Chemistry 220a
Final Exam (150 pts)
Saturday, Dec. 21, 2002

Name _____

Write and sign the VU Honor Pledge:

_____
signature

This Exam is closed book and closed notes

NOTE: It is difficult for me to give you partial credit if you do not show your work!

Neatness counts

Good Luck !!

$R = 8.314 \times 10^{-3}$ KJ•mol^{-1}•°K^{-1}

$h = 6.62 \times 10^{-34}$ J•sec

$c = 3.0 \times 10^{10}$ cm • sec^{-1}

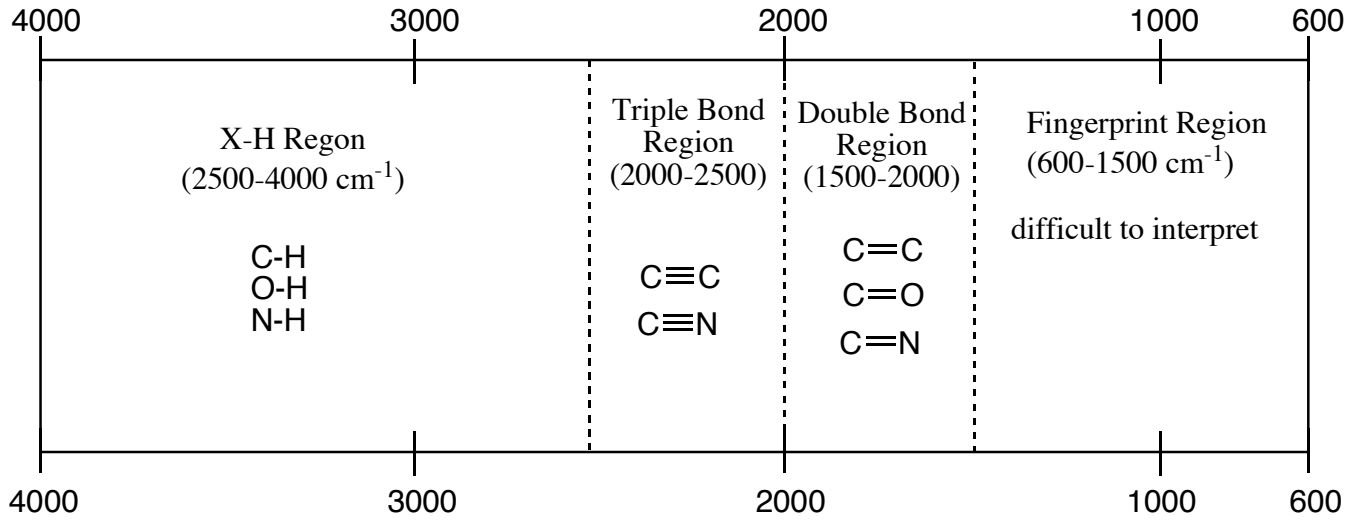
$$[\square] = \frac{\square}{c \cdot l}$$

$$E = h\square$$

$$\square = c / \square$$

$$A = \square c\, l$$

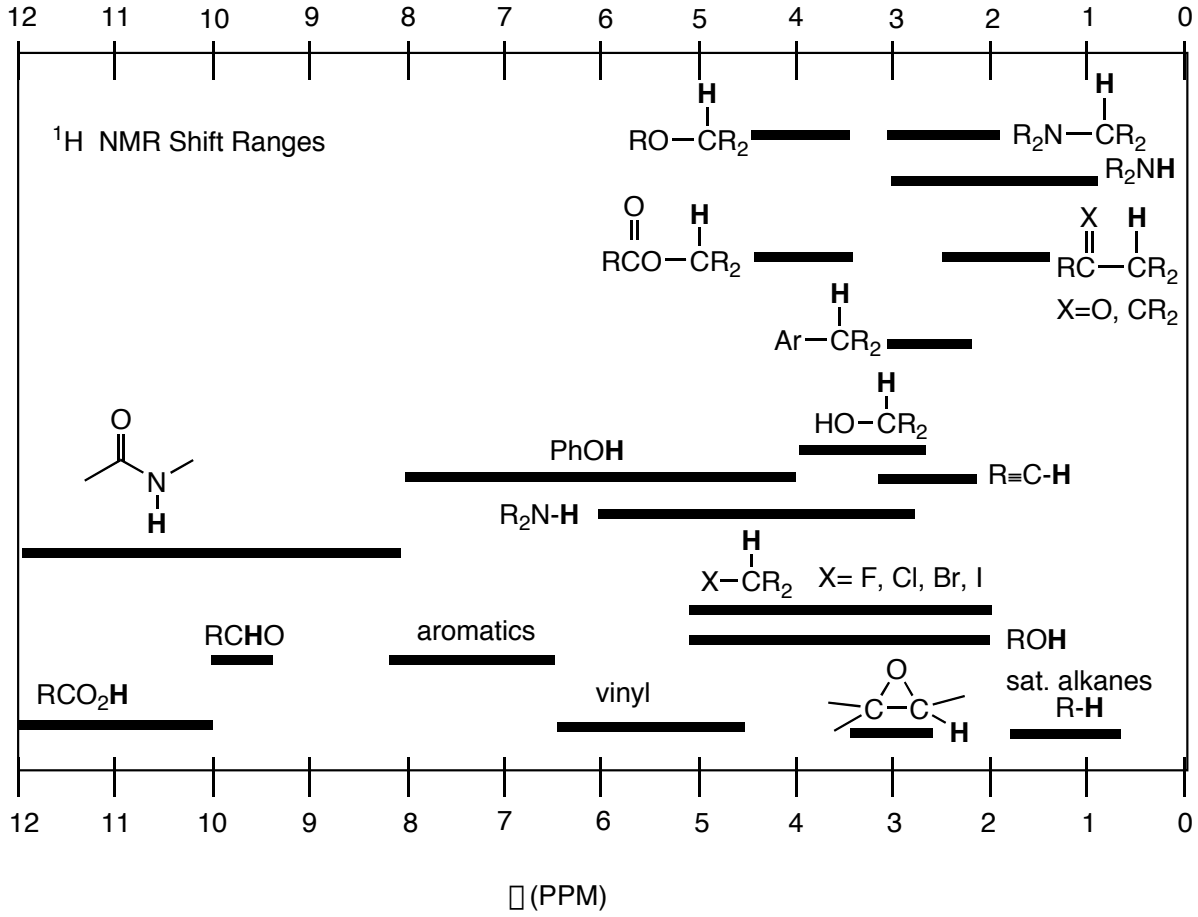
Typical IR Absorptions for Funtional Groups

