Protective Groups in Organic Synthesis, Third Edition. Theodora W. Greene, Peter G.M. Wuts
Copyright © 1999 John Wiley & Sons, Inc.
ISBNs: 0-471-16019-9 (Hardback); 0-471-22057-4 (Electronic)

10

REACTIVITIES, REAGENTS, AND REACTIVITY CHARTS

REACTIVITIES

In the selection of a protective group, it is of paramount importance to know the reactivity of the resulting protected functionality toward various reagents and reaction conditions. The number of reagents available to the organic chemist is large; approximately 8000 reagents are reviewed in the excellent series of books by the Fiesers.[1] In an effort to assess the effect of a wide variety of standard types of reagents and reaction conditions on the different possible protected functionalities, 108 prototype reagents have been selected and grouped into 16 categories:[2]

A. Aqueous
B. Nonaqueous Bases
C. Nonaqueous Nucleophiles
D. Organometallic
E. Catalytic Reduction
F. Acidic Reduction
G. Basic or Neutral Reduction
H. Hydride Reduction
I. Lewis Acids
J. Soft Acids
K. Radical Addition

L. Oxidizing Agents
M. Thermal Reactions
N. Carbenoids
O. Miscellaneous
P. Electrophiles

These 108 reagents are used in the Reactivity Charts that have been prepared for each class of protective groups. The reagents and some of their properties are described on the following pages.

REAGENTS

A. AQUEOUS

1. pH < 1, 100°	Refluxing HBr
2. pH < 1	1 *N* HCl
3. pH 1	0.1 *N* HCl
4. pH 2–4	0.01 *N* HCl; 1–0.01 *N* HOAc
5. pH 4–6	0.1 *N* H_3BO_3; phosphate buffer; HOAc–NaOAc
6. pH 6–8.5	H_2O
7. pH 8.5–10	0.1 *N* HCO_3^-; 0.1 *N* OAc^-; satd. $CaCO_3$
8. pH 10–12	0.1 *N* CO_3^{2-}; 1–0.01 *N* NH_4OH; 0.01 *N* NaOH; satd $Ca(OH)_2$
9. pH > 12	1–0.1 *N* NaOH
10. pH > 12, 150°	

B. NONAQUEOUS BASES

11. NaH	
12. $(C_6H_5)_3CNa$	$pK_a = 32$
13. $[C_{10}H_8]^- \cdot Na^+$	$pK_a \cong 37$
14. $CH_3SOCH_2^-Na^+$	$pK_a = 35$
15. KO–*t*-C_4H_9	$pK_a = 19$
16. LiN(*i*-$C_3H_7)_2$	(LDA) $pK_a = 36$
17. Pyridine; Et_3N	$pK_a = 5; 10$
18. $NaNH_2$; NaNHR	$pK_a = 36$

C. NONAQUEOUS NUCLEOPHILES

19. $NaOCH_3/CH_3OH$, 25°	$pK_a = 16$
20. Enolate anion	$pK_a = 20$
21. NH_3; RNH_2; RNHOH	$pK_a = 10$

22. RS^-; N_3^-; SCN^-
23. OAc^-; X^- — $pK_a = 4.5$
24. NaCH, pH 12
25. HCN, cat. CN^-, pH 6 — $pK_a = 9$. For cyanohydrin formation

D. ORGANOMETALLIC

26. RLi
27. RMgX
28. Organozinc — Reformatsky reaction. Similar: R_2Cu; R_2Cd
29. Organocopper — R_2CuLi
30. Wittig; ylide — Includes sulfur ylides

E. CATALYTIC REDUCTION

31. H_2/Raney Ni
32. H_2/Pt, pH 2–4
33. H_2/Pd–C
34. H_2/Lindlar
35. H_2/Rh–C or H_2/Rh–Al_2O_3 — Avoids hydrogenolysis of benzyl ethers

F. ACIDIC REDUCTION

36. Zn/HCl
37. Zn/HOAc; $SnCl_2$/HCl
38. Cr(II), pH 5

G. BASIC OR NEUTRAL REDUCTION

39. Na// NH_3
40. Al(Hg)
41. $SnCl_2$/Py
42. H_2S or HSO_3^-

H. HYDRIDE REDUCTION

43. $LiAlH_4$
44. Li–*s*-Bu_3BH, −50° — Li-Selectride
45. $[(CH_3)_2CHCH(CH_3)]_2BH$ — Disiamylborane
46. B_2H_6, 0°
47. $NaBH_4$
48. $Zn(BH_4)_2$ — Neutral reduction
49. $NaBH_3CN$, pH 4–6
50. (*i*-$C_4H_9)_2AlH$, −60° — Dibal
51. $Li(O–t\text{-}C_4H_9)_3AlH$, 0°

I. LEWIS ACIDS (ANHYDROUS CONDITIONS)

52. $AlCl_3$, 80°	
53. $AlCl_3$, 25°	
54. $SnCl_4$, 25°; $BF_3{\cdot}Et_2O$	
55. $LiClO_4$; $MgBr_2$	For epoxide rearrangement
56. TsOH, 80°	Catalytic amount
57. TsOH, 0°	Catalytic amount

J. SOFT ACIDS

58. Hg(II)	
59. Ag(I)	
60. Cu(II)/Py	For example, for Glaser coupling

K. RADICAL ADDITION

61. HBr/initiator	"Acidic" HX addition; acidity ≅ TsOH, 0°
62. HX/initiator	Neutral HX addition; X = P, S, Se, Si
63. NBS/CCl_4, $h\nu$ or heat	Allylic bromination
64. $CHBr_3$; $BrCCl_3$; CCl_4/In·	Carbon-halogen addition

L. OXIDIZING AGENTS

65. OsO_4	
66. $KMnO_4$, 0°, pH 7	
67. O_3, −50°	
68. RCO_3H, 0°	Epoxidation of olefins; prototype for H_2O_2/H^+
69. RCO_3H, 50°	Baeyer-Villiger oxidation of hindered ketones
70. CrO_3/Py	Collins oxidation
71. CrO_3, pH 1	Jones oxidation
72. H_2O_2/OH^-, pH 10–12	
73. Quinone	Dehydrogenation
74. $^1O_2$	Singlet oxygen
75. CH_3SOCH_3, 100°	(DMSO); HCO_3^- may be added to maintain neutrality
76. NaOCl, pH 10	
77. Aq. NBS	Nonradical conditions
78. I_2	
79. C_6H_5SCl; C_6H_5SeX	
80. Cl_2; Br_2	
81. MnO_2/CH_2Cl_2	
82. $NaIO_4$, pH 5–8	
83. SeO_2, pH 2–4	
84. SeO_2/Py	In EtOH/cat. Py

85. $K_3Fe(CN)_6$, pH 7–10	Phenol coupling
86. Pb(IV), 25°	Glycol and α-hydroxy acid cleavage
87. Pb(IV), 80°	Oxidative decarboxylation
88. $Tl(NO_3)_3$, pH 2	Oxidative rearrangement of olefins

M. THERMAL REACTIONS

89. 150°	Some Cope rearrangements and Cope eliminations
90. 250°	Claisen or Cope rearrangement
91. 350°	Ester cracking; Conia "ene" reaction

N. CARBENOIDS

92. $:CCl_2$	
93. $N_2CHCO_2C_2H_5/Cu$, 80°	
94. $CH_2I_2/Zn–Cu$	Simmons–Smith addition

O. MISCELLANEOUS

95. n-Bu_3SnH/initiator	
96. $Ni(CO)_4$	
97. CH_2N_2	
98. $SOCl_2$	
99. Ac_2O, 25°	Acetylation
100. Ac_2O, 80°	Dehydration
101. DCC	Dicylohexylcarbodiimide, $C_6H_{11}N{=}C{=}NC_6H_{11}$
102. CH_3I	
103. $(CH_3)_3O^+BF_4^-$	Or CH_3OSO_2F=Magic Methyl: **SEVERE POISON**
104. 1. LiN–i-Pr_2; 2. MeI	For C-alkylation
105. 1. K_2CO_3; 2. MeI	For O-alkylation

P. ELECTROPHILES

106. RCHO	
107. RCOCl	
108. C^+ion/olefin	For cation-olefin cyclization

REACTIVITY CHARTS

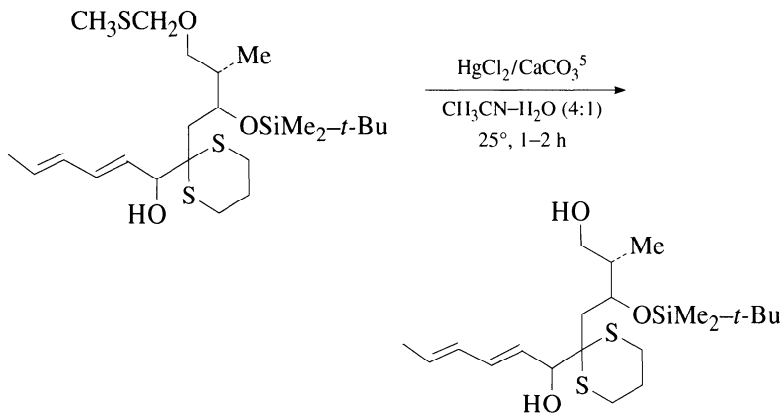
One requirement of a protective group is stability to a given reaction. The charts that follow were prepared as a guide to relative reactivities and thereby as an aid in the choice of a protective group. The reactivities in the charts were estimated

by the individual and collective efforts of a group of synthetic chemists. *It is important to realize that not all the reactivities in the charts have been determined experimentally and considerable conjecture has been exercised.* For those cases in which a literature reference was available concerning the use of a protective group and one of the 108 prototype reagents, the reactivity is printed in italic type. However, an exhaustive search for such references has not been made; therefore, the absence of italic type does not imply an experimentally unknown reactivity.

There are four levels of reactivity in the charts:

"H" (high) indicates that under the conditions of the prototype reagent, the protective group is readily removed to regenerate the original functional group.

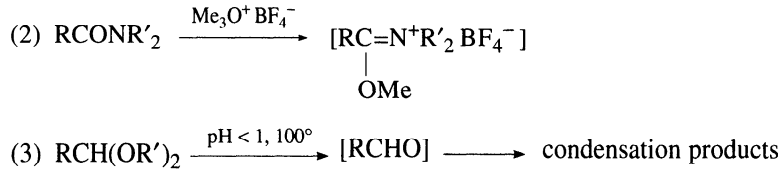
"M" (marginal) indicates that the stability of the protected functionality is marginal and depends on the exact parameters of the reaction. The protective group may be stable, may be cleaved slowly, or may be unstable to the conditions. Relative rates are always important, as illustrated in the following example[5] (in which a monothioacetal is cleaved in the presence of a dithiane), and may have to be determined experimentally.



"L" (low) indicates that the protected functionality is stable under the reaction conditions.

"R" (reacts) indicates that the protected compound reacts readily, but that the original functional group is not restored. The protective group may be changed to a new protective group (eq. 1) or to a reactive intermediate (eq. 2), or the protective group may be unstable to the reaction conditions and react further (eq. 3).

(1) $ROCOC_6H_4\text{–}p\text{-}NO_2 \xrightarrow{H_2\,/\,Pd\text{-}C} ROCOC_6H_4\text{–}p\text{-}NH_2$



The reactivities in the charts refer *only* to the protected functionality, not to atoms adjacent to the functional group; for example, RCOOEt $\xrightarrow{\text{LDA}}$: "L" (low) reactivity of PG(Et). However, if the protected functionality is $R_2CHCOOEt$, this substrate obviously *will* react with LDA. Reactivity of the entire substrate must be evaluated by the chemist.

Five reagents [#25: HCN, pH 6; #88: $Tl(NO_3)_3$; #103: $Me_3O^+ BF_4^-$; #104: LiN–*i*-Pr_2/MeI; and #105: K_2CO_3/MeI] were added after some of the charts had been completed; reactivities to these reagents are not included for all charts.

The number used to designate a protective group (PG) in a Reactivity Chart is the same as that used in the body of the text in the *first* edition.

Protective group numbers in the Reactivity Charts are not continuous, since not all of the protective groups described in the text are included in the charts. The protective groups that are included in the Reactivity Charts are, in general, those that have been used most widely; consequently, considerable experimental information is available for them.

The Reactivity Charts were prepared in collaboration with the following chemists, to whom we are most grateful: John O. Albright, Dale L. Boger, Dr. Daniel J. Brunelle, Dr. David A. Clark, Dr. Jagabandhu Das, Herbert Estreicher, Anthony L. Feliu, Dr. Frank W. Hobbs, Jr., Paul B. Hopkins, Dr. Spencer Knapp, Dr. Pierre Lavallée, John Munroe, Jay W. Ponder, Marcus A. Tius, Dr. David R. Williams, and Robert E. Wolf, Jr.

[1] L. F. Fieser and M. Fieser, *Reagents for Organic Synthesis*, Wiley-Interscience, New York, 1967, Vol. 1; M. Fieser and L. F. Fieser, Vols. 2–7, 1969–1979; M. Fieser, Vols. 8–17, 1980–1994.

[2] The categories and prototype reagents used in this study are an expansion of an earlier set of 11 categories and 60 prototype reagents,[3] originally compiled for use in LHASA[4] (Logic and Heuristics Applied to Synthetic Analysis), a long-term research program at Harvard University for Computer-Assisted Synthetic Analysis.

[3] E. J. Corey, H. W. Orf, and D. A. Pensak, *J. Am. Chem. Soc.*, **98**, 210 (1976).

[4] Selected references include E. J. Corey, *Quart. Rev., Chem. Soc.*, **25**, 455 (1971); H. W. Orf, Ph. D. Thesis, Harvard University, 1976.

[5] E. J. Corey and M.G. Bock, *Tetrahedron Lett.*, 2643 (1975).

Reactivity Chart 1. Protection for Hydroxyl Group: Ethers

1. Methyl Ether
2. Methoxymethyl Ether (MOM)
3. Methylthiomethyl Ether (MTM)
6. 2-Methoxyethoxymethyl Ether (MEM)
8. Bis(2-chloroethoxy)methyl Ether
9. Tetrahydropyranyl Ether (THP)
11. Tetrahydrothiopyranyl Ether
12. 4-Methoxytetrahydropyranyl Ether
13. 4-Methoxytetrahydrothiopyranyl Ether
15. Tetrahydrofuranyl Ether
16. Tetrahydrothiofuranyl Ether
17. 1-Ethoxyethyl Ether
18. 1-Methyl-1-methoxyethyl Ether
21. 2-(Phenylselenyl)ethyl Ether
22. *t*-Butyl Ether
23. Allyl Ether
26. Benzyl Ether
28. *o*-Nitrobenzyl Ether
35. Triphenylmethyl Ether
36. α-Naphthyldiphenylmethyl Ether
37. *p*-Methoxyphenyldiphenylmethyl Ether
41. 9-(9-Phenyl-10-oxo)anthryl Ether (Tritylone)
43. Trimethylsilyl Ether (TMS)
45. Isopropyldimethylsilyl Ether
46. *t*-Butyldimethylsilyl Ether (TBDMS)
48. *t*-Butyldiphenylsilyl Ether
51. Tribenzylsilyl Ether
53. Triisopropylsilyl Ether

(See chart, pp. 709–711.)

Reactivity Chart 1. Protection for the Hydroxyl Group: Ethers

RG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	pH<1, 100°	pH<1	pH 1	pH 2-4	pH 4-6	pH 6-8.5	pH 8.5-10	pH 10-12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^-Na^+$	$MeSOCH_2^-Na^+$	KO-t-Bu	LiN-i-Pr_2	$Py; R_3N$	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^-; N_3^-; SCN^-	OAc^-; X^-	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney (Ni)	H_2/Pt pH 2-4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
	A. AQUEOUS										B. BASIC								C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
1	H	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
2	H	H	H	M	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	H	M	L
3	H	H	M	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	R	L	R	R	R	R	M
6	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L
8	H	H	H	M	L	L	L	L	M	H	L	R	R	R	R	R	L	R	R	R	M	R	L	R	L	R	R	M	R	L	R	R	L	L	L	H	H	M
9	H	H	H	H	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	H	L	L	L	H	H	M
11	H	H	H	H	H	L	L	L	L	M	L	M	R	R	L	M	L	L	L	L	L	L	L	L		L	L	L	L	L	R	R	R	L	R	H	H	M
12	H	H	H	H	H	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L		L	L	L	L	L	L	L	L	L	L	H	H	M
13	H	H	H	H	H	H	M	L	L	M	L	L	M	L	L	L	L	L	L	L	L	L	L	L		M	L	L	L	L	R	R	L	R	R	H	H	M
15	H	H	H	H	H	H	H	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	H	H	H
16	H	H	H	M	L	L	L	L	L	M	L	M	R	R	L	M	L	L	L	L	L	L	L	L		L	L	L	L	L	R	R	L	R	R	H	H	M
17	H	H	H	H	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L		L	L	L	L	L	L	L	L	L	L	H	H	L
18	H	H	H	H	H	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L		L	L	L	L	L	L	L	L	L	L	H	H	M
21	H	H	H	H	H	H	M	L	L	M	L	R	R	R	M	R	L	R	M	L	L	L	L	L		R	L	L	L	L	R	R	L	R	R	H	H	M
22	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
23	H	H	L	L	L	L	L	L	M	R	L	L	L	L	R	L	L	L	R	L	L	L	L	L	L	L	L	L	L	L	R	R	L	R	L	L	L	L
26	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	L	L	L	L
28	H	H	L	L	L	L	L	L	H	L	R	M	R	R	L	R	L	L	L	L	L	L	L	L	M	R	R	L	R	L	R	R	L	R	R	H	H	M
35	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	H	H	L	L	L	H	H	H
36	H	H	H	H	L	L	L	L	L	M	L	L	L	H	L	L	L	L	L	L	L	L	L	L		H	H	L	L	L	H	H	H	L	L	H	H	H
37	H	H	H	H	M	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	M	R	L	L	L	L	L	L	L	L	H	H	H	L	L	H	H	M
41	H	H	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	M	R	L	L	L	H	L	R	R	L	R	R	R	R	L	R	R	R	R
43	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	H	H	H	L	L	R	L	L	H	H	L	L	H	H	H
45	H	H	H	H	H	M	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	M	M	H	L	L	H	H	M
46	H	H	H	H	H	L	L	L	L	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L
48	H	M	M	L	L	L	L	L	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L
51	H	H	H	H	L	L	L	L	H	H	H	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	H	H	L
53	H	H	H	H	H	L	L	L	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L

Reactivity Chart 1. Protection for the Hydroxyl Group: Ethers (*Continued*)

