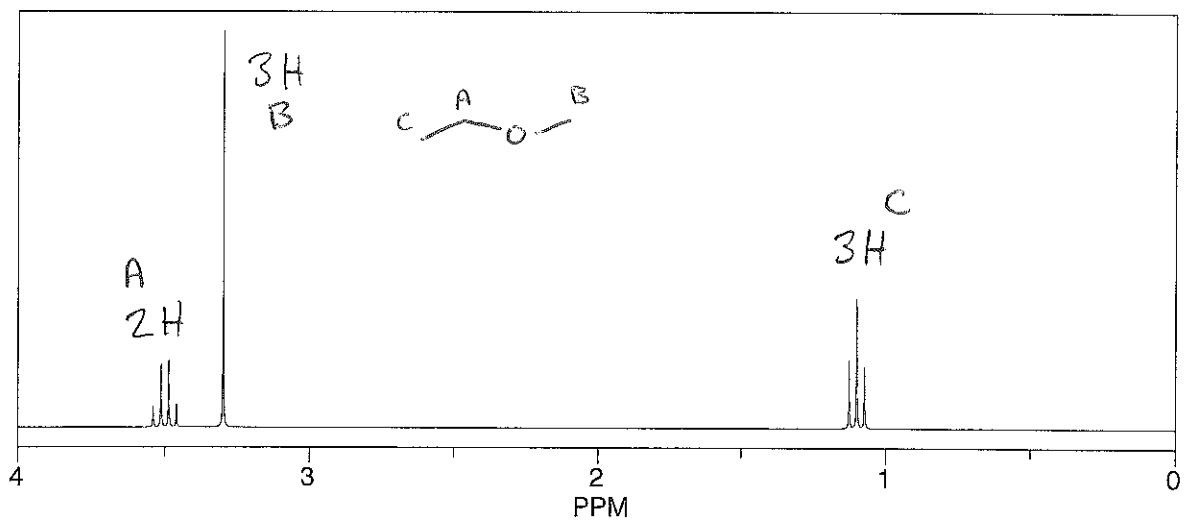
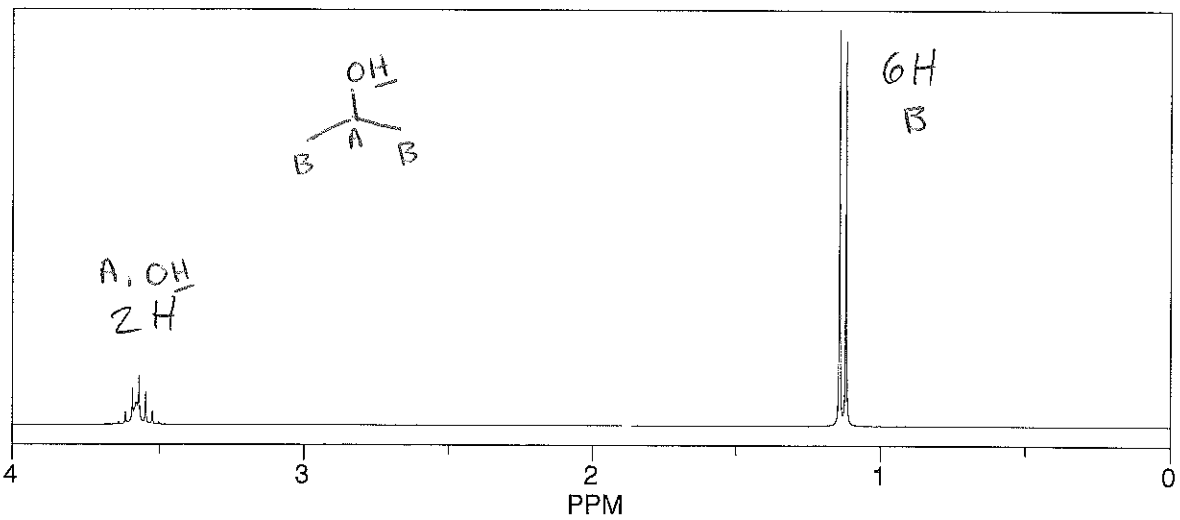
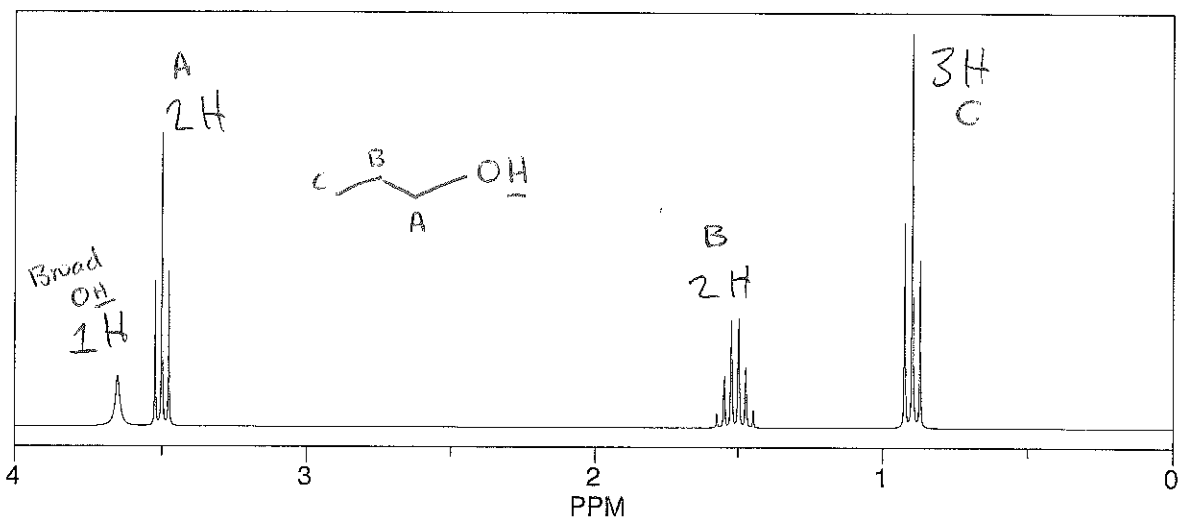
(# of signals)

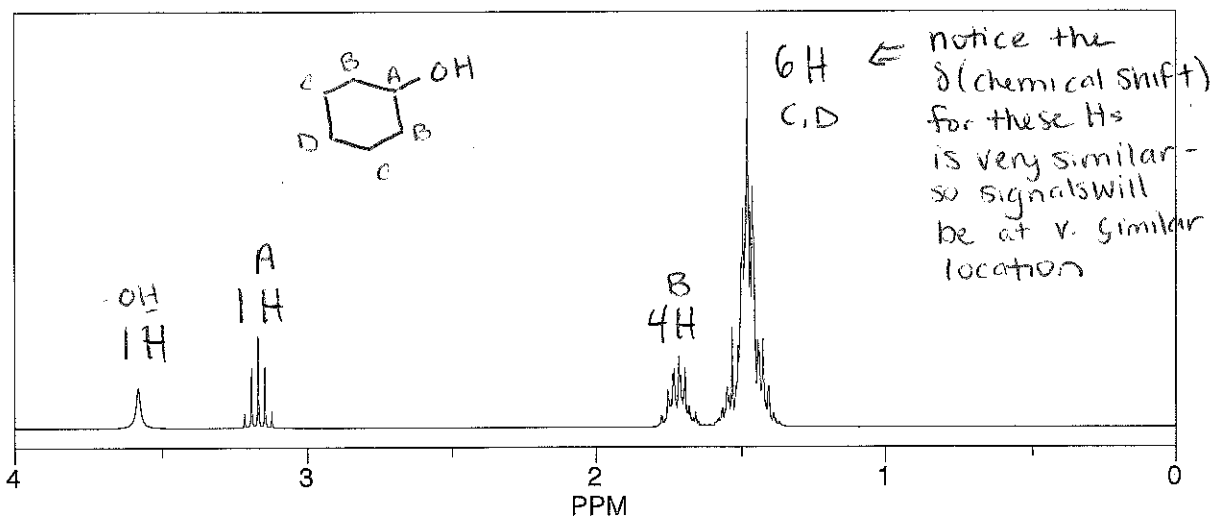
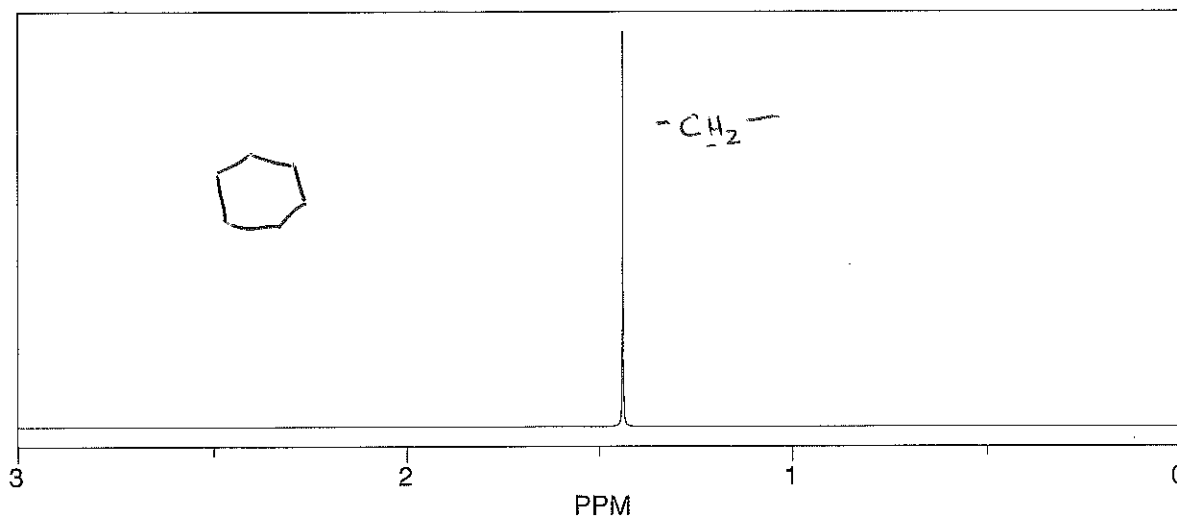
Molecule	# of Sets of Equivalent H Atoms	Ratio of Signal Integrations	Splitting Patterns	Other Notes
 $\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{OH} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	4	3:2:2:1	t, m, t, s	alcohol = broad -OCH ₂ = 3-4 ppm
 $\begin{array}{c} \text{O} \\ \\ \text{H}_3\text{C}-\text{C}-\text{O}-\text{C}-\text{C}-\text{CH}_3 \\ \quad \\ \text{H} \quad \text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	3	3:2:9	s, s, s	t-butyl group (large singlet) -OCH ₂ = 3-4 ppm
 $\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	1	-	s	symmetric
 $\begin{array}{c} \text{H} \quad \text{H} \quad \text{CH}_3 \\ \quad \quad \\ \text{H}_3\text{C}-\text{C}=\text{C}-\text{C}-\text{C}-\text{CH}_3 \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	6	3:1:2:6:1	d, m, q t, m, d	Alkene H: 5-5.7 ppm
