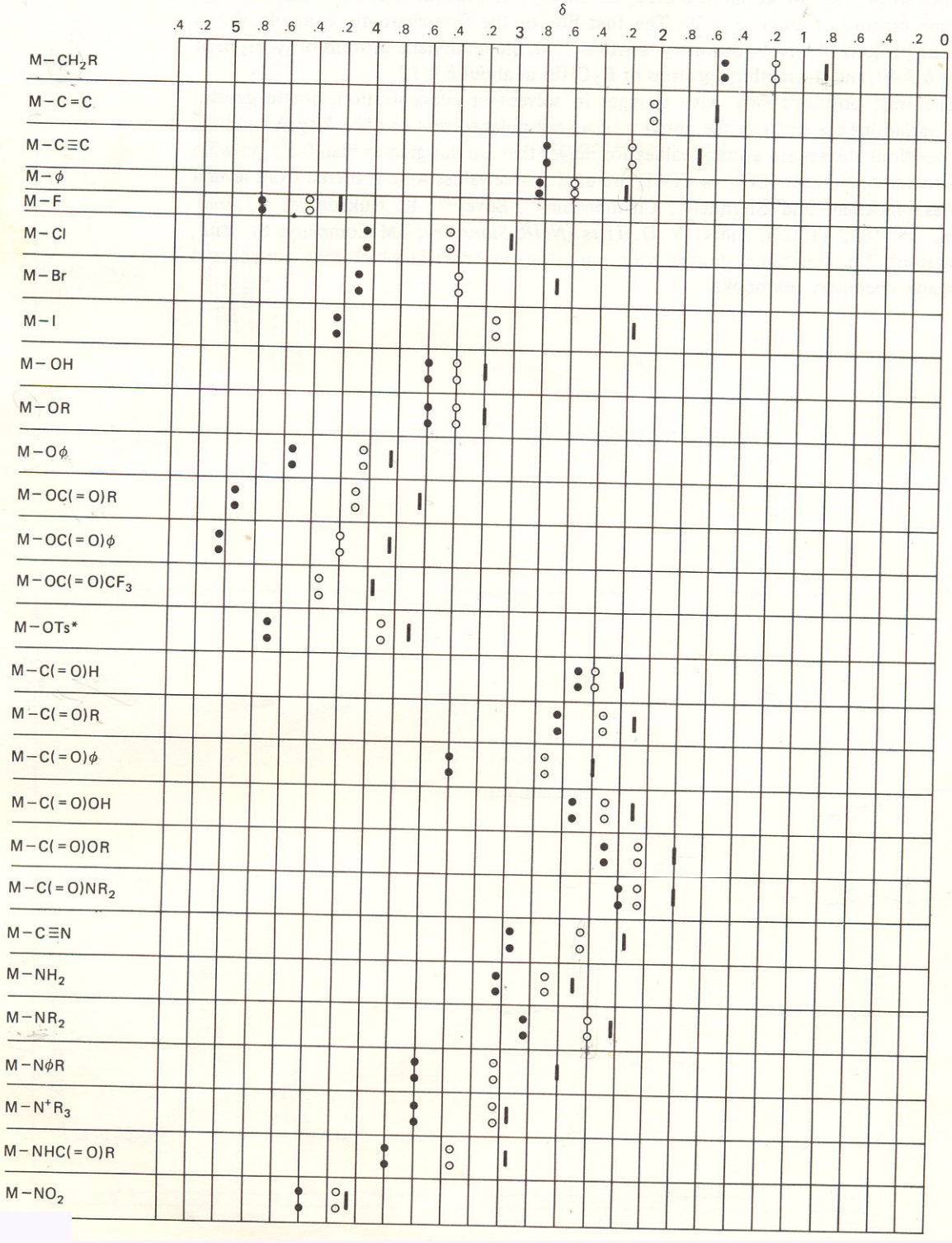
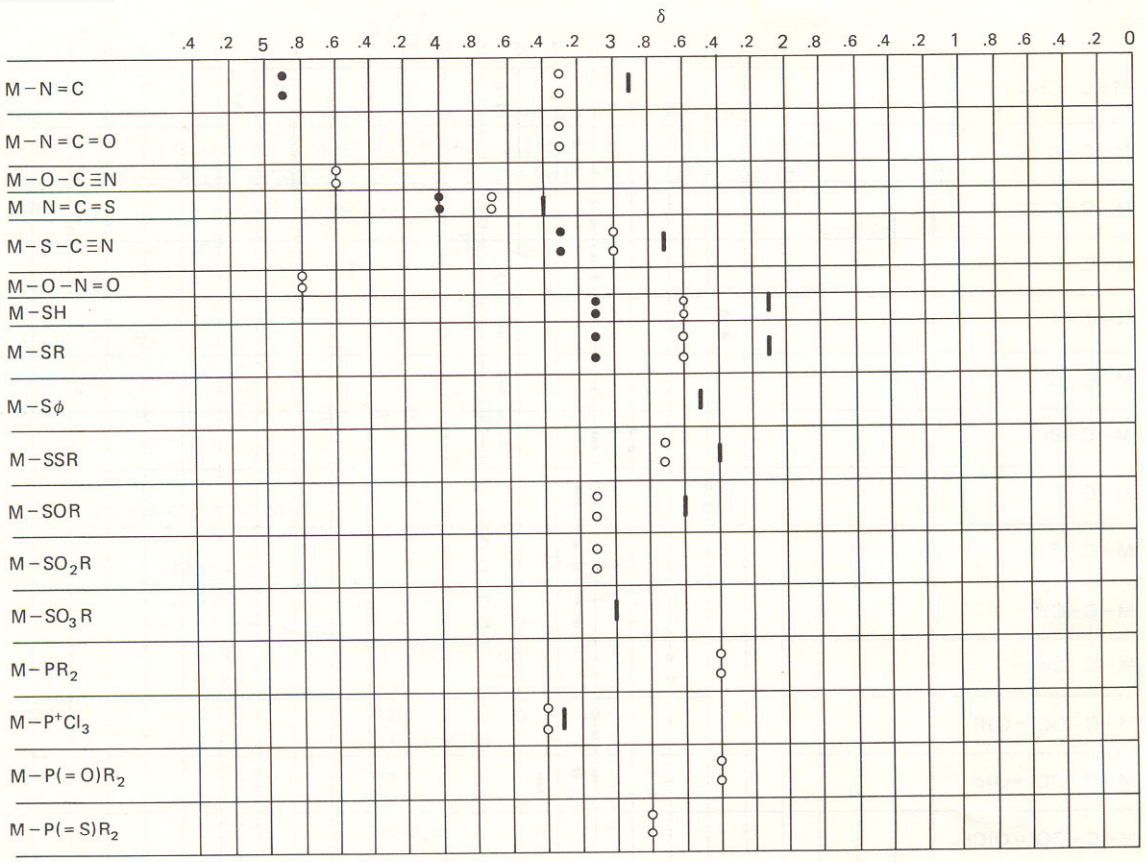
CHART 1. CHEMICAL SHIFTS OF PROTONS ON A CARBON ATOM ADJACENT (α - POSITION) TO A FUNCTIONAL GROUP IN ALIPHATIC COMPOUNDS (M—Y).