	Na/NH_3	Al(Hg)	$SnCl_2$/Py	HSO_3^-; H_2S	$LiAlH_4$	Li-s-Bu_3BH	$(C_5H_{11})_2BH$	B_2H_6, 0°	$NaBH_4$	$Zn(BH_4)_2$	$NaBH_3CN$ pH 4-6	i-Bu_2AlH	Li(OtBu)$_3$AlH	$AlCl_3$, 80°	$AlCl_3$, 25°	$SnCl_4$; BF_3	$LiClO_4$; $MgBr_2$	TsOH, 80°	TsOH, 0°	Hg(II)	Ag(I)	Cu(II)/Py	HBr/Zn·	HX/Zn·	NBS/CCl_4	Br_3CCl/Zn·	OsO_4	$KMnO_4$,pH 7,0°	O_3, -50°	RCO_3H, 0°	RCO_3H, 50°	CrO_3/Py	CrO_3, pH 1	H_2O_2 pH 10-12	Quinone	$^1O_2$	DMSO, 100°	NaOCl pH 10	aq NBS
PG	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	G.				H. HYDRIDE REDN.									I.						J.			K.				L. OXIDANTS												
1	*L*	L	L	L	*L*	L	*L*	L	*L*	L	*L*	L	L	H	H	H	L	*L*	L	L	*L*	L	L	*L*	M	L	*L*	L	*L*	*L*	L	*L*	*L*	L	*L*	L	L	*L*
2	*L*	*L*	L	L	*L*	*L*	L	L	L	L	L	*L*	L	H	H	*H*	L	H	L	*L*	L	L	H	*L*	R	L	L	*L*	R	*L*	M	*L*	*L*	L	L	L	L	R
3	*R*	L	*M*	L	L	L	L	L	L	*L*	L	*L*	L	H	H	*M*	M	M	L	H	*H*	L	M	*L*	M	M	L	R	R	R	R	L	H	L	L	R	M	R	R
6	L	L	L	L	*L*	L	L	L	L	L	L	L	L	H	H	*H*	*H*	H	*L*	L	L	L	H	*L*	R	L	*L*	L	R	L	L	*L*	M	L	L	L	L	M
8	R	M	M	L	M	L	L	L	L	L	L	M	L	H	H	H	L	H	M	L	R	L	H	*L*	R	R	L	L	R	L	M	L	H	L	L	L	L	M
9	*L*	*L*	L	L	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	L	H	H	H	*M*	*H*	*L*	*L*	*L*	*L*	H	*L*	M	L	*L*	L	*H*	*L*	*H*	*L*	H	*L*	L	L	L	L	L
11	R	L	*L*	L	L	L	L	L	L	L	L	L	L	H	M	M	L	H	L	H	*H*	L	M	*L*	M	L	L	R	R	R	R	L	H	L	L	R	M	R	R
12	L	L	L	L	*L*	L	L	L	L	L	M	L	L	H	H	H	L	H	L	L	L	L	H	*L*	M	L	L	L	R	L	*H*	L	H	L	L	L	L	L	R
13	R	L	*L*	L	L	L	L	L	L	L	M	L	L	H	H	H	L	H	L	L	L	L	H	*L*	M	L	L	R	R	*R*	R	L	H	L	L	R	M	R	R
15	L	L	L	L	*L*	L	L	L	L	L	H	L	L	H	H	H	*M*	H	L	L	L	L	H	*L*	M	L	L	L	*R*	L	H	*L*	H	L	L	L	L	L	R
16	R	L	*L*	L	L	L	L	L	L	L	L	L	L	H	M	M	L	H	L	H	*H*	L	M	*L*	M	L	L	R	R	R	R	L	H	L	L	R	M	R	R
17	L	L	L	L	*L*	*L*	L	L	L	L	L	*L*	L	H	H	H	L	H	L	L	L	L	M	*L*	R	L	L	*L*	R	*L*	H	L	H	L	L	L	L	L	M
18	L	L	L	L	*L*	L	L	L	L	L	M	L	L	H	H	*H*	M	H	M	L	L	L	H	L	M	L	L	L	L	H	R	L	R	L	L	L	L	L	M
21	*R*	*M*	L	L	*L*	L	L	L	*L*	L	L	L	L	H	M	M	L	*M*	L	L	L	L	R	*L*	*R*	L	R	R	*R*	*R*	R	R	R	R	L	R	L	L	M
22	*L*	L	L	L	*L*	L	L	L	L	L	L	L	L	H	H	H	L	H	*L*	L	L	L	M	L	L	L	L	L	*L*	*L*	L	*L*	*L*	L	L	L	L	L	L
23	H	L	L	L	L	L	R	R	L	L	L	R	L	H	H	H	L	L	L	R	L	L	R	*R*	*R*	R	R	R	R	R	R	L	M	L	L	R	L	L	R
26	*H*	L	L	L	*L*	L	*L*	*L*	L	L	L	*L*	L	H	H	*H*	L	*L*	*L*	*L*	*L*	L	R	*L*	R	L	*L*	L	*L*	*L*	L	*L*	*L*	L	L	L	L	L	L
28	R	R	L	L	R	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	R	*L*	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L
35	*H*	*M*	*H*	L	*L*	L	L	L	L	L	M	L	L	H	H	*H*	*L*	H	*H*	L	L	L	H	L	L	L	L	L	L	*L*	*H*	*L*	H	*L*	L	L	L	L	L
36	H	*M*	L	L	L	L	L	L	L	L	M	L	L	H	H	H	L	H	H	L	L	L	H	L	L	L	L	L	L	L	*H*	L	H	L	L	L	L	L	L
37	H	*M*	L	L	L	L	L	L	L	L	M	L	L	H	H	H	L	H	H	L	L	L	H	L	L	L	L	L	L	*M*	*H*	L	H	L	L	L	L	L	L
41	R	R	L	R	R	R	R	L	R	R	L	R	M	H	H	H	*M*	H	L	L	L	L	H	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L
43	H	L	*M*	H	*H*	H	*L*	H	*H*	H	H	H	H	H	M	M	L	H	L	L	L	L	H	*M*	*R*	*M*	L	H	L	*L*	H	*L*	H	H	L	L	H	H	H
45	L	L	L	L	L	L	L	L	L	L	M	L	L	H	L	L	L	H	M	L	L	L	H	*L*	M	*L*	L	L	L	L	H	L	*H*	L	L	L	L	L	L
46	*L*	*L*	L	*L*	*L*	L	*L*	L	*L*	*L*	L	*L*	*L*	H	M	*M*	L	H	*L*	*L*	*L*	L	H	*L*	M	*L*	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	L	L
48	L	L	L	L	L	L	L	L	L	L	L	*L*	L	H	L	L	L	M	L	L	L	L	L	*L*	M	*L*	L	L	L	L	L	L	*L*	M	L	L	L	*L*	L	L
51	R	*R*	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	H	L	L	L	L	R	*L*	R	*L*	L	L	L	L	L	L	H	L	L	L	L	L	L
53	L	L	L	L	L	L	L	L	L	L	L	L	L	H	M	M	L	H	L	L	L	L	H	*L*	M	*L*	L	L	L	L	L	L	H	L	L	L	L	L	L

Reactivity Chart 1. Protection for the Hydroxyl Group: Ethers (*Continued*)

PG	I_2	PhSeX; PhSCl	Br_2; Cl_2	MnO_2/CH_2Cl_2	$NaIO_4$ pH 5-8	SeO_2 pH 2-4	SeO_2/Py	$K_3Fe(CN)_6$, pH 8	Pb(IV), 25°	Pb(IV), 80°	$Tl(NO_3)_3$	150°	250°	350°	:CCl_2	N_2CHCO_2R/Cu	CH_2I_2/Zn(Cu)	R_3SnH/In·	$Ni(CO)_4$	CH_2N_2	$SOCl_2$	Ac_2O, 25°	Ac_2O, 80°	DCC	MeI	$Me_3O^+BF_4^-$	1.LDA 2.MeI	1.K_2CO_3 2.MeI	RCHO	RCOCl	C^+/olefin
	L. OXIDANTS											M.			N.			O. MISCELLANEOUS											P.		
	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
1	*L*	*L*	M	*L*	L	L	L	L	L	L	*L*	L	*L*	L	L	L	L	*L*	L	*L*	*L*	*L*	L	L	*L*	L	*L*	L	L	*L*	*L*
2	*L*	L	R	L	*L*	H	L	L	L	H	H	L	L	R	*L*	L	L	*L*	L	*L*	L	*L*	*L*	L	L	M	L	L	L	*L*	H
3	L	L	R	L	R	H	M	L	R	R	*R*	L	*M*	R	*M*	R	L	M	L	*L*	L	*L*	*L*	L	*R*	R	M	R	L	L	M
6	L	L	M	L	L	L	L	L	L	M	M	*L*	L	R	*L*	*L*	L	*L*	L	*L*	L	L	L	L	L	M	L	L	L	L	H
8	L	L	M	L	L	H	L	L	M	H		L	L	R	L	M	R	R	L	L	L	L	M	L	L	M					
9	*L*	*L*	M	*L*	*L*	H	*L*	L	M	H	H	*L*	M	*H*	L	*L*	L	*L*	L	*L*	*L*	*L*	*L*	L	*L*	M	*L*	*L*	*L*	*L*	R
11	L	L	R	L	R	H	M	M	H	H		M	M	*H*	*M*	*M*	L	M	L	L	L	L	L	L	R	R	R	R			
12	*L*	L	R	L	L	H	L	L	H	H		L	M	*H*	L	L	L	L	L	L	L	L	M	*L*	L	M					
13	L	L	R	L	R	H	M	M	R	H		L	M	*H*	*M*	*M*	L	M	L	L	L	L	M	L	R	R	R	R			
15	L	L	R	L	M	H	L	L	H	H		L	M	R	L	L	L	L	L	L	L	L	H	L	L	M					
16	L	L	R	L	R	H	M	M	H	H		*R*	R	R	*M*	*M*	L	M	L	L	L	L	L	L	R	R	R	R			
17	L	L	M	L	*L*	H	L	L	M	H		L	L	R	*L*	L	L	L	L	L	L	L	L	L	L	M					
18	L	L	M	L	M	H	L	L	M	H		L	M	R	L	L	L	L	L	L	L	L	M	L	L	M					
21	R	L	R	*R*	*R*	R	*R*	L	*R*	*R*		R	R	R	M	M	*M*	*M*	*L*	*L*	L	*L*	*L*	L	R	R					
22	L	*L*	L	*L*	L	L	L	L	L	L	M	L	R	R	L	L	*L*	L	L	L	*L*	L	L	L	L	L	L	L	L	L	H
23	M	R	R	L	L	R	R	L	L	R	R	L	R	R	R	R	R	M	M	L	L	L	*L*	L	L	M	L	L	L	L	H
26	*L*	*L*	M	L	*L*	L	*L*	L	L	L	*L*	*L*	M	R	L	L	L	*L*	L	*L*	*L*	*L*	*L*	L	*L*	M	L	L	L	L	*L*
28	L	L	*M*	L	L	L	L	L	L	L	*L*	L	M	R	L	L	L	L	L	L	L	L	L	L	L	M	M	L	L	L	L
35	L	L	L	L	L	H	L	L	L	H		*L*	M	R	L	L	L	*L*	L	L	L	L	*M*	L	*L*	L				*L*	
36	L	L	L	L	L	H	L	L	L	H		L	M	R	L	L	L	L	L	L	L	L	L	L	L	L					
37	L	L	L	L	M	H	L	L	M	H		L	M	R	L	L	L	L	L	L	L	L	*M*	*L*	L	L					
41	L	L	L	L	L	L	L	L	L	L		L	R	R	L	L	L	M	L	L	L	L	*M*	L	L	L	*L*				
43	*L*	*L*	L	L	H	H	L	*H*	*H*	H	*H*	*L*	*L*	R	L	L	*L*	*L*	L	L	L	*M*	*H*	L	L	H	M	L	*L*	*L*	L
45	L	L	L	L	M	H	L	L	H	H		L	L	R	L	L	L	L	L	L	L	L	*H*	L	L	M					
46	*L*	*L*	L	*L*	L	H	L	L	M	*L*	M	*L*	*L*	R	L	L	L	L	L	L	L	L	*M*	L	L	M	L	L	*L*	*L*	*L*
48	L	L	L	L	L	L	L	L	L	M		L	L	R	L	L	L	L	L	L	L	L	*L*	L	L	L				*L*	
51	L	L	M	L	L	H	L	L	M	H		L	L	R	L	L	L	L	L	L	L	L	*M*	L	L	L					
53	L	L	L	L	L	H	L	L	M	H		L	L	R	L	L	L	L	L	L	L	L	*M*	L	L	M					

Reactivity Chart 2. Protection for Hydroxyl Group: Esters

1. Formate Ester
3. Acetate Ester
6. Trichloroacetate Ester
10. Phenoxyacetate Ester
19. Isobutyrate Ester
22. Pivaloate Ester
23. Adamantoate Ester
27. Benzoate Ester
31. 2,4,6-Trimethylbenzoate (Mesitoate) Ester
34. Methyl Carbonate
36. 2,2,2-Trichloroethyl Carbonate
39. Allyl Carbonate
41. *p*-Nitrophenyl Carbonate
42. Benzyl Carbonate
46. *p*-Nitrobenzyl Carbonate
47. *S*-Benzyl Thiocarbonate
48. *N*-Phenylcarbamate
51. Nitrate Ester
53. 2,4-Dinitrophenylsulfenate Ester

(See chart, pp. 713–715.)

Reactivity Chart 2. Protection for the Hydroxyl Group: Esters

	pH<1, 100°	pH<1	pH 1	pH 2-4	pH 4-6	pH 6-8.5	pH 8.5-10	pH 10-12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^{-}Na^{+}$	$MeSOCH_2^{-}Na^{+}$	KO-t-Bu	LiN-i-Pr_2	Py; R_3N	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^{-}; N_3^{-}; SCN^{-}	OAc^{-}; X^{-}	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney(Ni)	H_2/Pt pH 2-4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
PG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	A. AQUEOUS										B. BASIC								C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
1	H	H	H	M	L	L	*H*	*H*	*H*	H	H	L	*H*	*H*	*H*	H	*L*	*H*	*H*	*H*	H	H	*L*	M		H	H	M	M	H	M	M	M	L	*L*	M	M	L
3	H	M	L	*L*	L	L	M	*H*	*H*	H	R	H	*H*	*H*	*H*	H	L	*R*	*H*	*R*	M	L	*L*	*H*	L	H	H	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*
6	H	M	L	L	L	L	*H*	*H*	H	H	L	H	*H*	*H*	*H*	L	*L*	L	*H*	*R*	H	H	L	*R*		H	H	H	H	L	R	R	R	L	*R*	R	R	H
10	H	M	L	L	L	L	M	*H*	H	H	M	M	*H*	*H*	*H*	H	*L*	*R*	*H*	*R*	M	H	L	*L*		H	H	L	L	L	L	L	L	L	*L*	L	L	L
19	H	M	L	L	L	L	*L*	M	*H*	H	H	H	*H*	*H*	*L*	M	*L*	*H*	*M*	*M*	M	L	L	*L*		H	H	L	L	L	L	L	L	L	*L*	L	L	L
22	H	M	L	L	L	L	L	L	M	H	L	L	*H*	*M*	*H*	L	*L*	*M*	*M*	*M*	*H*	L	L	*L*	L	*H*	M	L	L	L	L	L	L	L	*L*	L	L	L
23	H	H	L	L	L	L	L	*L*	M	H	L	L	*H*	*M*	*L*	L	*L*	*L*	*L*	*L*	L	L	L	*L*		L	L	L	L	L	L	L	L	L	*L*	L	L	L
27	H	M	L	*L*	L	L	L	M	*H*	H	L	*L*	*H*	*H*	*L*	*L*	*L*	*H*	*M*	*M*	M	*L*	*L*	*L*	L	H	H	L	L	*L*	*L*	L	L	*L*	*L*	*L*	L	L	L
31	H	M	L	L	L	L	L	L	L	H	*L*	L	*H*	*L*	*H*	L	*L*	*L*	*L*	*L*	L	L	L	*L*		L	L	L	L	L	L	L	*L*	L	*L*	L	L	L
34	H	M	L	L	L	L	L	*H*	H	H	L	L	*H*	*H*	*M*	L	*L*	*H*	*M*	*M*	M	L	*L*	*L*	M	R	R	L	H	M	R	*L*	*L*	L	*L*	R	*H*	H
36	H	*M*	*L*	L	L	L	M	H	H	H	L	H	*H*	*H*	*H*	H	*L*	*H*	*R*	*R*	M	H	*L*	*R*		R	R	L	H	M	R	*L*	*L*	L	R	H	*H*	H
39	H	M	L	L	L	L	L	H	H	H	L	H	*H*	*H*	*M*	H	*L*	*R*	*M*	*M*	M	L	L	*L*		R	R	L	H	L	R	R	R	L	*R*	L	L	L
41	H	M	L	L	L	L	H	H	H	H	L	L	*H*	*H*	*R*	L	*L*	*H*	*R*	*R*	M	L	L	*M*		R	R	M	M	M	R	R	R	L	*R*	R	R	R
42	H	M	L	L	L	L	L	H	H	H	L	H	*H*	*H*	*M*	H	*L*	*H*	*M*	*M*	M	L	L	*L*	M	R	R	L	L	L	H	H	*H*	L	*M*	L	L	L
46	H	M	L	*L*	L	L	L	H	H	H	L	H	*H*	*H*	*R*	H	*L*	*H*	*R*	*R*	M	L	*L*	*L*		R	R	L	L	L	H	H	*H*	L	*R*	R	R	*R*
47	H	*L*	L	L	L	L	L	H	H	H	L	H	*H*	*H*	*R*	H	*L*	*H*	*R*	*R*	M	L	L	*L*		R	R	M	M	H	*R*	R	R	L	*H*	L	L	L
48	H	L	*L*	L	L	L	L	L	M	H	R	H	*H*	*H*	*R*	R	*L*	*H*	*M*	*L*	M	L	L	*L*		R	R	L	L	L	L	L	L	L	*L*	L	L	L
51	H	H	M	*L*	L	L	L	L	H	H	L	L	*H*	*H*	*H*	M	*L*	*H*	*H*	*H*	*H*	M	L	*L*		H	H	M	M	M	*H*	*H*	*H*	L	*H*	H	*H*	H
53	H	M	M	*L*	L	L	L	H	*H*	H	L	L	*H*	*H*	*H*	H	*L*	*H*	*H*	*H*	H	*H*	H	*H*		M	M	*H*	*H*	*H*	*H*	H	H	L	*H*	H	H	H

Reactivity Chart 2. Protection for the Hydroxyl Group: Esters (*Continued*)