 $\begin{array}{c} \text{H}_3\text{C} \quad \text{H} \quad \text{O} \\ \quad \quad \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{CH}_3 \quad \text{H} \end{array}$	3	9:2:1	s, d, t	t-butyl group (large singlet) Aldehyde: 9.5-10 ppm
 $\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \quad \quad \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{C}\equiv\text{C}-\text{C}-\text{C}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$	3	3:2:2 (6:4:4)	t, m, t	Symmetric alkyne
 $\begin{array}{c} \text{H}_3\text{C} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	5	1:1:4:4:2	s, m, q m, m	alcohol, broad -OCH = 3-4 ppm
 $\begin{array}{c} \text{OH} \\ \\ \text{H}_3\text{C}-\text{C}-\text{CH}_3 \\ \\ \text{H} \end{array}$	3	1:1:6	s, m, d	alcohol = broad -OCH = 3-4 ppm
 $\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{C}-\text{C}-\text{O}-\text{CH}_3 \\ \\ \text{H} \end{array}$	3	3:2:3	t, q, s	-OCH ₂ 3-4 ppm -OCH ₃ 3-4 ppm
 $\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{O}-\text{C}-\text{C}-\text{CH}_3 \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$	3	3:2:2 (6:4:4)	t, q, t	symmetric -OCH ₂ 3-4 ppm
 $\begin{array}{c} \text{O} \\ \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{C}-\text{O}-\text{CH}_3 \\ \quad \quad \\ \text{H} \quad \text{CH}_3 \quad \text{H} \end{array}$	4	6:1:2:3	d, m d, s	-O-CH ₃ = 3-4 ppm

Type of Hydrogen (R = alkyl, Ar = aryl)	Chemical Shift (δ)*	Type of Hydrogen (R = alkyl, Ar = aryl)	Chemical Shift (δ)*
R ₂ NH	0.5-5.0	RCH ₂ OH	3.4-4.0
ROH	0.5-6.0	RCH ₂ Br	3.4-3.6
RCH ₃	0.8-1.0	RCH ₂ Cl	3.6-3.8
RCH ₂ R	1.2-1.4		3.7-3.9
R ₃ CH	1.4-1.7		4.1-4.7
R ₂ C=CRCHR ₂	1.6-2.6	RCH ₂ F	4.4-4.5
RC≡CH	2.0-3.0	ArOH	4.5-4.7
	2.1-2.3	R ₂ C=CH ₂	4.6-5.0
	2.2-2.6	R ₂ C=CHR	5.0-5.7
ArCH ₃	2.2-2.5		3.3-4.0
RCH ₂ NR ₂	2.3-2.8		9.5-10.1
RCH ₂ I	3.1-3.3		10-13
RCH ₂ OR	3.3-4.0		

* Values are relative to tetramethylsilane. Other atoms within the molecule may cause the signal to appear outside these ranges.







Note: May need to multiply integrations by 2 to get full molecule.