| M = methyl
| M = methylene
⋮ M = methine





*OTs is $-O_2S-C_6H_4-CH_3$

CHART 2. CHEMICAL SHIFTS OF PROTONS ON A CARBON ATOM ONCE REMOVED (β - POSITION) FROM A FUNCTIONAL GROUP IN ALIPHATIC COMPOUNDS (M—C—Y).

M is methyl
M is methylene
M is methine

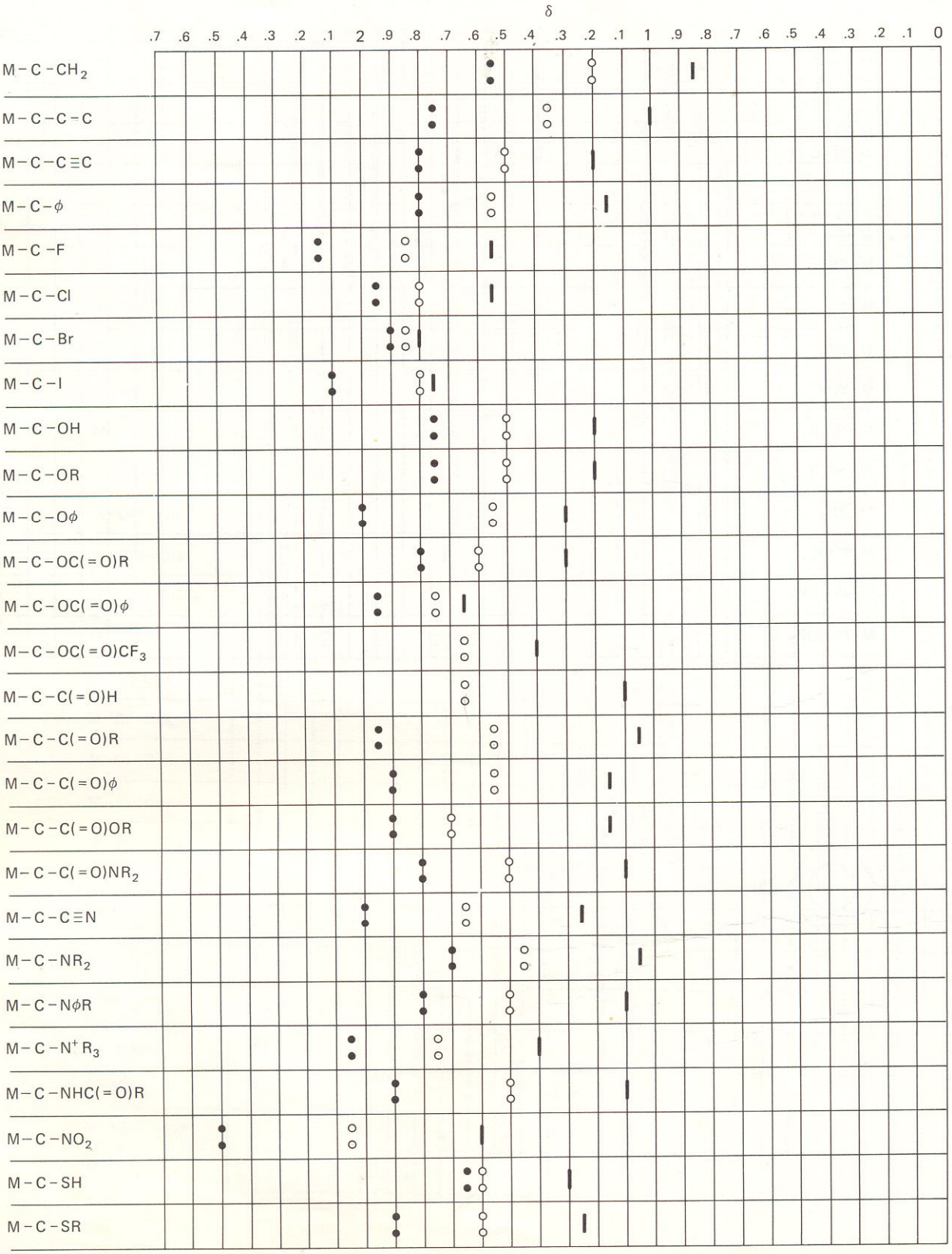
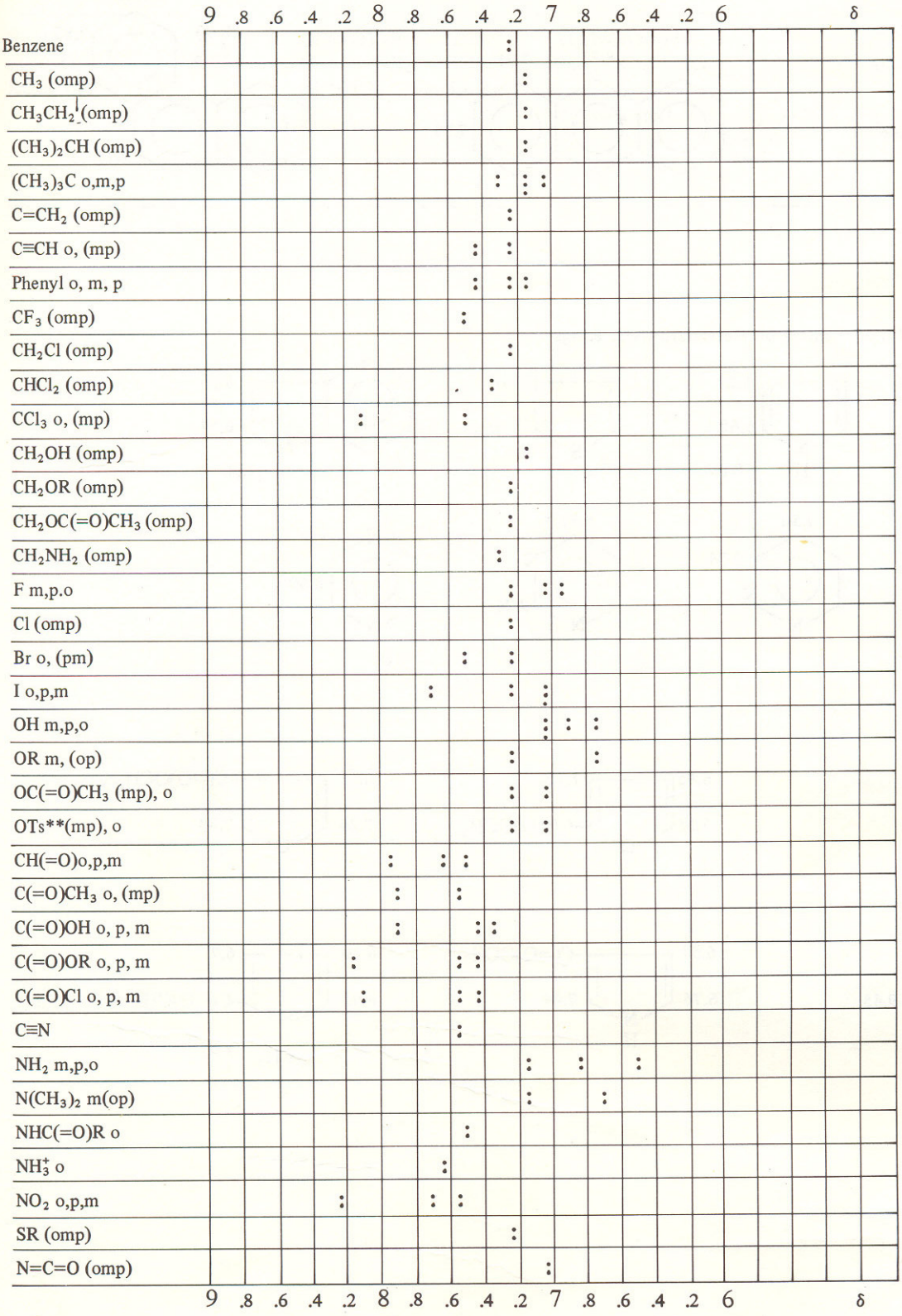