	Na/NH_3	Al(Hg)	$SnCl_2$/Py	HSO_3^-; H_2S	$LiAlH_4$	Li-s-Bu_3BH	$(C_5H_{11})_2BH$	B_2H_6, 0°	$NaBH_4$	$Zn(BH_4)_2$	$NaBH_3CN$ pH 4-6	i-Bu_2AlH	Li(OtBu)$_3$AlH	$AlCl_3$, 80°	$AlCl_3$, 25°	$SnCl_4$; BF_3	$LiClO_4$; $MgBr_2$	TsOH, 80°	TsOH, 0°	Hg(II)	Ag(I)	Cu(II)/Py	HBr/In·	HX/In·	NBS/CCl_4	Br_3CCl/In·	OsO_4	$KMnO_4$, pH 7, 0°	O_3, -50°	RCO_3H, 0°	RCO_3H, 50°	CrO_3/Py	CrO_3, pH 1	H_2O_2 pH 10-12	Quinone	$^1O_2$	DMSO, 100°	NaOCl pH 10	aq NBS
PG	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	G.				H. HYDRIDE REDN.									I.						J.			K.				L. OXIDANTS											
1	H	L	L	*L*	H	*H*	*M*	M	M	*M*	M	H	M	H	H	L	L	H	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	H	L	M	H	L
3	H	L	L	*L*	*H*	*M*	*L*	L	*L*	*L*	L	*H*	*L*	L	*L*	*L*	*L*	M	L	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	L	L	*L*	L	L
6	H	H	L	*L*	H	*H*	*L*	L	L	*M*	L	*H*	L	R	R	L	L	M	L	L	R	L	R	L	L	L	L	L	L	L	L	L	L	H	*L*	L	H	H	L
10	H	H	L	*L*	H	*M*	*L*	L	L	*L*	L	H	L	R	R	L	L	M	L	L	L	L	M	L	L	L	L	L	M	L	L	L	L	L	*L*	L	*L*	M	L
19	H	H	L	*L*	H	*L*	*L*	L	L	*L*	L	H	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
22	*H*	L	L	*L*	H	*L*	*L*	L	*L*	*L*	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
23	H	L	L	*L*	H	*L*	*L*	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
27	*H*	L	L	*L*	*H*	*L*	*L*	L	*L*	*L*	L	H	L	L	L	*L*	L	M	L	L	L	L	L	L	*L*	*L*	*L*	L	*L*	L	*L*	L	*L*	L	L	L	*L*	L	L
31	H	L	L	*L*	*H*	*L*	*L*	L	*L*	*L*	L	L	L	L	L	L	L	L	*L*	L	L	*L*	L	L	*R*	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L
34	H	L	L	*L*	H	*L*	*L*	L	L	*L*	*L*	H	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L
36	H	R	L	*L*	H	*M*	*L*	L	L	*L*	L	H	L	R	R	*L*	L	M	L	L	R	L	M	L	*L*	L	L	L	L	L	L	*L*	L	H	*L*	L	*M*	M	L
39	H	L	L	*L*	H	*L*	*H*	R	L	*L*	L	H	L	R	R	H	L	M	L	M	L	L	R	R	R	R	H	H	H	H	H	L	L	R	*L*	R	L	H	R
41	H	H	L	*L*	H	*M*	*L*	L	L	*M*	L	H	R	R	M	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	*M*	H	L
42	H	L	L	*L*	H	*L*	*L*	L	L	*L*	L	H	L	R	R	L	L	M	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	L	*L*	L	L	L	L
46	H	*R*	L	*L*	H	*L*	*L*	L	L	*L*	L	H	L	R	M	L	L	M	L	L	L	L	L	L	*R*	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L
47	H	L	L	*L*	H	*H*	*L*	L	M	*M*	L	H	M	R	M	L	L	M	L	R	M	L	L	L	L	L	L	R	R	M	R	L	R	H	*L*	L	L	H	*R*
48	H	L	L	*L*	*H*	*L*	*M*	H	L	*L*	L	H	L	R	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
51	*H*	H	H	*M*	*H*	*H*	*H*	H	R	H	H	H	H	*R*	*R*	*R*	L	M	L	L	L	L	H	H	H	H	L	L	L	*L*	L	L	M	L	L	L	L	L	L
53	H	*H*	H	H	H	*H*	*H*	H	H	*H*	H	H	H	H	H	H	L	M	L	M	M	L	R	R	R	R	L	R	R	R	R	L	R	H	L	M	H	H	H

Reactivity Chart 2. Protection for the Hydroxyl Group: Esters (*Continued*)

	I_2	PhSeX; PhSCl	Br_2; Cl_2	MnO_2/CH_2Cl_2	$NaIO_4$ pH 5-8	SeO_2 pH 2-4	SeO_2/Py	$K_3Fe(CN)_6$, pH 8	Pb(IV), 25°	Pb(IV), 80°	$Tl(NO_3)_3$	150°	250°	350°	:CCl_2	N_2CHCO_2R/Cu	$CH_2I_2/Zn(Cu)$	$R_3SnH/In\cdot$	$Ni(CO)_4$	CH_2N_2	$SOCl_2$	Ac_2O, 25°	Ac_2O, 80°	DCC	MeI	$Me_3O^+BF_4^-$	1.LDA 2.MeI	1.K_2CO_3 2.MeI	RCHO	RCOCl	C^+/olefin
PG	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
				L. OXIDANTS								M.			N.			O. MISCELLANEOUS											P.		
1	L	L	L	L	L	M	*M*	M	L	L		L	M	H	L	L	L	L	L	L	M	*L*	L	L	L						
3	L	L	*L*	*L*	*L*	*L*	*L*	L	L	*L*	*L*	*L*	M	*H*	L	*L*	L	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	*L*	R	M	L	L	L
6	L	L	L	L	L	L	L	H	L	L		M	H	H	L	L	R	*R*	*M*	*L*	L	L	L	L	L						
10	L	L	R	L	L	L	M	L	L	L		L	L	H	L	L	L	*L*	L	L	L	L	L	L	L						
19	L	L	L	L	L	L	L	L	L	L		L	M	H	L	L	L	L	L	L	L	L	L	L	L						
22	L	L	L	L	L	L	L	L	L	L	*L*	L	M	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
23	L	L	L	L	L	L	L	L	L	L		L	L	H	R	L	L	*L*	L	L	L	L	L	L	L						
27	L	L	L	L	L	L	L	L	L	L	*L*	*L*	M	H	L	L	L	*L*	L	*L*	L	*L*	L	L	L	L	L	L	L	L	L
31	L	L	L	L	L	*L*	*L*	L	L	*L*		L	M	H	L	L	L	L	L	*L*	L	*L*	L	L	L						
34	L	L	L	L	L	L	L	L	*L*	L	*L*	M	*H*	H	L	L	L	L	L	L	*L*	L	L	L	L	R	L	M	L	L	L
36	L	L	L	L	L	L	L	L	L	L	*L*	M	H	H	L	L	H	*R*	*M*	*L*	L	L	L	L	L	R	R	H	L	L	L
39	*M*	R	R	L	L	H	*H*	L	L	R		M	H	H	R	R	R	*H*	*H*	L	L	L	L	L	L						
41	L	L	L	L	L	L	*M*	L	L	L		M	H	H	L	L	L	*R*	L	L	L	L	L	L	L						
42	L	L	L	L	L	*M*	*M*	L	L	L	*L*	M	H	H	L	L	L	L	*L*	L	L	L	L	L	L	R	M	M	L	L	L
46	L	L	L	L	L	H	*H*	L	L	L		M	H	H	L	L	L	*H*	L	L	*L*	L	L	L	L						
47	M	L	H	L	L	L	L	L	L	R		M	H	H	L	L	L	*R*	L	*L*	L	*L*	*L*	L	L						
48	L	L	L	L	L	L	L	L	L	L		M	M	H	L	L	L	L	L	L	L	*R*	L	L	*L*		*R*	*L*			
51	L	L	L	L	L	L	L	L	L	L		H	H	H	L	L	L	H	L	L	H	*L*	L	*L*	L						
53	M	L	R	L	*M*	*M*	*M*	L	R	R		H	H	H	L	L	M	H	*M*	L	M	*L*	L	*L*	H						

Reactivity Chart 3. Protection for 1,2- and 1,3-Diols

1. Methylenedioxy Derivative
2. Ethylidene Acetal
6. Acetonide Derivative
11. Benzylidene Acetal
13. *p*-Methoxybenzylidene Acetal
18. Methoxymethylene Acetal
20. Dimethoxymethylenedioxy Derivative
28. Cyclic Carbonates
29. Cyclic Boronates

(See chart, pp. 717–719.)

Reactivity Chart 3. Protection for 1,2- and 1,3-Diols

PG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	pH<1, 100°	pH<1	pH 1	pH 2-4	pH 4-6	pH 6-8.5	pH 8.5-10	pH 10-12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^{\cdot-}Na^+$	$MeSOCH_2^-Na^+$	KO-t-Bu	LiN-i-Pr_2	Py; R_3N	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^-; N_3^-; SCN^-	OAc^-; X^-	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney (Ni)	H_2/Pt pH 2-4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
				A. AQUEOUS							B. BASIC								C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
1	H	H	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L		L	L	L	L	L	L	L	L	L	L	L	L
2	H	H	H	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	L	L	*L*		L	L	L	L	L	M	L	L	L	H	M	L
6	H	H	*H*	M	L	L	L	*L*	*L*	*L*	*L*	L	*L*	L	*L*	L	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*		L	*L*	L	*L*	*L*	M	*L*	L	L	H	M	*L*
11	H	H	H	*H*	L	L	L	L	*L*	M	*L*	R	L	L	L	L	L	L	*L*	L	L	L	L	L		L	L	L	*L*	L	H	*H*	H	L	H	H	L
12	H	H	H	H	M	L	L	L	L	M	L	R	L	L	L	L	L	L	L	L	L	L	L	L		L	L	L	L	L	H	H	H	L	H	H	M
18	H	H	H	*H*	*H*	L	L	L	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L		M	H	H	L	L	L	H	L	L	H	H	H
20	H	H	H	H	H	L	L	L	L	*M*	L	L	L	*M*	*L*	L	L	L	*M*	*L*	L	*L*	L	L		*M*	*H*	H	L	L	L	H	L	L	H	H	H
28	H	*L*	*L*	L	L	L	L	*H*	*H*	H	L	*H*	*H*	*H*	*L*	L	L	*H*	*M*	*H*	*L*	*L*	*L*	L	L	H	H	H	L	L	L	H	L	*L*	L	L	L
29	H	H	H	H	H	*H*	H	H	H	H	L	L	*H*	*H*	*H*	L	*L*	*H*	*H*	*H*	*L*	*L*	*L*	*H*	M	H	H	H	H	H	L	H	L	L	H	H	M

Reactivity Chart 3. Protection for 1,2- and 1,3-Diols (*Continued*)

PG	Na/NH_3 39	Al (Hg) 40	$SnCl_2$/Py 41	HSO_3^-; H_2S 42	$LiAlH_4$ 43	Li-s-Bu_3BH 44	$(C_5H_{11})_2BH$ 45	B_2H_6, 0° 46	$NaBH_4$ 47	$Zn(BH_4)_2$ 48	$NaBH_3CN$ pH 4-6 49	i-Bu_2AlH 50	Li ($OtBu)_3AlH$ 51	$AlCl_3$, 80° 52	$AlCl_3$, 25° 53	$SnCl_4$; BF_3 54	$LiClO_4$; $MgBr_2$ 55	TsOH, 80° 56	TsOH, 0° 57	Hg(II) 58	Ag(I) 59	Cu(II)/Py 60	HBr/In· 61	HX/In· 62	NBS/CCl_4 63	Br_3CCl/In· 64	OsO_4 65	$KMnO_4$, pH 7, 0° 66	O_3, -50° 67	RCO_3H, 0° 68	RCO_3H, 50° 69	CrO_3/Py 70	CrO_3, pH 1 71	H_2O_2 pH 10-12 72	Quinone 73	$^1O_2$ 74	DMSO, 100° 75	NaOCl pH 10 76	aq NBS 77
	G.				H. HYDRIDE REDN.									I.						J.				K.				L. OXIDANTS										
1	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	M	L	L	L	L	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L
2	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	L	L	L	L	L	M	L	L	L	L	L	L	R	L	L	L	L	L	L	L
6	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	L	M	L	L	L	M	L	L	L	L	L	L	L	M	L	L	L	L	L	L
11	H	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L
12	H	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	L	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L
18	L	L	L	L	R	L	L	L	L	L	M	L	L	H	H	H	H	M	R	H	L	L	L	H	L	L	L	L	M	L	L	L	L	L	L	L	M
20	L	L	L	L	R	L	L	L	L	L	L	L	L	H	H	H	H	M	R	H	L	L	L	H	L	L	L	L	M	L	L	L	L	L	L	L	M
28	H	L	L	L	H	L	L	L	L	L	L	L	L	H	H	H	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L
29	H	M	L	L	H	H	H	H	H	H	H	H	H	H	H	L	L	L	L	L	H	H	L	L	L	L	L	L	H	H	L	L	L	L	L	L	H

Reactivity Chart 3. Protection for 1,2- and 1,3-Diols (*Continued*)

PG	I_2	PhSeX; PhSCl	Br_2; Cl_2	MnO_2/CH_2Cl_2	$NaIO_4$ pH 5-8	SeO_2 pH 2-4	SeO_2/Py	$K_3Fe(CN)_6$, pH 8	Pb(IV), 25°	Pb(IV), 80°	$Tl(NO_3)_3$	150°	250°	350°	$:CCl_2$	N_2CHCO_2R/Cu	$CH_2I_2/Zn(Cu)$	$R_3SnH/In^{\cdot}$	$Ni(CO)_4$	CH_2N_2	$SOCl_2$	Ac_2O, 25°	Ac_2O, 80°	DCC	MeI	$Me_3O^+BF_4^-$	1.LDA 2.MeI	1.K_2CO_3 2.MeI	RCHO	RCOCl	C^+/olefin
	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
	L. OXIDANTS											M.			N.			O. MISCELLANEOUS											P.		
1	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	M	L	L	M	L	L	L	L	H
2	L	L	L	L	L	M	L	L	L	M		L	L	M	L	L	L	L	L	L	L	L	M	L	L	M	L				
6	L	L	L	L	L	M	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	M	L	L	M	L	L	L	L	H
11	L	L	R	L	L	H	L	L	L	M		L	M	H	L	L	L	L	L	L	L	L	M	L	L	M				L	
12	L	L	R	L	L	H	L	L	L	M		L	M	H	L	M	L	L	L	L	L	L	M	L	L	R					
18	L	L	L	L	M	H	L	L	L	H		L	M	H	L	L	L	M	R	L	L	M	R	L	L	R					
20	L	L	L	L	M	R	L	L	L	H		M	H	H	L	L	L	L	R	L	L	M	R	L	L	R					
28	L	L	L	L	L	L	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	R	L	H	L	L	L
29	L	L	L	L	H	H	L	H	H	H	H	L	H	H	L	L	L	M	L	L	M	M	H	L	L	R	L	H	L	M	H

Reactivity Chart 4. Protection for Phenols and Catechols

Phenols

1. Methyl Ether
2. Methoxymethyl Ether
3. 2-Methoxyethoxymethyl Ether
4. Methylthiomethyl Ether
6. Phenacyl Ether
7. Allyl Ether
8. Cyclohexyl Ether
9. *t*-Butyl Ether
10. Benzyl Ether
11. *o*-Nitrobenzyl Ether
12. 9-Anthrylmethyl Ether
13. 4-Picolyl Ether
15. *t*-Butyldimethylsilyl Ether
16. Aryl Acetate
17. Aryl Pivaloate
18. Aryl Benzoate
19. Aryl 9-Fluorenecarboxylate
20. Aryl Methyl Carbonate
21. Aryl 2,2,2-Trichloroethyl Carbonate
22. Aryl Vinyl Carbonate
23. Aryl Benzyl Carbonate
25. Aryl Methanesulfonate

Catechols

27. Methylenedioxy Derivative
28. Acetonide Derivative
30. Diphenylmethylenedioxy Derivative
31. Cyclic Borates
32. Cyclic Carbonates

(See chart, pp. 721–723.)

Reactivity Chart 4. Protection for Phenols and Catechols

PG	pH<1, 100°	pH<1	pH 1	pH 2-4	pH 4-6	pH 6-8.5	pH 8.5-10	pH 10-12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^-Na^+$	$MeSOCH_2^-Na^+$	KO-t-Bu	LiN-i-Pr_2	Py; R_3N	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^-; N_3^-; SCN^-	OAc^-; X^-	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney(Ni)	H_2/Pt pH 2-4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
				A. AQUEOUS							B. BASIC								C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
1	H	M	*L*	L	L	L	*L*	*L*	*L*	*L*	*L*	L	L	*L*	*L*	L	L	*L*	*L*	*L*	*L*	*H*	L	*H*	L	*L*	*L*	L	*L*	L	L	*L*	*L*	L	L	*L*	*L*	L
2	H	H	*H*	*M*	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	*L*	*L*	L	M	L	*L*	*L*	*L*	*L*	L	*L*	L	L	L	M	*L*	L	L	H	M	L
3	H	*H*	L	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	*L*	L	M	L	L	L	L	L	L
4	H	H	M	*M*	L	L	L	L	L	L	L	L	R	L	L	L	L	L	*L*	L	L	M	L	L	L	M	*L*	L	L	L	R	R	R	L	R	H	H	M
6	H	L	*L*	L	L	L	L	L	*L*	H	R	R	R	R	M	R	L	R	R	R	L	M	L	M	L	R	R	M	M	R	M	R	R	L	L	H	*H*	H
7	H	L	L	L	L	L	L	L	M	H	L	L	R	L	R	L	L	L	R	L	L	M	L	M	L	R	M	L	M	L	R	R	R	L	R	M	L	L
8	H	*H*	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	*L*	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L
9	H	*H*	*H*	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	M	L
10	H	*H*	L	L	L	L	L	*L*	*L*	L	*L*	L	R	L	L	L	L	L	L	L	L	M	L	*L*	L	M	L	L	L	H	H	*H*	L	H	*L*	L	L
11	H	*L*	L	L	L	L	L	L	*L*	R	L	R	R	R	L	R	L	R	L	L	*L*	M	L	L	L	R	R	M	R	L	H	H	H	L	H	R	R	R
12	H	M	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	*L*	*H*	L	M	L	R	M	L	L	L	H	H	H	L	H	L	L	L
13	H	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	M	L	L	L	R	M	L	L	L	H	H	H	L	H	M	L	L
15	H	H	H	H	M	L	L	L	M	H	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	H	M	M
16	H	H	H	M	L	L	*H*	H	*H*	H	R	R	R	H	R	R	L	H	H	H	*H*	M	L	H	L	R	R	L	L	L	L	M	L	L	L	L	L	L
17	H	M	L	L	L	L	L	L	*M*	H	L	L	R	M	L	L	L	M	M	M	L	M	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L
18	H	H	*H*	L	L	L	L	M	*H*	H	L	L	R	H	L	L	L	H	M	M	M	M	L	H	L	R	R	L	L	L	L	L	*L*	L	L	L	L	L
19	H	M	L	L	L	L	L	M	H	H	R	R	R	R	R	R	L	H	M	M	M	M	L	H	L	R	R	L	L	L	L	L	L	L	L	L	L	L
20	H	H	*H*	*H*	L	L	L	M	*H*	H	L	L	R	H	M	L	L	H	M	R	M	H	L	H	M	H	H	L	L	L	L	H	L	L	H	H	M
21	H	*M*	*L*	L	L	L	M	H	H	H	R	R	R	R	R	R	L	H	R	R	M	M	L	H	L	H	H	M	R	M	R	*L*	*L*	L	R	H	*H*	H
22	*H*	*M*	*L*	L	L	L	L	*H*	H	H	L	L	R	H	L	L	L	H	M	R	M	M	L	H	L	H	H	L	L	L	R	R	R	L	R	H	L	L
23	H	H	M	L	L	L	L	M	H	H	L	L	R	H	M	L	L	H	M	M	M	M	L	H	L	H	H	L	L	L	H	H	*H*	L	L	M	L	L
25	L	L	*L*	L	L	L	L	*L*	*H*	H	R	R	R	H	L	R	L	R	M	M	M	L	L	M	*L*	*H*	*M*	L	R	*M*	R	L	*L*	L	L	L	*L*	L
27	H	M	L	L	L	L	*L*	*L*	L	L	*L*	*L*	L	L	*L*	L	*L*	*L*	*L*	L	*L*	L	L	L	L	L	M	L	L	L	*L*	L	*L*	L	L	L	L	L
28	H	H	*H*	*M*	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	L	*L*	L	L	L	*L*	*L*	L	L	L	L	L	M	L	L	L	H	M	L
30	H	H	H	*H*	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	L	H	H	*H*	L	L	H	M	M
31	H	H	*H*	L	L	L	L	L	H	H	R	R	H	H	R	R	L	R	H	H	H	H	L	H	M	H	H	H	H	H	L	H	L	L	L	H	H	M
32	H	H	H	L	L	L	M	*H*	H	H	L	L	R	H	L	L	L	H	M	M	M	L	L	H	L	R	R	L	L	L	L	L	L	L	L	M	L	L

Reactivity Chart 4. Protection for Phenols and Catechols (*Continued*)