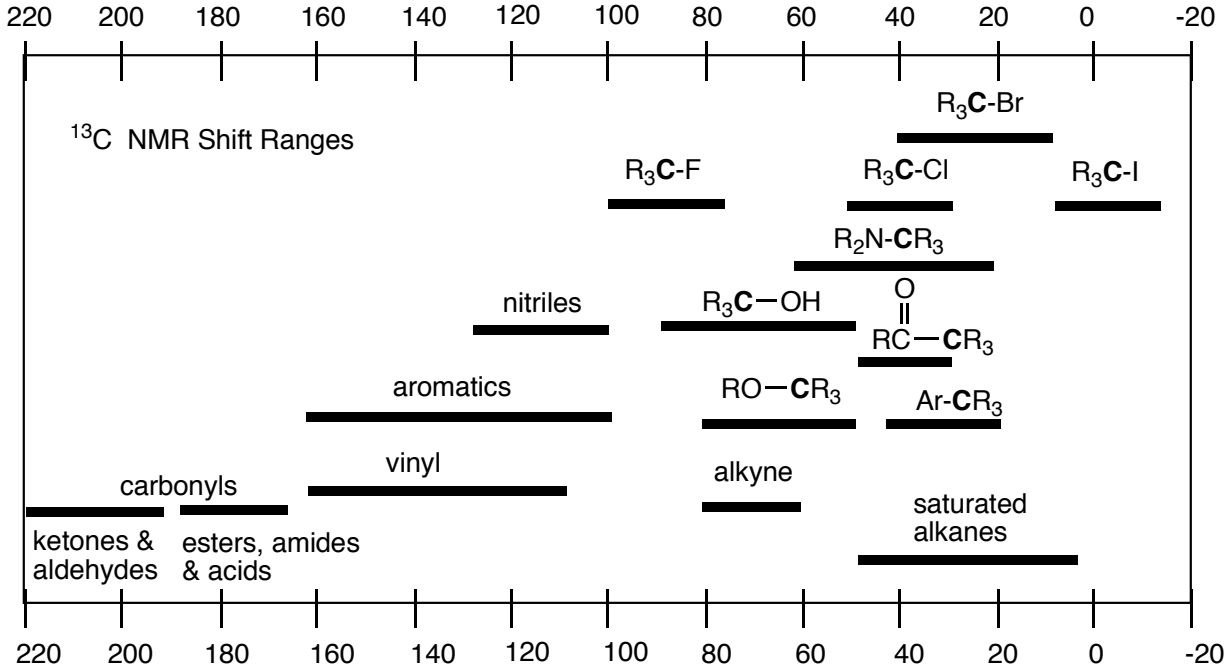


Functional Group	cm^{-1}
Alkanes, Alkyl groups	
C-H	2850-2960
Alkenes	
=C-H	3020-3150
C=C	1600-1700
Alkynes	
≡C-H	3300
C≡C	2100-2200
Alkyl Halides	
C-Cl	600-800
C-Br	500-600
C-I	500
Alcohols	
O-H	3400-3650
C-O	1050-1150
Aromatics	
=C-H	3030
	1600, 1500

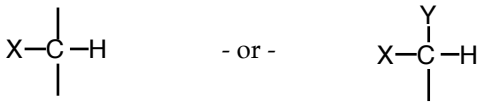
Functional Group	cm^{-1}
Amines	
N-H	3300-3500
Amide	
N-H	3180-3350
Carbonyl Group	
C=O	1650-1780
Carboxylic Acids	
O-H	2500-3100
Nitriles	
C≡N	2210-2260
Nitro Group	
$-NO_2$	1540

Approximate NMR Shift Ranges

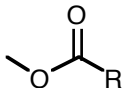
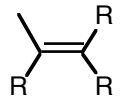
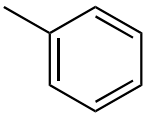
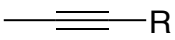
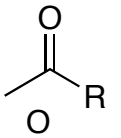
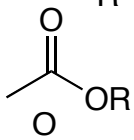
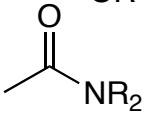




Shoolery's Additivity Rules for Predicting the Chemical Shift of Protons of the Type:



$$\delta\,(\text{ppm}) = 0.233 + \sum \sigma_i$$

Functional Group (X,Y)	σ_i **(ppm)**
-Cl	2.53
-Br	2.33
-I	1.82
-OH	2.56
-OR	2.36
-OAr	3.23
	3.13
-SR	1.64
$-NR_2$	1.57
$-CH_3$	0.47
	1.32
	1.85
	1.44
	1.70
	1.55
	1.59
$-CF_3$	1.14
-CN	1.70