CHART 1. CHEMICAL SHIFTS FOR METHYLENE GROUPS ATTACHED TO TWO FUNCTIONAL GROUPS ($Y-CH_2-Z$).

GROUP	$-CH_3$	$-C=C$	$-C\equiv C$	$-\phi$	$-CF_2$	$-CF_3$	$-Cl$	$-Br$	$-I$	$-OH$	$-OR$	$-O\phi$	$-O(C=O)R$	$-(C=O)R$	$-(C=O)\phi$	$-(C=O)OR$	$-C(=O)NR_2$	$-C\equiv N$	$-NR_2$	$-NH(C=O)R$	$-N_3$	$-SR$
$-CH_3$	1.17	1.90 2.02	2.14	2.55	1.91	1.84	3.57 3.23	3.43 3.03	3.20 2.52	3.70 3.26	3.40 3.06	3.93	4.25 3.83	2.47 2.40	2.54	2.25 2.25	2.23 2.29	2.40	2.63 2.27	2.97	2.67	2.53 2.34
$-C=C$		2.60 2.87	3.39 2.99	3.30 3.40	2.76	2.69	4.08	3.93 3.88	3.87 3.37	4.13	3.95 3.91	4.78	4.68	3.25	3.39	3.00 3.10	3.14	3.15 3.25	3.30 3.12	3.82	3.52	3.08 3.19
$-C\equiv C$			3.11	3.52	2.88	2.81	4.09 4.20	3.90 4.00	3.49	4.28	4.03	4.90	4.71 4.80	3.37	3.51	3.22	3.26	3.37	3.50 3.24	3.97	3.67	3.31
$-\phi$				3.97 3.93	3.29	3.50 3.22	4.50 4.61	4.35 4.41	3.90	4.58	4.70 4.44	4.91 5.31	5.08 5.21	3.55 3.78	3.92	3.40 3.63	3.66	3.65 3.78	3.48 3.65	4.34	4.04	3.68 3.72
$-CF_2$					2.63	2.58	3.97	3.76	3.26	4.01 4.01	3.80	4.67	4.57	3.12	3.28	2.99	3.03	3.12	3.01	3.71	3.41	3.08
$-CF_3$						2.51	3.90	3.70	3.56 3.19	3.93	4.73	4.60	4.54	3.07	3.21	2.92	2.96	3.07	2.94	3.64	3.34	3.01
$-Cl$							4.99 5.29	5.16 5.09	4.99 4.58	5.32	5.40 5.12	5.99	5.89	4.46	4.60	4.05 4.31	4.17 4.35	4.07 4.46	4.37	5.13	4.73	4.40
$-Br$								4.94 4.89	4.38	5.12	4.92	6.36 5.79	5.69	4.26	4.40 3.40	3.70 4.11	3.92 4.15	4.26	4.13	4.83	4.53	4.20
$-I$									3.90 3.87	4.61	4.41	5.16	5.06	3.75	3.89	3.60	3.65 3.64	3.65 3.75	3.62	4.32	4.02	3.69
$-OH$										4.55 4.35	5.15	6.02	5.92	4.49	4.63	4.34	4.38	4.49	4.35	5.06	4.76	4.43
$-OR$											5.55 4.95	5.82	5.72	4.29	4.43	4.13 4.22	4.18	4.20 4.29	4.15	4.94	4.64	4.23
$-O\phi$												6.69	6.59	5.16	5.30	5.09	4.45 4.05	5.16	5.03	5.86	5.56	5.10
$-OC(=O)R$													6.46	4.42 5.10	5.20	4.91	4.95	5.10	4.92	5.63	5.37	5.00
$-C(=O)R$														3.60 3.63	3.77	3.37 3.48	3.52	3.63	3.50	4.10 4.20	3.90	3.57
$-C(=O)\phi$															3.91	3.62	3.66	3.77	3.64	4.34	4.02	3.71
$-C(=O)OR$																3.35 3.33	3.37	3.48	3.17 3.35	4.05	3.75	3.42
$-C(=O)NR_2$																	3.30 3.41	3.52	3.39	4.09	3.79	3.46
$-C\equiv N$																		3.63	3.50	4.20	3.90	3.57
$-NR_2$																			3.10 3.37	4.07	3.77	3.44
$-NHC(=O)R$																				4.75	4.45	4.14
$-N_3$																					4.15	3.84
$-SR$																						3.51