	Na/NH_3	Al(Hg)	$SnCl_2$/Py	HSO_3^-; H_2S	$LiAlH_4$	Li-n-Bu_3BH	$(C_5H_{11})_2BH$	B_2H_6, 0°	$NaBH_4$	$Zn(BH_4)_2$	$NaBH_3CN$ pH 4-6	i-Bu_2AlH	Li(OtBu)$_3$AlH	$AlCl_3$, 80°	$AlCl_3$, 25°	$SnCl_4$; BF_3	$LiClO_4$; $MgBr_2$	TsOH, 80°	TsOH, 0°	Hg(II)	Ag(I)	Cu(II)/Py	HBr/In·	HX/In·	NBS/CCl_4	Br_3CCl/In·	OsO_4	$KMnO_4$, pH 7, 0°	O_3, -50°	RCO_3H, 0°	RCO_3H, 50°	CrO_3/Py	CrO_3, pH 1	H_2O_2 pH 10-12	Quinone	$^1O_2$	DMSO, 100°	NaOCl pH 10	aq NBS
PG	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	G.				H. HYDRIDE REDN.									I.						J.			K.				L. OXIDANTS												
1	*R*	*L*	L	*L*	*L*	*L*	L	L	*L*	L	*L*	*L*	*L*	*H*	M	L	L	*L*	L	*L*	*L*	*L*	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	L	*L*	L	L	L	L	L	L
2	R	L	L	L	*L*	L	L	*L*	L	L	L	L	L	H	H	H	M	H	L	L	L	L	H	L	R	L	L	L	L	L	*L*	R	L	L	L	L	L	L
3	R	L	L	L	L	*L*	L	L	*L*	L	L	L	L	H	M	L	L	H	L	L	L	L	M	L	R	L	*L*	L	L	L	L	M	L	L	L	L	L	L
4	R	L	L	L	*L*	L	L	L	L	L	L	M	L	H	H	M	L	M	L	H	M	L	*H*	L	R	L	L	R	R	R	R	L	R	L	L	R	L	R	R
6	R	R	L	L	R	R	R	R	R	R	R	R	R	H	H	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L
7	R	L	L	L	L	L	R	R	L	L	L	L	L	H	H	L	L	L	L	R	L	L	R	R	R	R	R	R	R	R	R	L	L	L	L	R	L	L	R
8	R	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	M	L	L	*L*	L	L	L	*L*	L	L	L	L	L	L	L	L	L
9	R	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	H	L	L	L	L	M	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L
10	R	L	L	L	L	L	L	L	*L*	L	L	L	L	H	M	L	L	L	L	L	L	L	R	R	R	R	*L*	L	L	L	M	L	L	*L*	L	L	L	L	L
11	R	R	L	L	R	R	L	L	L	L	L	R	L	H	M	L	L	L	L	L	L	L	M	M	M	M	L	L	L	L	M	L	L	L	L	L	L	L	L
12	R	L	L	L	L	L	L	L	L	L	L	L	L	H	M	L	L	M	L	L	L	L	R	R	R	R	L	L	L	L	M	L	L	L	L	L	L	L	L
13	R	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	M	L	L	L	L	R	R	R	R	L	R	R	R	R	L	M	L	L	L	L	L	L
15	R	L	L	L	L	L	L	L	L	L	M	M	L	H	M	L	L	H	L	L	L	L	H	L	L	L	L	L	L	L	M	L	R	L	L	L	L	L	L
16	R	L	L	L	*H*	H	L	L	*M*	L	L	H	M	*R*	*R*	M	L	H	L	L	L	L	*L*	L	*L*	*L*	L	L	L	L	L	L	*L*	H	L	L	L	H	L
17	R	L	L	L	H	L	L	L	L	L	L	M	L	R	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
18	R	L	L	L	H	M	L	L	L	L	L	H	M	R	R	M	L	H	L	L	L	L	*L*	L	L	*L*	L	L	L	L	L	L	L	H	L	L	L	M	L
19	R	L	L	L	H	H	L	L	L	L	L	H	M	H	H	L	L	H	L	L	L	L	R	L	R	L	L	L	L	L	L	L	L	M	L	L	L	M	L
20	R	L	L	L	H	L	L	L	L	L	M	H	M	H	H	L	L	H	M	L	L	L	H	L	L	L	L	*L*	L	L	L	L	H	M	L	L	L	M	L
21	R	M	L	L	H	M	L	L	M	L	L	H	M	H	H	L	L	H	L	L	R	L	M	L	L	*L*	L	L	L	L	L	*L*	*L*	R	L	L	L	R	L
22	R	L	L	L	H	L	R	R	L	L	L	H	M	H	H	L	L	H	L	H	L	L	R	R	R	R	R	R	R	R	R	L	R	R	L	R	L	R	R
23	R	L	L	L	H	L	L	L	L	L	L	H	M	H	H	L	L	H	L	L	L	L	M	L	R	L	L	L	L	L	M	L	M	M	L	L	L	L	L
25	*R*	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
27	R	L	L	L	*L*	L	L	*L*	*L*	L	L	*L*	L	*H*	*H*	L	L	M	*L*	L	*L*	L	M	L	R	L	*L*	L	L	L	*L*	M	*L*	L	L	*L*	L	L	L
28	R	L	L	L	L	L	L	L	L	L	M	L	L	H	H	M	L	M	L	L	L	L	H	L	*L*	L	L	L	L	L	L	R	L	L	L	L	L	L
30	R	M	L	L	L	L	L	L	L	L	L	L	L	H	H	M	L	M	L	L	L	L	H	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L
31	R	M	L	L	H	H	H	H	H	H	H	H	H	H	H	H	L	H	L	*L*	*L*	*L*	H	L	L	L	L	L	R	L	L	L	R	L	L	L	L	L	L
32	R	L	L	L	H	L	L	L	L	L	L	H	M	H	H	L	L	H	L	L	L	I	H	L	L	L	L	L	L	L	L	L	R	R	L	L	L	M	L

Reactivity Chart 4. Protection for Phenols and Catechols (*Continued*)

	I_2	PhSeX; PhSCl	Br_2; Cl_2	MnO_2/CH_2Cl_2	$NaIO_4$ pH 5-8	SeO_2 pH 2-4	SeO_2/Py	$K_3Fe(CN)_6$, pH 8	Pb(IV), 25°	Pb(IV), 80°	$Tl(NO_3)_3$	150°	250°	350°	:CCl_2	N_2CHCO_2R/Cu	CH_2I_2/Zn(Cu)	R_3SnH/In·	$Ni(CO)_4$	CH_2N_2	$SOCl_2$	Ac_2O, 25°	Ac_2O, 80°	DCC	MeI	$Me_3O^+BF_4^-$	1.LDA 2.MeI	1.K_2CO_3 2.MeI	RCHO	RCOCl	C^+/olefin
PG	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
				L. OXIDANTS									M.			N.						O. MISCELLANEOUS								P.	
1	*L*	*L*	*L*	*L*	*L*	L	L	*L*	L	*L*	*L*	L	L	*L*	L	L	*L*	L	L	*L*	*L*	*L*	L	L	*L*	*L*	L	*L*	*L*	*L*	*L*
2	L	L	L	L	L	M	L	L	M	R	R	L	M	H	L	L	L	L	L	*L*	L	*L*	L	L	L	L	L	*L*	L	L	H
3	L	L	L	L	*L*	L	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	L	L
4	L	L	R	L	R	M	L	L	R	R	R	L	M	H	M	R	L	M	L	L	L	L	L	L	R	R	L	L	L	L	M
6	L	M	M	L	L	R	L	L	M	R	R	L	L	M	R	R	L	L	L	L	L	L	L	L	L	M	R	M	L	L	L
7	L	R	R	L	L	H	M	L	L	R	R	M	R	R	R	R	R	M	M	L	L	L	L	L	L	M	L	L	L	L	R
8	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
9	L	L	L	L	L	L	L	L	L	M	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H
10	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	*L*	L	L	L	L	*L*	L
11	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
12	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
13	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	R	R	L	L	L	L	L
15	L	L	L	L	L	M	L	L	M	R	R	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L
16	L	L	L	L	L	M	L	R	L	*L*	M	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	R	H	L	L	L
17	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
18	L	L	L	L	L	L	L	L	L	L	L	L	*L*	M	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L
19	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	R	M	L	L	L
20	L	L	L	L	L	H	L	L	L	M	R	L	M	H	L	L	L	L	L	L	*L*	L	L	L	*L*	R	L	M	L	L	M
21	L	L	L	L	L	L	L	M	L	L	L	L	M	H	L	L	R	R	M	L	L	L	L	L	L	M	R	H	L	L	L
22	M	R	R	L	L	L	L	L	M	R	R	L	M	H	R	R	R	R	R	L	L	L	L	L	L	R	L	H	L	L	R
23	L	L	L	L	L	L	L	L	L	L	*R*	L	M	H	L	L	L	L	L	L	L	L	L	L	L	R	L	M	L	L	L
25	L	L	L	L	L	L	L	L	L	*L*	*L*	M	L	L	L	L	L	L	L	L	L	L	*L*	L	L	L	R	L	L	L	L
27	*L*	L	*L*	*L*	*L*	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	*L*	M	*L*	L	L	*L*	L	L	L	*L*	L	*L*
28	L	L	L	L	L	M	L	L	L	M	M	L	*L*	H	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	M
30	L	L	L	L	L	R	L	L	L	R	R	L	M	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M
31	L	L	L	L	L	L	L	L	L	R	R	L	M	H	L	L	L	*L*	L	*L*	R	R	R	L	R	R	R	R	R	R	H
32	L	L	L	L	L	*L*	L	M	L	L	M	L	L	M	L	L	L	L	L	*L*	L	L	L	L	L	R	L	L	L	L	L

Reactivity Chart 5. Protection for the Carbonyl Group

1. Dimethyl Acetals and Ketals
3. Bis(2,2,2-trichloroethyl) Acetals and Ketals
5. 1,3-Dioxanes
6. 5-Methylene-1,3-dioxanes
7. 5,5-Dibromo-1,3-dioxanes
8. 1,3-Dioxolanes
9. 4-Bromomethyl-1,3-dioxolanes
10. 4-*o*-Nitrophenyl-1,3-dioxolanes
11. *S,S'*-Dimethyl Acetals and Ketals
19. 1,3-Dithianes
20. 1,3-Dithiolanes
24. 1,3-Oxathiolanes
26. *O*-Trimethylsilyl Cyanohydrins
29. *N,N*-Dimethylhydrazones
30. 2,4-Dinitrophenylhydrazones
33. *O*-Phenylthiomethyl Oximes
34. Substituted Methylene Derivatives
43. Bismethylenedioxy Derivatives

(See chart, pp. 725–727.)

Reactivity Chart 5. Protection for the Carbonyl Group

	pH<1, 100°	pH<1	pH 1	pH 2-4	pH 4-6	pH 6-8.5	pH 8.5-10	pH 10-12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^-Na^+$	$MeSOCH_2^-Na^+$	KO-t-Bu	LiN-i-Pr_2	Py; R_3N	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^-; N_3^-; SCN^-	OAc^-; X^-	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney(Ni)	H_2/Pt pH 2-4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
PG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	A. AQUEOUS										B. BASIC								C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
1	H	*H*	*H*	L	*L*	L	L	L	*L*	L	*L*	L	L	L	*L*	*L*	L	L	*L*	*L*	*L*	*L*	L	*L*		*L*	*L*	L	*L*	*L*	L	L	*L*	*L*	*L*	H	H	L
3	H	H	H	L	L	L	L	L	M	R	R	R	H	R	R	R	L	R	R	R	*M*	R	R	R		R	R	R	R	R	R	R	R	*M*	H	R	M
5	H	H	*H*	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L		L	L	L	L	L	L	M	L	L	L	H	H	M
6	H	H	H	L	L	L	L	L	L	R	L	*L*	H	R	R	L	L	L	L	L	L	L	L	L		*L*	L	L	L	L	R	R	R	*L*	*R*	H	H	M
7	H	H	H	L	L	L	L	M	R	R	R	R	H	R	R	*R*	L	R	R	R	M	R	R	R		R	R	R	R	R	R	R	R	L	*M*	H	R	M
8	H	H	*H*	M	L	L	*L*	*L*	*L*	*L*	*L*	L	L	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*		*L*	*L*	L	*L*	*L*	*L*	*R*	L	*L*	*L*	H	*L*	L
9	H	H	H	M	L	L	L	L	R	R	R	R	H	R	R	R	L	R	R	R	*L*	R	R	R		*L*	R	R	M	L	R	R	R	L	L	H	H	M
10	H	H	H	M	L	L	L	L	L	H	L	*M*	H	H	L	R	L	*M*	L	M	L	L	L	L		R	R	*M*	R	L	R	R	R	*M*	*R*	H	R	R
11	R	R	L	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	*L*	L	*L*	L	L	L		*L*	L	L	L	L	R	R	R	*H*	*R*	L	L	L
19	R	M	*L*	*L*	L	L	L	L	*L*	L	*L*	L	L	L	*L*	*L*	*L*	L	*L*	*L*	*L*	L	L	L		*L*	*L*	L	L	*L*	*R*	R	R	*H*	*R*	L	L	L
20	R	*R*	L	L	L	L	L	L	*L*	*H*	L	L	L	L	*L*	L	*L*	L	*L*	L	*L*	L	*L*	L		*L*	L	L	L	*L*	*R*	R	*L*	*H*	*R*	L	L	L
24	H	H	*H*	*H*	L	L	*L*	L	L	R	L	L	L	L	L	L	L	L	L	L	L	L	*L*	*L*		L	*L*	L	L	L	*R*	R	R	*H*	*R*	H	M	L
26	H	H	H	*H*	H	*H*	H	*H*	H	H	L	L	R	R	M	*L*	L	R	H	*L*	L	H	*L*	L		M	M	H	L	R	R	R	R	L	R	H	R	R
29	H	L	L	L	L	L	L	L	L	H	L	L	*M*	L	L	*R*	L	L	L	*L*	*R*	L	L	L		*L*	L	L	L	L	R	R	R	L	R	H	H	M
30	H	*L*	L	L	L	L	L	L	L	*H*	R	R	R	R	R	R	L	R	M	M	L	L	L	L		R	R	R	L	R	R	R	R	L	R	R	*R*	*R*
33	H	H	M	L	L	L	L	L	L	R	L	R	*H*	L	L	M	L	L	*L*	L	L	L	L	L		R	L	L	L	L	R	R	R	L	R	R	R	M
34	R	M	*L*	L	L	L	L	L	H	H	*H*	*H*	R	R	R	R	L	R	H	R	M	L	L	L		R	R	R	R	R	R	R	*L*	L	R	M	M	M
43	*H*	H	M	M	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	*L*	L	*L*	L	L	L		L	*L*	L	L	L	*L*	L	L	L	L	H	H	L

Reactivity Chart 5. Protection for the Carbonyl Group (*Continued*)

	Na/NH_3	Al(Hg)	$SnCl_2$/Py	HSO_3^-; H_2S	$LiAlH_4$	Li-s-Bu_3BH	$(C_5H_{11})_2BH$	B_2H_6, 0°	$NaBH_4$	$Zn(BH_4)_2$	$NaBH_3CN$ pH 4-6	i-Bu_2AlH	Li(OtBu)$_3$AlH	$AlCl_3$, 80°	$AlCl_3$, 25°	$SnCl_4$; BF_3	$LiClO_4$; $MgBr_2$	TsOH, 80°	TsOH, 0°	Hg(II)	Ag(I)	Cu(II)/Py	HBr/In·	HX/In·	NBS/CCl_4	Br_3CCl/In·	OsO_4	$KMnO_4$,pH 7,0°	O_3, -50°	RCO_3H, 0°	RCO_3H, 50°	CrO_3/Py	CrO_3, pH 1	H_2O_2 pH 10-12	Quinone	$^1O_2$	DMSO, 100°	NaOCl pH 10	aq NBS
PG	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	G.				H. HYDRIDE REDN.									I.						J.			K.				L. OXIDANTS											
1	*L*	*L*	L	L	*L*	L	L	*M*	*L*	L	L	*L*	L	H	*R*	*H*	L	*H*	*M*	*L*	L	L	H	L	L	L	*L*	L	*L*	L	L	L	*H*	L	L	L	L	L	L
3	R	M	L	L	R	*L*	L	M	*L*	*L*	*L*	L	L	H	H	H	L	H	*M*	L	R	L	R	R	R	R	L	L	L	L	L	L	H	L	L	L	*H*	L	L
5	L	L	L	L	L	L	L	*M*	L	L	L	L	L	H	H	H	L	L	*L*	L	L	L	H	L	L	L	*L*	L	L	*L*	L	L	M	L	L	L	L	L	L
6	R	L	L	L	*L*	L	R	R	*L*	L	L	L	L	H	H	H	L	H	*M*	R	L	L	H	R	H	R	*R*	R	R	*R*	R	L	H	L	L	M	L	L	R
7	R	H	M	L	R	*L*	L	*L*	*L*	*L*	*L*	M	M	H	H	H	L	L	*L*	L	R	L	H	H	H	H	L	L	L	L	L	L	H	*L*	L	L	*H*	L	L
8	*L*	*L*	L	*L*	*L*	*L*	L	*M*	*L*	*L*	L	*L*	*L*	H	*H*	H	*L*	*L*	*L*	*L*	*L*	L	H	L	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	*H*	*L*	L	L	*L*	L	*L*
9	L	H	L	L	M	*L*	L	M	*L*	L	L	L	L	H	H	H	L	L	*L*	L	R	L	H	H	L	L	L	*L*	L	L	L	L	*L*	L	L	L	L	R	L	L
10	R	R	L	L	R	R	L	M	L	L	L	L	*L*	H	H	H	L	L	*L*	L	L	L	H	H	L	L	H	L	L	L	L	L	H	L	L	L	L	L	L
11	*R*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	H	L	L	L	L	L	*H*	H	H	H	L	L	L	L	R	R	*R*	R	L	M	L	L	R	M	R	R
19	*R*	L	*L*	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	L	*L*	H	L	*L*	L	*L*	*L*	*H*	*H*	H	H	L	L	L	L	R	R	*R*	R	L	M	L	*L*	R	M	R	*R*
20	*R*	L	L	L	*L*	L	L	L	L	L	*L*	*L*	L	H	L	L	L	*L*	L	*H*	H	H	H	L	L	L	L	R	R	*R*	R	*L*	M	L	L	R	M	R	*R*
24	R	L	L	L	*L*	L	*L*	L	L	L	L	L	L	H	H	M	L	H	*L*	*H*	H	H	H	L	L	L	L	R	R	R	R	*L*	H	*L*	L	R	M	R	R
26	R	R	M	L	*R*	R	R	*R*	M	M	L	*R*	R	H	H	H	M	H	*H*	L	L	L	R	L	H	L	L	R	H	R	R	L	R	R	L	L	R	R	R
29	L	*L*	R	L	R	L	L	R	*L*	L	R	R	L	*H*	L	L	L	L	*L*	*L*	L	*R*	R	M	L	*M*	L	*H*	*H*	*H*	*H*	*H*	*H*	H	L	*H*	L	H	*H*
30	R	R	M	L	R	R	L	*L*	*L*	M	R	R	M	L	L	L	L	L	L	*L*	L	*H*	R	L	L	L	*L*	L	*H*	H	H	L	*L*	L	L	M	L	H	R
33	R	R	M	L	*L*	L	L	R	*L*	L	R	R	M	H	M	L	L	L	L	R	R	M	R	L	R	L	L	R	H	R	R	*L*	R	L	L	R	M	M	R
34	R	R	M	L	*R*	R	R	*R*	M	L	R	*R*	*M*	*M*	L	*L*	L	L	L	L	L	L	R	R	R	R	R	R	H	R	R	L	M	L	L	M	M	M	M
43	*L*	L	L	L	*L*	L	L	L	L	L	L	L	L	R	R	M	M	*L*	L	L	L	L	M	L	*L*	L	*L*	L	L	*L*	L	L	*L*	L	L	L	L	L	L

Reactivity Chart 5. Protection for the Carbonyl Group (*Continued*)

	I_2	PhSeX; PhSCl	Br_2; Cl_2	MnO_2/CH_2Cl_2	$NaIO_4$ pH 5-8	SeO_2 pH 2-4	SeO_2/Py	$K_3Fe(CN)_6$, pH 8	Pb(IV), 25°	Pb(IV), 80°	$Tl(NO_3)_3$	150°	250°	350°	:CCl_2	N_2CHCO_2R/Cu	$CH_2I_2/Zn(Cu)$	$R_3SnH/In\cdot$	Ni(CO)4	CH_2N_2	$SOCl_2$	Ac_2O, 25°	Ac_2O, 80°	DCC	MeI	$Me_3O^+BF_4^-$	1.LDA 2.MeI	1.K_2CO_3 2.MeI	RCHO	RCOCl	C^+/olefin
PG	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
	L. OXIDANTS											M.			N.			O. MISCELLANEOUS											P.		
1	L	*L*	L	*L*	*L*	M	L	L	L	L	*L*	*L*	H	*H*	L	*L*	L	L	L	L	L	*L*	L	L	*L*	M			*L*	*L*	M
3	L	L	L	L	L	M	L	L	L	L		*L*	M	R	*L*	*M*	H	R	M	L	L	L	L	L	L	M			L	L	M
5	L	L	R	L	L	M	L	L	*L*	L		L	*L*	R	L	*L*	L	L	L	L	L	L	L	L	L	*L*			L	*L*	*L*
6	R	R	R	L	*R*	M	R	L	R	R		L	L	R	R	R	R	L	R	L	L	L	L	L	L	M			L	L	*R*
7	L	L	R	L	L	M	L	L	L	*L*		L	L	R	*L*	*M*	H	R	M	L	L	L	L	L	L	M			L	L	M
8	*L*	*L*	*R*	L	*L*	H	*L*	*L*	*L*	L		*L*	*L*	R	*L*	*L*	*L*	L	L	*L*	*L*	*L*	*L*	L	*L*	*L*			L	L	*R*
9	L	L	R	L	M	H	L	L	L	*L*		L	L	R	*L*	*L*	H	R	L	L	L	L	L	L	L	M			L	L	M
10	L	L	R	L	M	H	L	L	L	M		L	L	R	*L*	*L*	L	R	L	L	L	L	L	L	L	M			L	L	M
11	*H*	L	R	M	*R*	M	L	L	R	R		L	*L*	R	M	M	L	M	L	L	L	L	L	L	R	*R*			L	L	M
19	L	*L*	R	M	R	M	L	L	*L*	M		L	L	R	M	M	L	M	L	L	L	*L*	L	L	*H*	*L*			L	*L*	M
20	*H*	*L*	R	M	R	M	L	*L*	R	R		*L*	*L*	R	M	M	L	M	L	*L*	L	L	L	L	*H*	*R*			*L*	*L*	*L*
24	L	L	R	L	R	M	L	L	R	R		*L*	*L*	R	M	M	L	M	L	L	L	L	M	L	*R*	R			L	L	M
26	L	L	R	R	R	R	L	R	R	R		L	M	R	L	R	L	L	L	L	L	*R*	R	L	L	M			L	L	*R*
29	L	L	*H*	*M*	*H*	*L*	*M*	L	*R*	R		L	R	R	R	R	R	L	L	L	L	L	*L*	L	*R*	R			*L*	L	M
30	L	L	*L*	M	H	*L*	*L*	L	R	R		L	M	R	R	R	R	L	L	L	L	*L*	L	L	M	R			L	L	L
33	L	L	R	L	R	M	L	L	R	R		L	R	R	R	R	R	M	L	L	L	L	L	L	R	R			L	L	M
34	L	L	R	R	L	L	L	L	L	L		L	M	R	R	R	R	R	L	L	L	L	*L*	L	L	M			L	L	*R*
43	L	L	*L*	L	*L*	L	L	L	*L*	M		L	L	L	L	L	L	*L*	L	*L*	*L*	L	M	L	L	M			L	L	L

Reactivity Chart 6. Protection for the Carboxyl Group

Esters

1. Methyl Ester
2. Methoxymethyl Ester
3. Methylthiomethyl Ester
4. Tetrahydropyranyl Ester
7. Benzyloxymethyl Ester
8. Phenacyl Ester
13. *N*-Phthalimidomethyl Ester
15. 2,2,2-Trichloroethyl Ester
16. 2-Haloethyl Ester
21. 2-(*p*-Toluenesulfonyl)ethyl Ester
23. *t*-Butyl Ester
27. Cinnamyl Ester
30. Benzyl Ester
31. Triphenylmethyl Ester
33. Bis(*o*-nitrophenyl)methyl Ester
34. 9-Anthrylmethyl Ester
35. 2-(9,10-Dioxo)anthrylmethyl Ester
42. Piperonyl Ester
45. Trimethylsilyl Ester
47. *t*-Butyldimethylsilyl Ester
50. *S*-*t*-Butyl Ester
59. 2-Alkyl-1,3-oxazolines

Amides and Hydrazides

64. *N,N*-Dimethylamide
68. *N*-7-Nitroindoylamide
71. Hydrazides
72. *N*-Phenylhydrazide
73. *N,N'*-Diisopropylhydrazide

(See chart, pp. 729–731.)

Reactivity Chart 6. Protection for the Carboxyl Group

PG	pH<1, 100°	pH<1	pH 1	pH 2-4	pH 4-6	pH 6-8.5	pH 8.5-10	pH 10-12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^{\cdot-}Na^+$	$MeSOCH_2^-Na^+$	KO-t-Bu	LiN-i-Pr_2	Py; R_3N	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^-; N_3^-; SCN^-	OAc^-; X^-	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney(Ni)	H_2/Pt pH 2-4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	A. AQUEOUS										B. BASIC								C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
1	H	*H*	*L*	*L*	L	L	*L*	M	*H*	H	*L*	*L*	*R*	*R*	*L*	*L*	*L*	*L*	*L*	R	M	H	*L*	*L*		*R*	R	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	L	*L*	L
2	H	H	H	M	L	L	L	L	H	H	L	L	*R*	*R*	L	L	L	L	R	R	M	L	L	L		R	R	L	L	L	L	L	L	L	L	H	M	L
3	H	M	*L*	*L*	*L*	*L*	*L*	*L*	M	H	L	L	*R*	*R*	L	L	L	L	R	R	M	M	L	L		R	R	L	L	L	R	R	R	L	R	H	M	M
4	H	*H*	*H*	*H*	L	L	L	M	H	H	*L*	L	*R*	*R*	L	L	L	L	R	R	M	L	L	L		R	R	L	L	L	L	H	L	L	L	H	H	L
7	H	H	*H*	M	L	L	L	L	H	H	L	L	*R*	*R*	L	L	L	L	R	R	M	*L*	L	L		R	R	L	L	L	H	H	*H*	L	M	H	M	L
8	H	*L*	*L*	*L*	L	L	L	M	*H*	H	R	R	*R*	*R*	M	R	L	R	R	R	M	*H*	L	H		R	R	R	L	R	H	H	*H*	L	M	H	*H*	*H*
13	H	*H*	L	L	L	L	H	H	*H*	H	L	L	*R*	*R*	L	L	*L*	L	R	R	*H*	L	*L*	L		R	R	L	L	L	L	M	*L*	L	M	H	*R*	L
15	R	*L*	*L*	L	L	L	*M*	H	H	H	R	R	*R*	*R*	R	L	*L*	R	*L*	R	M	M	L	M		R	R	M	R	*L*	R	R	*L*	L	*L*	H	*H*	M
16	H	H	M	L	L	L	L	H	H	H	R	R	*R*	*R*	R	R	R	R	R	R	M	R	L	H		R	R	R	R	R	R	R	R	L	L	M	M	M
21	H	H	L	*L*	L	L	M	*H*	*H*	H	R	R	*R*	*R*	R	R	R	R	R	R	M	R	M	*H*		R	R	L	L	*H*	R	L	*L*	L	*L*	M	M	M
23	H	*H*	*H*	*H*	*L*	L	*L*	*L*	*H*	H	*L*	L	*R*	*R*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	H		R	R	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	H	*L*	L
27	H	H	H	L	L	L	L	H	H	H	L	L	*R*	*R*	L	L	L	L	R	R	M	L	L	L		R	R	L	H	L	R	R	L	R	R	M	L	L
30	H	M	*L*	L	L	L	*L*	*H*	*H*	H	*L*	L	*R*	*R*	*L*	L	*L*	L	R	R	M	M	L	L		R	R	L	L	*L*	H	H	*H*	L	*L*	L	*L*	L
31	H	H	*H*	H	*M*	L	L	M	*H*	H	L	L	*R*	*R*	*L*	L	L	L	R	R	L	L	L	L		R	R	L	L	L	H	H	H	L	M	H	H	M
33	H	M	L	L	L	L	L	M	H	H	L	L	*R*	*R*	L	L	L	L	R	R	M	L	L	L		R	R	L	L	L	R	R	R	L	R	R	R	R
34	H	*H*	M	L	L	L	L	L	*H*	H	L	L	*R*	*R*	L	L	L	L	R	R	M	*H*	L	L		R	R	L	L	L	H	H	H	L	M	M	L	L
35	H	H	*L*	L	L	L	L	M	H	H	L	L	*R*	*R*	L	L	L	L	R	R	M	M	L	L		R	R	M	L	M	*H*	*H*	*H*	L	M	R	R	L
42	H	*H*	H	L	L	L	L	M	H	H	L	L	*R*	*R*	L	L	L	L	R	R	M	M	L	L		R	R	L	L	L	H	H	H	L	M	H	M	L
45	H	H	H	H	H	*H*	H	H	H	H	L	L	*R*	*R*	L	L	*L*	*L*	R	R	*H*	*H*	*H*	*H*		R	R	H	H	H	H	H	H	H	H	H	H	H
47	H	H	H	*H*	*H*	*M*	*H*	*H*	H	H	*L*	L	*R*	*R*	L	L	L	L	R	R	M	L	L	L		R	R	L	L	L	L	H	L	L	L	H	H	H
50	H	H	M	L	L	L	L	*L*	M	H	L	L	*R*	*R*	L	*L*	L	L	R	R	R	R	M	H		R	R	R	R	*L*	R	R	R	*L*	R	H	L	L
59	H	*H*	M	L	L	*L*	L	L	*M*	H	*L*	L	*M*	*L*	*L*	*L*	L	L	L	L	*L*	*R*	*L*	L		*L*	*L*	*L*	L	L	R	R	R	L	R	R	R	R
64	*H*	L	L	*L*	L	L	L	L	L	*H*	L	L	*M*	*M*	*L*	L	L	*L*	L	*L*	L	L	L	*L*		*R*	R	L	L	L	*M*	L	*L*	L	L	L	L	L
68	H	*M*	*L*	L	L	L	L	*M*	*H*	H	L	L	R	*H*	H	L	L	L	L	*M*	*L*	L	L	L		R	R	L	L	L	R	R	R	*R*	R	R	R	R
71	*H*	*H*	M	L	L	L	L	L	M	H	R	R	R	R	R	R	L	R	R	*L*	L	L	L	L		R	R	L	*L*	*L*	*H*	*H*	*M*	L	L	M	L	L
72	H	H	M	*L*	L	L	L	L	M	H	R	R	R	R	*L*	R	L	R	R	*L*	L	L	L	L		R	R	L	*L*	*L*	*H*	*H*	*M*	L	*L*	M	*L*	L
73	H	H	L	L	L	L	L	L	L	H	L	L	*H*	R	*L*	R	L	R	L	*L*	L	L	L	L		R	R	L	L	L	*H*	*H*	*M*	L	L	*M*	L	L

Reactivity Chart 6. Protection for the Carboxyl Group (*Continued*)

	$NaNH_3$	Al(Hg)	$SnCl_2$/Py	HSO_3^-; H_2S	$LiAlH_4$	Li-n-Bu_3BH	$(C_5H_{11})_2BH$	B_2H_6, 0°	$NaBH_4$	$Zn(BH_4)_2$	$NaBH_3CN$ pH 4-6	i-Bu_2AlH	Li(OtBu)$_3$AlH	$AlCl_3$, 80°	$AlCl_3$, 25°	$SnCl_4$; BF_3	$LiClO_4$; $MgBr_2$	TsOH, 80°	TsOH, 0°	Hg(II)	Ag(I)	Cu(II)/Py	HBr/In·	HX/In·	NBS/CCl_4	Br_3CCl/In·	OsO_4	$KMnO_4$, pH 7, 0°	O_3, -50°	RCO_3H, 0°	RCO_3H, 50°	CrO_3/Py	CrO_3, pH 1	H_2O_2 pH 10-12	Quinone	$^1O_2$	DMSO, 100°	NaOCl pH 10	aq NBS
PG	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	G.				H. HYDRIDE REDN.									I.						J.			K.				L. OXIDANTS											
1	*R*	*L*	L	*L*	*R*	M	*L*	*L*	*L*	*L*	*L*	R	M	R	M	L	L	M	*L*	*L*	*L*	L	*L*	*L*	*L*	*L*	*L*	L	*L*	*L*	*L*	*L*	L	M	*L*	*L*	*L*	M	*L*
2	R	L	L	L	R	M	L	L	L	L	L	R	M	H	H	L	L	H	L	L	L	L	L	L	L	L	L	L	M	L	H	L	H	L	L	L	L	L	L
3	R	L	L	L	R	M	L	L	*L*	L	L	R	M	H	H	M	L	R	L	*H*	*H*	L	L	L	*H*	L	L	R	R	R	R	L	R	L	L	R	M	R	R
4	R	L	L	L	R	M	L	L	L	L	L	R	M	H	H	*H*	L	H	*M*	L	L	L	M	L	*M*	L	L	L	M	L	H	L	H	M	L	L	L	H	*L*
7	R	L	L	L	R	M	L	L	L	L	L	R	M	R	R	M	L	H	L	L	L	L	L	L	R	L	L	L	M	L	H	L	H	L	L	L	L	L	L
8	R	R	L	L	R	R	R	R	M	M	L	R	M	R	R	M	L	R	*L*	L	L	L	L	L	L	L	L	L	L	L	R	L	L	R	L	L	L	M	R
13	R	L	L	L	R	M	R	R	L	L	L	R	L	R	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	H	H	L
15	R	M	L	*L*	R	M	L	*L*	L	L	L	R	M	R	R	*L*	L	L	L	*L*	R	L	R	R	R	R	L	L	L	*L*	L	L	L	M	L	L	M	H	*L*
16	R	M	M	L	R	M	L	L	L	L	R	R	M	R	R	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	M	H	L	L	M	H	L
21	R	M	M	L	R	M	L	L	L	L	R	R	M	R	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	H	L	L	M	H	L
23	R	L	L	L	R	L	L	*L*	*L*	L	*L*	*L*	L	R	*H*	*H*	L	M	L	L	*L*	L	L	L	*L*	L	L	L	L	*L*	H	L	H	L	L	L	L	L	L
27	R	L	L	L	R	M	R	R	L	L	L	R	M	R	R	R	L	H	L	*R*	L	L	R	R	R	R	R	R	R	R	R	L	H	R	L	R	L	H	R
30	*H*	L	L	*L*	R	M	L	*L*	*L*	L	L	R	M	R	*R*	M	L	*L*	*L*	L	L	L	L	L	R	L	*L*	*L*	*L*	*L*	L	*L*	*L*	*L*	M	L	L	L	M	L
31	R	L	L	L	R	L	L	*L*	L	L	M	R	L	R	R	L	L	H	M	*L*	L	L	M	L	L	L	L	L	L	M	H	L	H	M	L	L	H	M	L
33	H	R	L	L	R	M	L	L	L	L	L	R	M	R	R	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	M	L	L	L	M	L
34	H	L	L	L	R	M	L	L	L	L	L	R	M	R	R	M	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	M	L	L	R	L	L	L
35	H	R	M	L	R	R	M	M	M	M	L	R	M	R	R	M	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	M	L	L	L	M	L
42	H	L	L	L	R	M	L	L	L	L	L	R	M	R	R	M	L	R	L	L	L	L	L	L	R	L	L	L	L	L	L	L	H	M	L	L	L	M	L
45	R	H	L	H	R	H	H	R	H	H	H	R	H	H	H	H	H	H	M	H	H	L	H	L	*L*	L	L	H	L	H	H	L	H	H	L	L	H	H	H
47	R	L	L	L	R	M	L	*L*	L	L	H	R	M	H	H	H	L	H	L	L	L	L	L	L	L	L	L	M	L	H	H	L	H	H	L	L	H	H	M
50	R	L	L	L	R	M	L	*L*	L	L	L	R	M	R	*M*	L	L	*H*	L	*R*	*R*	*R*	L	L	L	L	L	R	*R*	L	M	L	M	R	L	R	M	H	H
59	R	M	L	L	*L*	L	*M*	*L*	*L*	*L*	*M*	*M*	L	*R*	*L*	*L*	*L*	*R*	L	L	L	L	*L*	*L*	*L*	*L*	R	R	*L*	R	R	*L*	R	L	L	L	L	L	L
64	R	L	L	L	*R*	L	*R*	R	L	L	L	*R*	*L*	*L*	L	*L*	L	*L*	L	*L*	L	L	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L
68	R	R	L	L	R	L	R	R	L	L	L	R	L	*M*	L	L	L	*L*	L	R	L	L	R	R	R	R	R	M	R	L	M	L	L	M	L	*R*	L	L	M
71	*L*	L	L	L	R	L	R	R	L	L	L	R	L	R	L	L	L	L	L	*R*	L	H	R	L	R	L	R	R	R	*R*	R	R	M	R	R	R	R	*R*	*H*
72	R	L	L	L	*R*	L	R	R	L	L	L	R	L	*M*	L	L	L	L	L	H	*L*	*H*	L	L	R	L	R	R	R	R	R	R	H	R	R	R	R	H	H
73	R	L	L	L	R	L	R	R	L	L	L	R	L	*M*	L	L	L	L	L	H	*L*	H	L	L	R	L	R	R	R	R	R	R	*H*	R	R	R	R	H	*H*

Reactivity Chart 6. Protection for the Carboxyl Group (*Continued*)