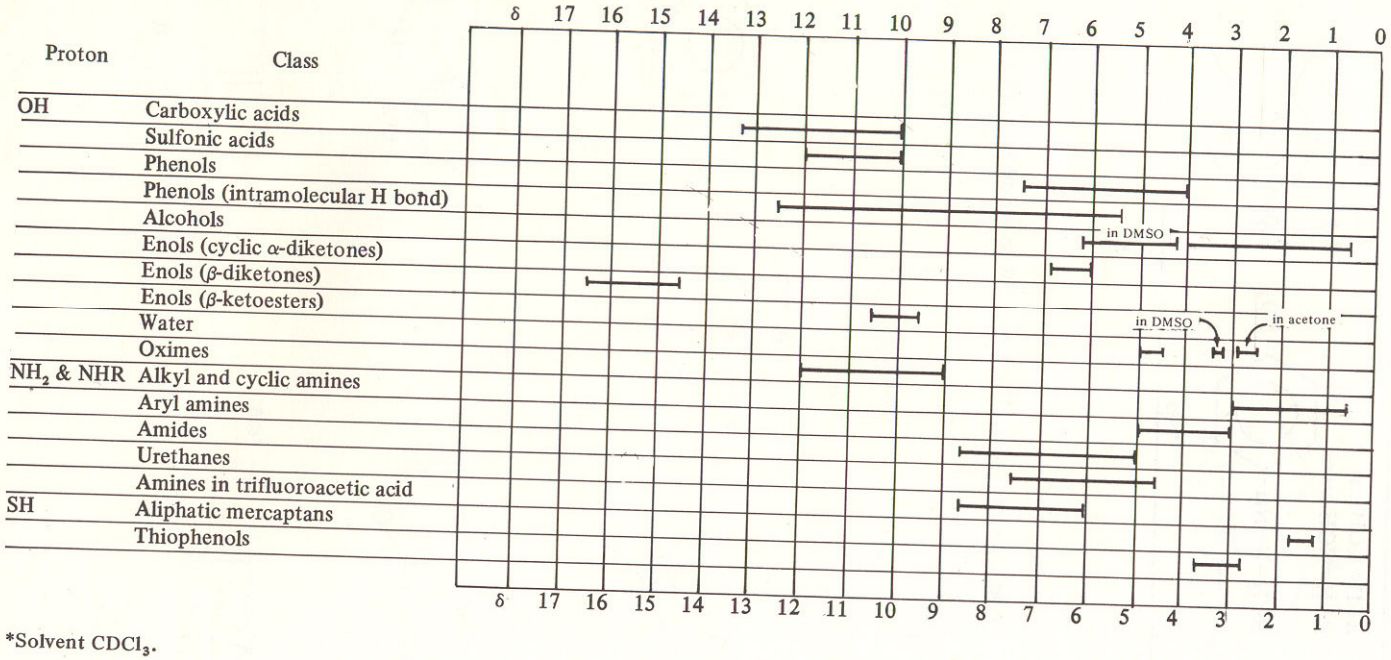
CHART 1. CHEMICAL SHIFTS OF PROTONS ON MONOSUBSTITUTED* BENZENE RINGS



*The principle of additivity can be used to calculate approximate chemical shifts for polysubstituted rings.

**OTs = *p*-toluenesulfonyloxy group

PROTONS SUBJECT TO HYDROGEN-BONDING EFFECTS (Protons on Heteroatoms)*



*Solvent $CDCl_3$.