PG	I_2	PhSeX; PhSCl	Br_2; Cl_2	MnO_2/CH_2Cl_2	$NaIO_4$ pH 5-8	SeO_2 pH 2-4	SeO_2/Py	$K_3Fe(CN)_6$, pH 8	Pb(IV), 25°	Pb(IV), 80°	$Tl(NO_3)_3$	150°	250°	350°	$:CCl_2$	N_2CHCO_2R/Cu	CH_2I_2/Zn(Cu)	R_3SnH/In·	$Ni(CO)_4$	CH_2N_2	$SOCl_2$	Ac_2O, 25°	Ac_2O, 80°	DCC	MeI	$Me_3O^+BF_4^-$	1.LDA 2.MeI	1.K_2CO_3 2.MeI	RCHO	RCOCl	C^+/olefin
	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
	L. OXIDANTS											M.			N.			O. MISCELLANEOUS											P.		
1	*L*	L	*L*	*L*	*L*	L	*L*	L	L	*L*		*L*	*L*	*L*	*L*	*L*	L	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*L*			*L*	*L*	*L*
2	L	L	R	L	L	L	L	L	L	H		L	L	R	L	L	L	L	L	L	L	L	L	L	L	L			L	L	M
3	L	L	R	L	R	M	L	L	R	R		L	L	R	M	M	L	M	L	L	L	L	L	L	*R*	R			L	L	L
4	L	L	M	L	L	H	L	L	L	H		*M*	*H*	R	L	L	L	L	L	L	*M*	M	M	L	L	L			L	*L*	M
7	L	L	R	L	L	M	L	L	L	H		L	L	R	L	L	L	L	L	L	L	L	M	L	L	L			L	L	M
8	L	R	R	L	L	L	L	L	L	L		L	L	R	L	L	L	L	L	L	L	L	L	L	L	*L*			L	L	L
13	L	L	L	L	L	L	L	H	L	L		L	M	R	L	L	L	L	L	L	L	L	L	L	L	R			L	L	L
15	L	L	L	L	*L*	L	L	M	L	L		M	H	R	L	M	R	R	M	L	L	*L*	L	*L*	L	L			L	L	L
16	L	L	L	L	L	L	L	L	L	L		L	M	R	L	L	R	R	L	L	L	L	L	L	L	L			L	L	L
21	L	L	L	L	L	L	L	L	L	M		M	H	R	L	L	L	L	L	L	L	L	L	L	L	L			L	L	L
23	*L*	*L*	L	*L*	L	H	L	L	*L*	H		*M*	*H*	H	L	*L*	L	L	L	*L*	*L*	*L*	M	L	L	L			*L*	*L*	H
27	R	R	R	L	L	M	L	L	L	M		R	R	R	R	R	R	L	R	L	L	L	L	L	L	L			L	L	R
30	L	L	*L*	*L*	*L*	M	L	L	L	L		L	L	R	L	L	L	*L*	L	L	*L*	L	L	*L*	L	L			L	*L*	L
31	L	L	L	L	L	H	L	L	L	H		M	H	R	L	L	L	L	L	L	L	L	M	L	L	L			L	L	H
33	L	L	L	L	L	L	L	L	L	L		L	L	R	L	L	L	L	L	L	L	L	L	L	L	L			L	*L*	L
34	L	L	L	L	L	M	L	L	L	L		L	L	R	L	L	L	L	L	L	L	L	L	L	L	L			L	L	L
35	L	L	M	L	L	M	L	L	L	L		L	L	R	L	L	L	L	L	L	L	L	L	L	L	L			L	L	L
42	L	L	M	L	L	M	L	L	L	R		L	L	R	L	*M*	L	L	L	L	L	L	L	L	L	L			L	L	R
45	H	L	L	L	H	H	L	H	H	H		*L*	*L*	R	L	M	L	L	L	L	*L*	H	H	L	L	H			L	M	L
47	H	L	L	L	M	H	L	H	H	H		L	L	R	L	L	L	L	L	L	L	L	H	L	L	L			L	M	L
50	L	L	R	*L*	L	L	L	L	L	R		M	H	R	M	M	L	L	L	L	L	*L*	L	L	L	R			L	L	L
59	L	L	*R*	L	L	M	M	L	L	R		L	L	R	L	L	L	L	L	L	*L*	*L*	*L*	*L*	*R*	*R*			*L*	*R*	R
64	L	L	L	L	L	L	L	L	L	*L*		*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	R			L	L	*L*
68	L	L	M	L	L	L	L	L	L	M		L	L	M	R	R	R	L	L	M	L	L	L	L	L	R			L	L	*M*
71	*R*	*R*	*R*	R	R	R	M	*R*	*H*	R		M	*R*	*R*	L	R	L	L	L	L	R	R	R	L	R	R			*R*	*R*	*R*
72	H	R	R	H	H	R	M	H	H	R		M	R	R	L	M	L	L	L	L	R	*R*	R	L	R	R			R	R	R
73	H	R	R	H	*H*	R	M	H	*H*	R		M	R	R	L	M	L	L	L	L	R	R	R	L	R	R			R	*R*	R

Reactivity Chart 7. Protection for the Thiol Group

1. *S*-Benzyl Thioether
3. *S*-*p*-Methoxybenzyl Thioether
5. *S*-*p*-Nitrobenzyl Thioether
6. *S*-4-Picolyl Thioether
7. *S*-2-Picolyl *N*-Oxide Thioether
8. *S*-9-Anthrylmethyl Thioether
9. *S*-Diphenylmethyl Thioether
10. *S*-Di(*p*-methoxyphenyl)methyl Thioether
12. *S*-Triphenylmethyl Thioether
15. *S*-2,4-Dinitrophenyl Thioether
16. *S*-*t*-Butyl Thioether
19. *S*-Isobutoxymethyl Monothioacetal
20. *S*-2-Tetrahydropyranyl Monothioacetal
23. *S*-Acetamidomethyl Aminothioacetal
25. *S*-Cyanomethyl Thioether
26. *S*-2-Nitro-1-phenylethyl Thioether
27. *S*-2,2-Bis(carboethoxy)ethyl Thioether
30. *S*-Benzoyl Derivative
36. *S*-(*N*-Ethylcarbamate)
38. *S*-Ethyl Disulfide

(See chart, pp. 733–735.)

Reactivity Chart 7. Protection for the Thiol Group

	pH<1, 100°	pH<1	pH 1	pH 2-4	pH 4-6	pH 6-8.5	pH 8.5-10	pH 10-12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^-Na^+$	$MeSOCH_2^-Na^+$	KO-t-Bu	LiN-i-Pr_2	Py; R_3N	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^-; N_3^-; SCN^-	OAc^-; X^-	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney(Ni)	H_2/Pt pH 2-4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
PG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	A. AQUEOUS										B. BASIC								C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
1	H	*L*	L	*L*	L	L	L	L	L	M	L	R	R	R	*L*	R	L	L	L	L	L	*L*	L	L		*R*	R	L	L	L	R	R	R	*M*	R	L	L	L
3	H	*H*	*M*	*L*	L	L	L	L	*L*	M	L	R	R	R	L	R	L	L	L	L	L	L	L	L		R	R	L	L	L	R	R	R	*M*	*R*	M	L	L
5	H	L	L	L	L	L	L	L	M	H	M	R	R	R	L	R	L	R	M	L	L	M	L	M		R	R	L	R	L	R	R	*R*	*M*	R	R	R	R
6	H	*L*	L	L	L	L	L	L	*L*	M	L	R	R	R	L	R	L	L	L	L	L	*L*	L	L		R	R	L	L	L	R	R	R	*M*	R	L	L	L
7	H	*H*	*M*	L	L	L	L	L	L	M	L	R	R	R	L	R	L	L	L	L	L	L	L	L		R	R	L	L	L	R	R	R	*R*	R	R	R	R
8	H	*M*	L	L	L	L	L	L	L	M	L	R	R	R	L	R	L	L	L	L	L	*H*	L	L		R	R	L	L	L	R	R	R	*M*	R	L	L	L
9	*H*	*L*	L	L	L	L	L	L	L	M	L	R	R	R	L	R	L	*M*	*L*	L	L	M	L	L		R	R	L	L	L	R	R	R	*M*	R	L	L	L
10	H	H	L	L	L	L	L	L	L	M	L	R	R	R	L	R	L	*M*	L	L	L	M	L	L		R	R	L	L	L	R	R	R	*M*	R	L	L	L
12	H	*H*	*M*	*L*	L	L	L	L	L	M	L	*L*	R	L	*L*	L	L	L	*L*	L	L	*R*	L	L		L	L	L	L	L	R	R	R	*R*	R	M	L	L
15	H	L	L	L	L	M	H	H	H	H	*R*	*R*	R	R	*R*	R	L	*R*	*M*	M	M	H	L	*H*		R	R	L	R	L	R	R	R	*R*	R	R	R	R
16	H	*M*	*L*	L	L	L	L	*L*	*L*	M	L	L	L	L	L	*L*	*L*	L	*L*	*L*	*L*	L	L	L		*L*	L	L	L	L	R	R	M	*L*	M	L	L	L
19	H	H	L	L	L	L	L	L	M	H	L	L	R	H	L	L	L	L	L	L	L	H	L	L		L	L	L	L	L	R	R	R	L	R	H	L	L
20	H	H	L	L	L	L	L	L	M	H	L	L	R	H	L	L	L	L	L	L	L	R	L	L		L	L	L	L	L	R	R	R	L	R	H	L	L
23	*H*	*M*	*L*	*L*	*L*	*L*	*L*	*L*	*L*	*H*	R	R	R	R	L	R	L	R	R	L	*L*	L	L	L		R	R	L	L	L	R	R	R	*M*	R	L	*L*	L
25	H	R	L	L	L	L	L	M	M	H	R	R	R	R	M	R	L	R	R	L	*L*	*L*	L	L		R	R	L	L	L	R	R	R	*L*	R	R	R	L
26	H	*L*	L	L	L	L	H	H	*H*	R	H	H	R	H	H	H	H	H	H	R	H	M	*L*	*M*		R	R	L	R	L	R	R	R	*R*	R	R	R	R
27	H	*L*	L	L	L	L	L	H	*H*	R	H	H	R	H	H	H	L	H	R	R	R	M	L	*M*		R	R	*R*	R	L	R	R	R	*L*	R	L	L	L
30	H	L	L	L	L	L	M	H	H	H	L	L	H	H	H	H	H	H	H	H	H	H	L	H		H	H	H	L	H	R	R	R	L	R	H	L	L
36	H	L	L	L	L	M	H	H	H	H	R	R	R	H	H	R	H	H	H	H	H	H	L	L		H	H	L	L	L	R	R	R	L	R	H	L	L
38	H	L	L	L	L	L	L	L	H	H	R	R	R	H	R	R	L	R	R	R	L	M	L	H		H	H	H	M	H	R	R	R	H	R	H	H	H

Reactivity Chart 7. Protection for the Thiol Group (*Continued*)

PG	Na/NH_3	Al(Hg)	$SnCl_2$/Py	HSO_3^-; H_2S	$LiAlH_4$	Li-s-Bu_3BH	$(C_5H_{11})_2BH$	B_2H_6, 0°	$NaBH_4$	$Zn(BH_4)_2$	$NaBH_3CN$ pH 4-6	i-Bu_2AlH	Li(OtBu)$_3$AlH	$AlCl_3$, 80°	$AlCl_3$, 25°	$SnCl_4$; BF_3	$LiClO_4$; $MgBr_2$	TsOH, 80°	TsOH, 0°	Hg(II)	Ag(I)	Cu(II)/Py	HBr/In·	HX/In·	NBS/CCl_4	Br_3CCl/In·	OsO_4	$KMnO_4$,pH 7,0°	O_3, -50°	RCO_3H, 0°	RCO_3H, 50°	CrO_3/Py	CrO_3, pH 1	H_2O_2 pH 10-12	Quinone	$^1O_2$	DMSO, 100°	NaOCl pH 10	aq NBS
	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	G.				H. HYDRIDE REDN.									I.						J.			K.				L. OXIDANTS												
1	*H*	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	M	L	*L*	M	L	R	L	R	R	L	R	R	R	R	L	R	L	L	*R*	L	R	*R*
3	*H*	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	M	L	*R*	R	L	R	L	R	R	L	R	R	R	R	L	R	L	L	*R*	L	R	R
5	H	R	L	L	R	*M*	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	R	L	R	R	L	R	M	R	R	L	R	L	L	*R*	L	R	R
6	H	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	M	L	L	L	L	R	L	R	R	L	R	R	R	R	L	R	L	L	*M*	M	R	R
7	H	R	R	*R*	*R*	*R*	L	R	M	L	L	R	*R*	H	M	L	L	L	L	L	L	L	R	L	R	R	L	R	R	R	R	L	R	L	L	*M*	L	R	R
8	H	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	M	L	M	M	L	R	L	R	R	L	R	R	R	R	L	R	L	L	*R*	L	R	R
9	*H*	L	L	L	L	L	L	L	L	L	L	L	L	H	M	L	L	M	L	*M*	*M*	L	R	L	R	R	L	R	R	R	R	L	R	L	L	*R*	L	R	R
10	*H*	L	L	L	L	L	L	L	L	L	L	L	L	H	M	M	L	M	L	R	R	L	R	L	R	R	L	R	R	R	R	L	R	L	L	*R*	L	R	R
12	*H*	L	L	L	L	L	L	*H*	L	L	L	L	L	H	H	M	L	M	L	*R*	*R*	L	L	L	L	L	L	R	R	R	R	L	R	L	L	*M*	L	R	R
15	R	R	M	L	R	*M*	*M*	*M*	L	L	L	*R*	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	R	L	M	R	L	R	R	L	*M*	R	R	R
16	L	L	L	L	*L*	L	L	L	L	L	L	L	L	H	M	L	L	M	L	*R*	R	L	L	L	L	L	L	R	R	R	R	L	R	L	L	*M*	L	R	R
19	H	L	L	L	L	L	L	L	L	L	L	L	L	H	H	M	L	M	L	R	R	L	L	L	R	L	L	R	R	R	R	M	R	L	L	M	L	R	R
20	M	L	L	L	L	L	L	L	L	L	L	L	L	H	H	M	L	M	L	R	R	L	L	L	R	L	L	R	R	R	R	M	R	L	L	M	L	R	R
23	L	L	L	L	R	L	R	R	L	L	L	R	L	L	L	L	L	M	L	*R*	R	L	L	L	L	L	L	R	R	R	R	L	R	L	L	*R*	L	R	R
25	R	L	L	L	R	*M*	L	R	L	L	L	R	L	M	L	L	L	M	L	L	L	L	R	L	R	L	L	R	R	R	R	L	R	R	L	*R*	L	R	R
26	R	R	L	L	R	*M*	L	L	L	L	L	L	*R*	L	L	L	L	M	L	L	L	L	R	L	R	R	L	R	R	R	R	L	R	R	L	*R*	M	R	R
27	R	L	L	L	R	R	L	*L*	L	L	L	R	L	M	L	L	L	M	L	L	L	L	L	L	R	L	L	R	R	R	R	L	R	R	L	*M*	L	R	R
30	H	L	L	L	H	H	L	M	H	M	L	H	L	R	M	L	L	M	L	R	R	L	L	L	M	L	L	R	M	R	R	L	R	H	L	R	L	R	R
36	H	L	L	L	H	M	M	H	L	L	L	H	L	R	H	L	L	M	L	R	R	L	L	L	M	L	L	R	R	R	R	L	R	H	L	R	M	R	R
38	H	H	H	H	H	H	H	H	H	H	M	H	H	R	H	L	L	M	L	R	R	M	R	R	R	R	M	R	R	R	R	R	R	L	R	R	L	R	R

Reactivity Chart 7. Protection for the Thiol Group (*Continued*)

	I_2	PhSeX; PhSCl	Br_2; Cl_2	MnO_2/CH_2Cl_2	$NaIO_4$ pH 5-8	SeO_2 pH 2-4	SeO_2/Py	$K_3Fe(CN)_6$, pH 8	Pb(IV), 25°	Pb(IV), 80°	$Tl(NO_3)_3$	150°	250°	350°	$:CCl_2$	N_2CHCO_2R/Cu	$CH_2I_2/Zn(Cu)$	$R_3SnH/In\cdot$	$Ni(CO)_4$	CH_2N_2	$SOCl_2$	Ac_2O, 25°	Ac_2O, 80°	DCC	MeI	$Me_3O^+BF_4^-$	1.LDA 2.MeI	1.K_2CO_3 2.MeI	RCHO	RCOCl	C^+/olefin
PG	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
	L. OXIDANTS											M.			N.			O. MISCELLANEOUS											P.		
1	*L*	L	R	M	R	R	M	L	R	R		L	L	M	M	R	L	*R*	L	L	L	L	L	*L*	R	R	R	R	*L*	*L*	M
3	M	L	R	M	R	R	M	L	R	R		L	L	M	M	R	L	R	L	L	L	L	L	*L*	R	R	R	R	L	L	M
5	R	L	R	L	R	R	L	L	R	R		L	L	M	M	R	L	R	L	L	L	L	L	L	M	M	R	M	L	L	L
6	R	L	R	L	R	R	M	L	R	R		L	L	M	M	R	L	R	L	*L*	L	L	L	*L*	R	R	R	R	L	L	L
7	R	L	R	L	R	R	M	L	R	R		L	L	M	R	R	L	R	L	L	R	*R*	*R*	L	R	R	R	R	L	H	L
8	R	L	R	M	R	R	R	L	R	R		L	L	M	M	R	L	R	L	L	L	L	L	L	R	R	R	R	L	L	M
9	*M*	L	R	M	R	R	R	L	R	R		L	L	M	M	R	L	R	L	L	L	L	L	L	R	R	R	R	L	L	M
10	M	L	R	M	R	R	R	L	R	R		L	L	M	M	R	L	R	L	L	L	L	L	L	R	R	R	R	L	L	M
12	*R*	L	M	L	R	L	L	L	R	R		L	L	M	M	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M
15	R	L	M	L	L	M	L	R	R	R		L	L	M	M	R	L	R	L	L	L	L	L	L	L	L	R	L	L	L	L
16	*L*	L	M	L	R	L	L	L	R	R		L	L	R	M	R	L	L	L	L	L	*L*	L	L	M	M	M	M	*L*	L	M
19	R	L	R	L	R	M	L	L	R	R		L	M	R	M	R	L	M	L	L	L	L	L	L	R	R	M	R	L	L	M
20	R	L	R	L	R	M	L	L	R	R		L	M	R	M	R	L	M	L	L	L	L	L	L	R	R	M	R	L	L	M
23	*R*	L	R	L	R	M	L	L	R	R		L	L	M	M	R	L	L	L	L	L	L	M	L	R	R	R	R	L	L	L
25	R	L	R	L	R	M	L	M	R	R		L	L	M	M	R	L	*M*	L	L	L	L	L	L	R	R	R	R	L	L	L
26	R	L	R	L	R	*M*	*L*	*H*	R	R		M	H	H	M	R	L	R	L	L	L	L	L	L	R	R	R	R	L	L	L
27	R	L	R	L	R	M	L	H	R	R		M	H	H	M	R	L	L	L	L	L	L	L	L	R	R	R	R	L	L	L
30	L	L	R	L	L	L	L	H	L	M		M	R	R	M	M	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L
36	L	L	R	L	R	L	L	H	L	M		R	R	R	M	M	L	R	L	L	L	L	M	L	L	R	L	L	L	L	L
38	R	L	R	R	R	R	R	R	R	R		H	H	R	M	R	R	R	R	L	L	L	L	L	M	R	R	M	L	L	R

Reactivity Chart 8. Protection for the Amino Group: Carbamates

1. Methyl Carbamate
5. 9-Fluorenylmethyl Carbamate
8. 2,2,2-Trichloroethyl Carbamate
11. 2-Trimethylsilylethyl Carbamate
16. 1,1-Dimethylpropynyl Carbamate
20. 1-Methyl-1-phenylethyl Carbamate
22. 1-Methyl-1-(4-biphenylyl)ethyl Carbamate
24. 1,1-Dimethyl-2-haloethyl Carbamate
26. 1,1-Dimethyl-2-cyanoethyl Carbamate
28. *t*-Butyl Carbamate
30. Cyclobutyl Carbamate
31. 1-Methylcyclobutyl Carbamate
35. 1-Adamantyl Carbamate
37. Vinyl Carbamate
38. Allyl Carbamate
39. Cinnamyl Carbamate
44. 8-Quinolyl Carbamate
45. *N*-Hydroxypiperidinyl Carbamate
47. 4,5-Diphenyl-3-oxazolin-2-one
48. Benzyl Carbamate
53. *p*-Nitrobenzyl Carbamate
55. 3,4-Dimethoxy-6-nitrobenzyl Carbamate
58. 2,4-Dichlorobenzyl Carbamate
65. 5-Benzisoxazolylmethyl Carbamate
66. 9-Anthrylmethyl Carbamate
67. Diphenylmethyl Carbamate
71. Isonicotinyl Carbamate
72. *S*-Benzyl Carbamate
75. *N*-(*N'*-Phenylaminothiocarbonyl) Derivative

(See chart, pp. 737–739.)

Reactivity Chart 8. Protection for the Amino Group: Carbamates

PG		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
		pH<1, 100°	pH<1	pH 1	pH 2-4	pH 4-6	pH 6-8.5	pH 8.5-10	pH 10-12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^-Na^+$	$MeSOCH_2^-Na^+$	KO-t-Bu	LiN-i-Pr_2	$Py; R_3N$	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^-; N_3^-; SCN^-	OAc^-; X^-	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney (Ni)	H_2/Pt pH 2-4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
		A. AQUEOUS										B. BASIC								C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
1		H	H	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	H	L	L	L	L	L	L
5		H	H	M	L	L	L	L	L	M	H	H	M	H	L	L	L	M	H	M	L	H	L	L	L	L	H	H	H	M	L	L	L	L	L	R	L	L	L
8		H	H	L	L	L	L	L	M	M	H	R	R	R	R	R	R	R	H	L	R	M	M	L	L	L	H	H	R	R	R	L	L	L	L	R	L	L	H
11		H	H	H	M	L	L	L	L	M	M	L	L	L	L	L	L	L	L	L	R	M	M	L	L	L	H	H	L	L	L	L	L	L	L	R	M	L	L
16		H	H	H	L	L	L	L	L	L	M	L	R	R	R	R	L	L	R	L	L	L	L	L	L	L	H	H	R	M	R	L	L	L	L	R	H	H	L
20		H	H	M	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	M	H	L	L	R	H	H	L
22		H	H	H	M	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	M	R	L	M	H	H	L	R	H	H	H
24		H	H	M	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	R	M	L	L	L	L	H	H	M	R	L	M	H	R	L	R	H	H	H
26		H	L	L	L	L	L	M	H	H	M	H	M	R	M	H	H	H	H	R	M	H	R	M	M	L	H	H	M	R	M	R	R	L	L	R	R	R	L
28		H	H	M	M	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	H	L	L	L	H	H	M
30		H	H	M	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	M	L	L	L	H	M	L
31		H	H	H	M	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	M	L	L	L	H	M	L
35		H	H	H	H	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	M	L	L	L	H	H	M
37		H	H	H	M	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	M	L	L	L	H	H	M
38		H	H	M	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	M	L	L	L	H	H	M
39		H	H	M	M	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	H	L	L	R	H	H	L
44		H	H	M	L	L	L	L	H	H	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	H	L	L	R	H	H	L
45		H	L	L	L	L	L	L	L	L	M	L	L	M	L	L	L	L	L	M	L	L	L	L	L	L	H	H	L	L	L	L	H	L	L	R	H	H	L
47		H	L	L	L	L	L	L	L	L	M	L	L	M	L	L	L	L	L	M	L	L	L	L	L	L	H	H	L	L	L	L	H	L	L	R	H	H	L
48		H	H	L	L	L	L	L	L	L	H	L	R	L	L	L	L	L	L	L	R	L	L	L	L	L	H	H	L	L	L	L	H	L	L	R	H	H	L
53		H	H	L	L	L	L	L	L	L	M	L	R	R	L	L	H	H	H	M	M	H	H	L	L	L	H	H	L	R	L	L	H	H	L	R	R	R	R
55		H	H	M	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	M	M	L	L	L	L	L	H	H	L	R	L	L	H	H	L	R	R	R	R
58		H	H	M	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	M	M	L	L	L	L	L	H	H	L	R	L	L	H	H	L	R	R	R	L
65		H	H	M	M	L	L	L	L	L	M	H	L	R	H	H	H	H	H	H	H	L	L	L	L	L	H	H	L	R	L	L	H	H	L	R	H	H	L
66		H	H	L	L	L	L	L	L	L	M	L	L	R	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	R	L	L	H	H	L	R	H	H	L
67		H	H	H	M	L	L	L	L	L	M	L	R	L	L	L	L	L	L	L	L	H	L	L	L	L	H	H	M	L	L	L	H	H	L	R	H	M	L
71		H	L	L	L	L	L	L	L	L	M	L	L	R	H	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L	L	H	H	L	R	H	H	L
72		H	M	L	L	L	L	L	L	L	H	L	L	R	H	L	L	L	L	H	M	H	H	L	L	L	H	H	L	L	L	L	H	H	L	R	H	L	L
75		H	H	M	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	H	H	M	L	L	L	H	R	H	R	L	L	R

Reactivity Chart 8. Protection for the Amino Group: Carbamates (*Continued*)

	Na/NH_3	Al(Hg)	$SnCl_2$/Py	HSO_3^-; H_2S	$LiAlH_4$	Li-s-Bu_3BH	$(C_5H_{11})_2BH$	B_2H_6, 0°	$NaBH_4$	$Zn(BH_4)_2$	$NaBH_3CN$ pH 4-6	i-Bu_2AlH	Li(O-t-Bu)$_3AlH$	$AlCl_3$, 80°	$AlCl_3$, 25°	$SnCl_4$; BF_3	$LiClO_4$; $MgBr_2$	TsOH, 80°	TsOH, 0°	Hg(II)	Ag(I)	Cu(II)/Py	HBr/In·	HX/In·	NBS/CCl_4	Br_3CCl/In·	OsO_4	$KMnO_4$, pH 7, 0°	O_3, -50°	RCO_3H, 0°	RCO_3H, 50°	CrO_3/Py	CrO_3, pH 1	H_2O_2 pH 10-12	Quinone	$^1O_2$	DMSO, 100°	NaOCl pH 10	aq NBS
PG	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	G.				H. HYDRIDE REDN.									I.						J.			K.				L. OXIDANTS												
1	L	*L*	*L*	L	*R*	L	L	L	L	L	L	*R*	L	R	L	*L*	L	L	L	L	L	L	L	L	*L*	L	*L*	L	L	L	*L*	H	*L*	L	*L*	*L*	L	*L*
5	H	L	L	L	M	L	L	L	L	L	L	M	L	R	L	L	L	M	L	L	L	H	R	R	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L
8	R	M	H	L	R	L	L	*L*	L	L	L	M	L	R	R	R	L	L	L	L	L	L	M	M	M	M	L	L	*L*	*L*	L	*L*	*L*	L	L	R	L	L
11	L	L	L	L	R	L	L	L	L	L	L	M	L	R	L	L	L	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L
16	H	L	L	L	R	L	R	R	L	L	L	M	L	R	H	L	L	R	H	R	L	R	R	R	L	R	R	R	R	M	R	L	H	L	L	L	L	L	R
20	R	L	L	L	R	L	L	L	L	L	L	M	L	R	H	M	L	R	H	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L
22	R	L	L	L	R	L	L	L	L	L	M	M	L	R	H	M	L	R	H	L	L	L	H	L	L	L	L	L	L	L	M	L	H	L	L	L	L	L	L
24	*H*	L	H	L	R	L	L	L	L	L	L	M	L	R	*H*	M	L	M	L	L	M	L	M	L	L	L	L	L	L	L	L	L	M	L	L	L	R	L	L
26	H	L	L	L	R	M	L	M	L	L	L	M	L	R	H	M	L	M	L	L	L	H	L	L	L	L	L	L	L	L	L	H	L	R	L	L	M	M	L
28	*L*	*L*	L	*L*	M	L	L	L	*L*	L	M	*L*	L	R	*H*	M	L	R	*H*	L	*L*	L	H	L	L	L	L	*L*	*L*	*L*	M	L	H	L	L	L	L	L	L
30	L	L	L	L	M	L	L	L	L	L	L	M	L	R	M	L	L	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L
31	L	L	L	L	M	L	L	L	L	L	L	M	L	R	M	M	L	R	M	L	L	L	M	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L
35	L	L	L	L	M	L	L	L	L	L	L	M	L	R	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L
37	L	L	L	L	R	L	R	R	L	L	M	M	L	R	L	L	L	R	L	*R*	L	L	R	R	R	R	R	R	R	R	R	L	H	L	L	R	L	L	R
38	L	L	L	L	R	L	R	R	L	L	L	M	L	R	H	H	L	R	L	R	L	L	R	R	R	R	R	R	R	R	R	L	M	L	L	M	L	L	R
39	H	L	L	L	R	L	R	R	L	L	L	M	L	R	H	H	L	R	L	*R*	L	L	R	R	R	R	R	R	R	R	R	L	M	L	L	R	L	L	R
44	H	L	L	L	M	L	L	L	L	L	L	M	L	R	L	L	L	L	L	L	M	*H*	R	L	L	L	L	L	L	R	R	L	L	L	L	L	L	L	L
45	H	L	M	L	M	L	L	L	L	L	L	M	L	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	R	L	L	L	L	L	L	L	L
47	*H*	L	L	L	M	L	M	R	L	L	L	M	L	R	L	L	L	M	L	L	L	L	R	R	R	R	M	M	M	*H*	H	L	M	L	L	R	L	L	R
48	*H*	L	L	L	R	L	L	*L*	*L*	L	L	*L*	L	R	L	*L*	L	R	*L*	L	*L*	H	H	R	R	L	*L*	L	L	L	L	L	*L*	*L*	L	L	L	L	L	*L*
53	*H*	R	L	L	R	L	L	L	L	L	L	M	L	R	L	L	L	L	L	L	L	H	M	L	R	L	L	L	L	L	L	H	L	L	L	L	L	R	L
55	H	R	L	L	R	L	L	L	L	L	L	M	L	R	R	L	L	R	L	L	L	L	M	L	R	L	L	L	L	L	L	L	L	L	L	L	L	M	L
58	H	L	L	L	R	L	L	L	L	L	L	M	L	R	H	L	L	M	L	L	L	H	M	L	R	L	L	L	L	L	L	H	L	L	L	L	L	L	L
65	H	L	M	L	M	L	L	L	L	L	L	M	L	R	H	L	L	R	L	L	L	H	H	R	R	L	R	R	R	R	R	R	M	L	L	M	L	L	R
66	H	L	L	L	M	L	L	L	L	L	L	M	L	R	H	L	L	R	L	L	L	L	R	R	R	R	L	L	L	L	L	L	L	L	L	R	L	L	L
67	H	L	L	L	M	L	L	L	L	L	L	M	L	R	H	L	L	R	L	L	L	L	H	R	R	L	L	L	L	L	M	L	H	L	L	L	L	L	L
71	H	L	L	L	M	L	L	L	L	L	L	M	L	R	M	L	L	R	L	L	L	L	M	M	R	L	L	L	L	R	R	L	L	L	L	L	L	L	L
72	*H*	L	M	L	M	L	L	L	L	L	L	M	L	R	H	L	L	R	L	H	H	L	R	R	R	L	L	R	R	*H*	H	L	L	M	L	L	L	R	R
75	H	R	L	L	M	L	L	L	L	L	L	M	L	R	M	M	L	L	L	*R*	M	M	R	R	R	L	L	L	R	*H*	H	L	M	*H*	L	R	R	R	R

Reactivity Chart 8. Protection for the Amino Group: Carbamates (*Continued*)

	I_2	PhSeX; PhSCl	Br_2; Cl_2	MnO_2/CH_2Cl_2	$NaIO_4$ pH 5-8	SeO_2 pH 2-4	SeO_2/Py	$K_3Fe(CN)_6$, pH 8	Pb(IV), 25°	Pb(IV), 80°	$Tl(NO_3)_3$	150°	250°	350°	:CCl_2	N_2CHCO_2R/Cu	CH_2I_2/Zn(Cu)	R_3SnH/In·	Ni(CO)$_4$	CH_2N_2	$SOCl_2$	Ac_2O, 25°	Ac_2O, 80°	DCC	MeI	$Me_3O^+BF_4^-$	1.LDA 2.MeI	1.K_2CO_3 2.MeI	RCHO	RCOCl	C^+/olefin
PG	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
	L. OXIDANTS											M.			N.			O. MISCELLANEOUS											P.		
1	L	L	L	*L*	L	L	L	L	L	L	L	L	*L*	M	L	*L*	L	L.	L	*L*	L	*L*	L	L	L	R	L	L	*L*	L	L
5	L	L	L	L	L	M	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L
8	L	L	L	L	L	L	L	L	L	L	L	L	M	H	L	L	R	R	M	L	*L*	*L*	L	L	L	R	*L*	L	L	L	R
11	L	L	L	L	L	M	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L
16	L	R	R	L	L	R	R	L	R	R	R	L	M	H	R	R	R	R	R	L	L	L	L	L	L	R	R	L	L	L	R
20	L	L	L	L	L	H	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	M
22	L	L	L	L	L	H	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	M
24	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	L	M	R	L	L	L	L	L	L	L	R	L	L	L	L	H
26	L	L	L	L	L	L	H	M	L	L	L	M	H	H	L	L	L	L	L	L	L	L	L	L	L	R	R	H	L	L	M
28	L	L	L	L	L	H	*L*	L	*L*	L	L	*H*	H	H	L	L	L	L	L	*L*	L	L	L	*L*	L	R	*L*	L	*L*	*L*	H
30	L	L	L	L	L	M	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	M
31	L	L	L	L	L	M	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	M
35	L	L	L	L	L	M	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	H
37	L	R	*R*	L	L	H	L	L	M	R	R	L	M	H	R	R	R	R	H	L	L	L	L	L	L	R	L	L	L	L	R
38	L	R	R	L	L	M	R	L	M	R	R	L	M	R	R	R	R	R	*H*	L	L	L	L	L	L	R	L	L	L	L	R
39	L	R	R	L	L	M	M	L	M	R	R	L	M	R	R	R	R	R	H	L	L	L	L	L	L	R	L	L	L	L	R
44	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	R	L	H	L	L	L	L	L	R	R	L	R	L	L	M
45	L	L	L	L	L	L	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	R	R	L	R	L	L	L
47	L	L	R	L	L	L	L	L	M	R	M	L	L	M	R	R	R	R	R	L	L	L	L	L	L	R	L	L	L	L	L
48	L	*L*	L	L	*L*	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	*L*	L	R	L	L	L	*L*	M
53	L	L	L	L	L	L	R	L	L	L	L	L	L	M	L	L	L	R	L	L	L	L	L	L	L	R	L	L	L	L	M
55	L	L	L	L	L	L	M	L	L	L	L	L	L	M	M	M	M	R	L	L	L	L	L	L	L	R	L	L	L	L	M
58	L	L	L	L	L	L	R	L	L	L	L	L	L	M	L	L	L	R	L	L	L	L	L	L	L	R	L	L	L	L	L
65	L	L	R	L	L	L	R	L	M	R	M	L	L	M	M	M	M	M	L	L	L	L	L	L	R	R	L	L	L	L	H
66	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	M
67	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	H
71	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	M	L	R	L	L	L	L	L	R	R	L	R	L	L	L
72	L	L	R	L	R	L	L	L	L	M	L	L	L	M	L	L	L	R	L	L	L	L	L	L	L	R	L	L	L	L	L
75	R	R	R	L	R	M	L	L	M	R	M	L	M	H	R	R	R	R	L	R	L	L	M	L	R	R	R	R	L	L	M

Reactivity Chart 9. Protection for the Amino Group: Amides

1. *N*-Formyl
2. *N*-Acetyl
3. *N*-Chloroacetyl
5. *N*-Trichloroacetyl
6. *N*-Trifluoroacetyl
7. *N*-*o*-Nitrophenylacetyl
8. *N*-*o*-Nitrophenoxyacetyl
9. *N*-Acetoacetyl
12. *N*-3-Phenylpropionyl
13. *N*-3-(*p*-Hydroxyphenyl)propionyl
15. *N*-2-Methyl-2-(*o*-nitrophenoxy)propionyl
16. *N*-2-Methyl-2-(*o*-phenylazophenoxy)propionyl
17. *N*-4-Chlorobutyryl
19. *N*-*o*-Nitrocinnamoyl
20. *N*-Picolinoyl
21. *N*-(*N*′-Acetylmethionyl)
23. *N*-Benzoyl
29. *N*-Phthaloyl
31. *N*-Dithiasuccinoyl

(See chart, pp. 741–743.)

Reactivity Chart 9. Protection for the Amino Group: Amides

PG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	A. AQUEOUS										B. BASIC								C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
	pH<1, 100°	pH<1	pH 1	pH 2-4	pH 4-6	pH 6-8.5	pH 8.5-10	pH 10-12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^{\cdot}Na^+$	$MeSOCH_2^-Na^+$	KO-t-Bu	LiN-i-Pr_2	Py; R_3N	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^-; N_3^-; SCN^-	OAc^-; X^-	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney(Ni)	H_2/Pt pH 2-4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
1	H	*H*	*H*	*L*	L	L	L	M	H	*H*	*H*	L	R	L	L	L	L	L	L	L	*H*	L	L	M	L	H	H	L	L	L	L	*H*	L	L	L	H	L	L
2	*H*	M	L	*L*	L	L	L	*L*	M	H	*L*	R	R	R	L	*R*	*L*	R	*L*	L	*H*	*L*	*L*	L	L	H	M	L	L	L	*L*	L	*L*	L	M	L	L
3	*H*	M	L	L	L	L	L	*H*	H	H	M	R	R	R	L	R	*L*	R	R	L	H	R	L	R	L	H	M	M	R	L	M	R	R	L	L	H	H	*R*
5	H	L	L	L	L	L	M	H	H	H	L	L	R	L	L	R	*L*	L	R	R	H	M	L	R	L	H	M	M	R	M	R	R	R	L	R	H	H	M
6	H	*L*	*L*	*L*	L	L	M	*H*	*H*	H	L	L	R	L	L	L	*L*	L	R	R	*H*	M	L	R	L	H	M	L	M	M	R	R	*L*	L	L	H	H	M
7	H	L	L	L	L	L	L	L	M	H	M	R	R	R	L	R	L	R	L	L	H	L	L	L	L	H	H	M	L	L	R	*H*	R	L	R	H	H	R
8	H	L	L	L	L	L	L	L	M	H	M	R	R	R	L	L	L	R	M	M	M	M	L	M	L	H	R	L	L	L	R	R	*R*	L	R	H	H	R
9	H	*L*	L	L	L	L	L	L	H	H	R	R	R	R	R	R	L	R	R	R	*H*	L	L	L	R	H	R	R	R	R	M	R	L	L	M	L	L	L
12	H	L	L	L	L	L	L	L	M	H	M	R	R	R	L	R	L	R	L	L	M	L	L	L	L	H	M	L	L	L	L	L	L	L	R	L	L	L
13	H	L	L	L	L	L	L	L	M	H	R	R	R	R	R	R	L	R	R	L	M	L	L	L	L	H	R	L	L	L	L	L	L	L	R	L	L	L
15	H	L	L	L	L	L	L	L	M	H	L	L	R	L	L	L	L	L	L	L	M	L	L	L	L	H	R	L	L	L	R	*H*	R	L	R	H	H	R
16	H	L	L	L	L	L	L	L	H	H	L	L	R	M	L	H	L	L	L	L	M	L	L	L	L	H	R	R	L	L	R	H	R	R	R	H	H	H
17	H	L	L	L	L	L	L	L	*L*	H	M	R	R	R	R	R	L	R	R	L	M	R	L	R	L	H	M	L	R	L	M	R	R	L	L	L	L	L
19	H	L	L	L	L	L	L	L	M	H	L	L	R	R	L	L	L	L	M	R	M	M	L	M	L	H	R	R	L	L	R	*H*	R	L	R	H	H	R
20	H	L	L	L	L	L	L	L	M	H	L	L	*R*	L	L	L	L	L	L	L	H	L	L	L	L	H	M	L	L	L	L	L	L	L	R	L	L	L
21	H	L	L	L	L	L	L	L	M	H	R	R	R	R	R	R	L	R	L	L	H	L	L	L	L	H	R	L	L	L	R	R	R	R	R	L	L	L
23	H	*H*	L	L	L	L	L	*L*	*H*	H	L	L	*R*	L	*L*	*L*	L	L	L	L	*H*	L	L	M	L	H	M	L	L	L	L	L	*L*	L	R	L	L	L
29	*H*	L	*L*	*L*	L	L	L	L	*R*	H	L	*L*	*R*	L	*L*	L	L	L	*L*	*L*	*H*	*L*	L	L	L	H	M	*L*	L	L	L	L	*L*	L	R	L	L	L
31	M	*L*	L	L	L	L	*L*	M	H	H	L	L	R	R	L	L	L	L	H	H	H	*H*	L	H	L	H	R	R	M	H	R	R	R	R	R	R	R	R

Reactivity Chart 9. Protection for the Amino Group: Amides (*Continued*)

	Na/NH_3	Al(Hg)	$SnCl_2$/Py	HSO_3^-; H_2S	$LiAlH_4$	Li-s-Bu_3BH	$(C_5H_{11})_2BH$	B_2H_6, 0°	$NaBH_4$	$Zn(BH_4)_2$	$NaBH_3CN$ pH 4-6	i-Bu_2AlH	Li(OtBu)$_3$AlH	$AlCl_3$, 80°	$AlCl_3$, 25°	$SnCl_4$; BF_3	$LiClO_4$; $MgBr_2$	TsOH, 80°	TsOH, 0°	Hg(II)	Ag(I)	Cu(II)/Py	HBr/In·	HX/In·	NBS/CCl_4	Br_3CCl/In·	OsO_4	$KMnO_4$,pH 7,0°	O_3, -50°	RCO_3H, 0°	RCO_3H, 50°	CrO_3/Py	CrO_3, pH 1	H_2O_2 pH 10-12	Quinone	$^1O_2$	DMSO, 100°	NaOCl pH 10	aq NBS
PG	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	G.				H. HYDRIDE REDN.									I.						J.			K.				L. OXIDANTS											
1	R	L	L	L	*R*	L	H	R	L	L	L	H	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	*L*	L	M	L	H	M	L	L	L	L	L
2	R	L	L	L	*R*	L	H	R	*L*	L	*L*	H	L	L	*L*	*L*	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	*L*	L	*L*	*L*	L	*L*	L	L
3	R	M	L	L	R	M	H	R	L	L	L	H	L	M	M	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L
5	R	M	L	L	H	M	H	R	*H*	M	M	H	M	M	M	L	L	L	L	L	H	L	R	R	R	R	L	L	L	L	L	L	L	L	L	L	R	L
6	R	L	L	L	H	M	H	R	*H*	M	M	H	M	L	*L*	L	L	*L*	L	L	M	L	L	L	L	L	L	L	L	*L*	R	L	L	L	L	L	R	L
7	R	R	L	L	R	M	H	R	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L
8	R	R	L	L	R	M	H	R	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
9	R	L	L	L	R	R	H	R	R	R	R	H	R	R	R	M	L	L	L	L	L	*L*	L	L	L	L	L	*H*	L	L	M	L	*H*	L	L	L	L	R	R
12	R	L	L	L	R	L	H	R	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L
13	R	L	L	L	R	L	H	R	L	L	L	H	L	L	L	L	L	L	L	L	L	L	R	R	R	R	L	R	L	L	L	M	R	M	M	L	L	R	*H*
15	R	R	L	L	R	M	H	R	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
16	R	*H*	R	L	R	L	H	R	R	R	L	H	M	R	L	L	L	L	L	L	R	L	R	R	R	R	L	L	R	M	R	L	R	R	L	R	L	L	L
17	R	L	L	L	R	M	H	R	L	L	L	H	L	M	M	L	L	L	L	L	*H*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L
19	R	R	L	L	R	M	H	R	L	L	L	H	L	M	M	L	L	L	L	L	L	L	R	R	R	R	R	R	R	L	M	L	L	R	L	L	L	L	R
20	R	L	L	L	R	L	H	R	L	L	L	H	L	L	L	L	L	L	L	H	L	H	L	L	R	L	L	L	L	M	R	M	M	L	L	L	L	L	L
21	R	L	L	L	R	L	H	R	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	R	R	R	L	R	L	L	R	L	R	R
23	R	*L*	L	L	*R*	L	H	R	*L*	L	L	*H*	L	L	L	L	L	*L*	L	*L*	L	L	L	L	L	L	*L*	L	L	L	L	*L*	L	L	L	L	*L*	L	L
29	*R*	L	L	L	R	L	H	R	*L*	L	L	H	L	L	L	L	L	L	L	L	L	*H*	L	L	L	L	L	L	*L*	L	*L*	L	L	L	L	L	L	L	L
31	R	R	R	L	R	R	H	R	R	L	L	H	R	R	R	L	L	R	L	R	M	L	R	R	R	R	M	R	R	R	R	L	R	R	R	R	R	R	R

Reactivity Chart 9. Protection for the Amino Group: Amides (*Continued*)

	I_2	PhSeX; PhSCl	Br_2; Cl_2	MnO_2/CH_2Cl_2	$NaIO_4$ pH 5-8	SeO_2 pH 2-4	SeO_2/Py	$K_3Fe(CN)_6$, pH 8	Pb(IV), 25°	Pb(IV), 80°	$Tl(NO_3)_3$	150°	250°	350°	$:CCl_2$	N_2CHCO_2R/Cu	$CH_2I_2/Zn(Cu)$	$R_3SnH/In\cdot$	$Ni(CO)_4$	CH_2N_2	$SOCl_2$	Ac_2O, 25°	Ac_2O, 80°	DCC	MeI	$Me_3O^+BF_4^-$	1.LDA 2.MeI	1.K_2CO_3 2.MeI	RCHO	RCOCl	C^+/olefin
PG	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
	L. OXIDANTS											M.			N.			O. MISCELLANEOUS											P.		
1	L	L	M	L	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	*L*	L	R	*R*	L	L	*H*	L
2	L	L	L	L	L	L	L	L	L	*L*	L	*L*	*L*	L	L	L	L	L	L	*L*	L	*L*	*L*	*L*	L	*R*	*R*	L	L	*L*	L
3	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	R	L	L	L	L	*L*	L	L	R	R	L	L	L	L
5	L	L	L	L	L	L	L	M	L	L	L	*L*	M	R	L	L	H	R	M	L	L	L	*L*	L	L	R	L	M	L	L	L
6	L	L	L	L	M	L	L	M	L	L	L	L	M	R	L	L	L	R	L	L	L	L	*L*	*L*	L	R	L	L	L	*L*	L
7	L	L	L	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	R	R	L	L	L	L
8	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	R	R	L	L	L	L
9	L	L	R	L	*M*	*H*	*M*	L	M	R	M	L	L	M	L	M	L	*R*	L	M	L	M	M	L	L	R	R	R	L	M	M
12	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	R	R	L	L	L	L
13	M	L	*H*	M	M	M	M	R	M	R	L	L	L	L	L	L	L	L	L	R	L	R	R	R	L	R	R	R	L	R	L
15	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	L	R	L	L	L	L	L
16	L	L	L	L	L	L	L	R	L	M	R	R	R	R	M	R	R	R	L	L	L	L	*L*	L	L	R	L	M	L	L	R
17	L	L	L	L	L	L	L	L	L	L	L	R	R	R	L	L	R	R	L	L	L	L	*L*	L	L	R	R	L	L	L	L
19	L	L	M	L	L	L	L	L	L	R	M	L	L	L	R	R	R	L	L	L	L	L	*L*	L	L	R	L	L	L	L	*M*
20	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	L	L	L	L	L	*L*	L	M	R	L	M	L	L	L
21	L	L	R	L	R	M	L	L	R	R	L	M	H	H	M	M	L	L	L	L	L	L	*L*	L	R	R	R	R	L	L	L
23	L	L	L	L	L	L	L	*L*	L	L	L	L	*L*	L	L	L	L	L	L	*L*	L	*L*	*L*	L	L	R	L	L	L	*L*	L
29	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	*L*	*L*	L	R	L	L	L	L	L
31	M	M	R	R	M	R	*M*	R	R	R	L	L	M	H	M	M	H	R	R	L	L	L	*L*	L	M	R	M	L	L	L	L

Reactivity Chart 10. Protection for the Amino Group: Special –NH Protective Groups

1. *N*-Allyl
2. *N*-Phenacyl
3. *N*-3-Acetoxypropyl
5. Quaternary Ammonium Salts
6. *N*-Methoxymethyl
8. *N*-Benzyloxymethyl
9. *N*-Pivaloyloxymethyl
12. *N*-Tetrahydropyranyl
13. *N*-2,4-Dinitrophenyl
14. *N*-Benzyl
16. *N*-*o*-Nitrobenzyl
17. *N*-Di(*p*-methoxyphenyl)methyl
18. *N*-Triphenylmethyl
19. *N*-(*p*-Methoxyphenyl)diphenylmethyl
20. *N*-Diphenyl-4-pyridylmethyl
21. *N*-2-Picolyl *N*′-Oxide
24. *N*,*N*′-Isopropylidene
25. *N*-Benzylidene
27. *N*-*p*-Nitrobenzylidene
28. *N*-Salicylidene
33. *N*-(5,5-Dimethyl-3-oxo-1-cyclohexenyl)
37. *N*-Nitro
39. *N*-Oxide
40. *N*-Diphenylphosphinyl
41. *N*-Dimethylthiophosphinyl
47. *N*-Benzenesulfenyl
48. *N*-*o*-Nitrobenzenesulfenyl
55. *N*-2,4,6-Trimethylbenzenesulfonyl
56. *N*-Toluenesulfonyl
57. *N*-Benzylsulfonyl
59. *N*-Trifluoromethylsulfonyl
60. *N*-Phenacylsulfonyl

(See chart, pp. 745–747.)

Reactivity Chart 10. Protection for the Amino Group: Special —NH Protective Groups

PG	pH<1, 100°	pH<1	pH 1	pH 2–4	pH 4–6	pH 6–8.5	pH 8.5–10	pH 10–12	pH>12	pH>12, 150°	NaH	Ph_3CNa	$(C_{10}H_8)^-Na^+$	$MeSOCH_2^-Na^+$	KO-t-Bu	LiN-i-Pr_2	Py; R_3N	$NaNH_2$	NaOMe	Enolate	NH_3; RNH_2	RS^-; N_3^-; SCN^-	OAc^-; X^-	NaCN, pH 12	HCN, pH 6	RLi	RMgX	Organozinc	Organocopper	Wittig; ylide	H_2/Raney(Ni)	H_2/Pt pH 2–4	H_2/Pd	H_2/Lindlar	H_2/Rh	Zn/HCl	Zn/HOAc	Cr(II), pH 5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
				A. AQUEOUS										B. BASIC							C. NUCLEOPHILIC							D. ORGANOMET.					E. CAT. REDN.					F.		
1	H	L	L	L	L	L	L	L	L	R	L	R	R	R	*R*	R	L	R	L	L	L	L	L	L	L	L	L	L	L	R	R	H	L	R	L	L	L
2	H	*L*	L	L	L	L	L	L	*L*	R	R	R	R	R	R	R	L	R	M	M	*M*	L	L	R	R	R	R	M	L	R	*R*	R	L	R	H	*H*	L
3	H	R	L	L	L	L	M	R	R	R	L	R	R	R	L	R	L	R	*R*	R	R	L	L	L	L	R	R	L	L	L	*L*	L	L	L	L	L	L
5	H	L	L	L	L	L	L	L	L	R	L	R	L	M	M	R	L	R	L	L	L	*H*	L	M	L	R	R	*L*	L	R	L	L	L	L	H	L	L
6	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
8	H	H	*L*	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	L	H	H	*R*	L	L	L	L	L
9	H	H	M	L	L	L	M	H	H	H	L	L	R	R	L	L	L	H	H	M	*H*	L	L	L	L	R	R	L	L	L	L	L	L	L	M	L	L
12	H	H	*H*	H	H	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	H	H	H
13	H	L	*L*	L	L	L	L	L	H	H	L	M	R	L	L	L	L	H	M	M	*L*	*H*	L	R	L	R	R	M	M	L	R	R	R	L	R	R	R
14	H	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	M	M	L	*H*	L	L	L
16	H	L	L	L	L	L	L	L	L	R	L	M	R	L	L	L	L	L	L	L	L	L	L	R	L	H	H	M	M	L	H	H	H	L	R	R	R	R
17	H	H	H	*H*	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	L	H	H	L
18	H	*H*	*H*	*H*	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	L	H	H	L
19	H	H	*H*	H	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	L	H	H	L
20	M	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	R	L	L	L	H	H	*H*	L	L	H	*H*	L
21	H	L	L	L	L	L	L	L	L	R	L	L	R	L	L	*H*	L	*H*	L	L	L	L	L	L	L	R	R	L	L	L	R	R	R	R	R	R	R	R
24	H	H	H	M	L	L	L	L	L	H	L	L	R	L	L	L	L	L	L	L	H	L	L	L	R	R	R	R	M	R	R	R	R	L	R	R	R	R
25	H	H	*H*	M	L	L	L	L	M	H	L	L	R	L	L	L	L	L	L	L	*H*	L	L	L	R	R	R	R	M	R	*R*	R	*H*	L	R	R	R	R
27	H	H	H	M	L	L	L	L	L	H	L	M	R	L	L	*L*	L	L	L	L	H	L	L	R	R	R	R	R	M	M	R	R	R	L	R	R	R	R
28	H	H	*H*	M	L	L	L	L	M	H	R	R	R	R	R	R	L	R	R	R	H	*L*	L	R	R	R	R	R	R	R	*R*	R	R	L	R	R	R	R
33	H	H	*L*	L	L	L	L	L	L	H	L	R	R	R	R	R	L	R	H	R	H	R	L	R	L	R	R	R	M	M	R	R	R	L	R	R	R	R
37	H	*L*	*L*	L	L	L	L	L	*L*	H	L	L	R	L	L	L	H	H	H	H	R	*L*	*L*	*L*	*L*	R	H	H	M	L	R	H	*H*	L	H	H	H	H
39	H	M	L	L	L	L	L	L	L	H	L	L	R	L	L	M	L	L	L	L	L	L	L	L	L	R	R	L	L	L	H	*H*	*H*	H	*H*	*H*	H	H	H
40	H	*H*	*H*	*M*	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	*L*	L	L	L	L	L	L	L	L	L	L	M	L	L	H	M	L
41	H	*H*	*H*	*L*	L	L	L	L	L	H	L	L	R	L	L	L	L	L	L	L	L	L	L	L	L	M	M	M	L	L	R	R	R	L	R	H	L	L
47	H	M	L	L	L	L	L	L	M	H	L	L	R	L	L	L	L	L	L	R	H	H	*H*	H	H	L	L	L	L	L	R	R	R	L	R	L	L	L
48	H	H	*H*	*H*	L	L	L	L	M	H	L	M	R	L	L	L	L	L	L	R	H	*H*	H	H	*H*	R	R	M	M	L	*R*	R	R	L	R	H	H	R
55	*H*	L	L	L	L	L	L	L	*L*	*L*	L	L	H	L	L	L	L	L	L	L	*L*	L	L	L	L	H	H	H	L	L	L	L	L	L	H	L	L
56	*H*	L	L	L	L	L	L	L	L	*L*	L	L	*H*	L	L	L	L	L	L	L	*L*	*L*	L	L	L	H	H	H	L	L	*L*	L	L	L	*H*	*L*	L
57	H	M	L	L	L	L	L	L	L	H	R	R	R	R	R	R	L	R	R	R	L	R	L	L	L	H	H	H	L	L	*H*	H	H	L	L	H	M	M
59	H	L	L	L	L	L	L	L	L	H	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	L	L	L	L	L	L	L	L	M
60	H	L	L	L	L	L	L	*L*	R	H	R	R	R	R	R	R	L	R	R	R	R	R	L	R	R	H	H	H	R	R	H	H	H	L	R	H	*H*	M

Reactivity Chart 10. Protection for the Amino Group: Special —NH Protective Groups (*Continued*)

	Na/NH_3	Al(Hg)	$SnCl_2$/Py	HSO_3^-; H_2S	$LiAlH_4$	Li-s-Bu_3BH	$(C_5H_{11})_2BH$	B_2H_6, 0°	$NaBH_4$	$Zn(BH_4)_2$	$NaBH_3CN$ pH 4-6	i-Bu_2AlH	Li(OtBu)$_3$AlH	$AlCl_3$, 80°	$AlCl_3$, 25°	$SnCl_4$; BF_3	$LiClO_4$; $MgBr_2$	TsOH, 80°	TsOH, 0°	Hg(II)	Ag(I)	Cu(II)/Py	HBr/In·	HX/In·	NBS/CCl_4	Br_3CCl/In·	OsO_4	$KMnO_4$, pH 7, 0°	O_3, -50°	RCO_3H, 0°	RCO_3H, 50°	CrO_3/Py	CrO_3, pH 1	H_2O_2 pH 10-12	Quinone	$^1O_2$	DMSO, 100°	NaOCl pH 10	aq NBS
PG	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
	G.				H. HYDRIDE REDN.									I.						J.			K.				L. OXIDANTS											
1	R	L	L	L	L	L	R	R	L	L	L	L	L	L	L	L	L	L	L	R	L	L	R	R	R	R	R	R	R	R	R	R	L	R	R	R	M	M	R
2	*R*	R	L	R	R	R	R	R	R	R	M	R	R	L	L	L	L	L	L	L	L	L	L	L	L	L	R	R	R	R	R	R	L	R	R	R	M	M	R
3	R	L	L	L	R	L	L	L	L	L	L	R	M	R	L	L	L	R	L	L	L	L	L	L	L	L	R	R	R	R	R	R	L	R	R	R	M	R	R
5	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L
6	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	M	L	L	L	L	L	L	L	L	R	R	R	R	R	R	L	R	R	R	M	M	R
8	H	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	M	L	L	L	L	L	L	R	L	R	R	R	R	R	R	L	R	R	R	M	M	R
9	R	L	L	L	R	L	L	L	L	L	L	R	M	H	H	M	L	R	L	L	L	L	L	L	L	L	R	R	R	R	R	R	M	R	R	R	M	R	R
12	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	L	M	L	L	L	L	L	L	L	L	R	R	R	R	R	R	H	R	R	R	M	M	R
13	R	R	R	L	R	L	L	L	L	L	L	R	M	L	L	L	L	L	L	L	L	L	L	L	L	L	*L*	*M*	*M*	*M*	*H*	*L*	L	*L*	*L*	L	*L*	*M*	*L*
14	H	M	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	R	R	R	R	R	R	L	R	R	R	M	M	R
16	H	R	L	L	R	L	L	L	L	L	M	R	M	L	L	L	L	L	L	L	L	L	L	L	R	L	R	R	R	R	R	R	L	R	R	R	M	M	R
17	H	L	L	L	L	L	L	L	L	L	L	L	L	R	R	L	M	L	L	L	L	L	L	L	R	L	R	R	R	R	R	R	H	R	R	R	M	M	R
18	*H*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	R	R	R	R	R	H	R	R	L	M	M	R
19	H	L	L	L	L	L	L	L	L	L	L	L	L	R	R	L	M	L	L	L	L	L	L	L	L	L	R	R	R	R	R	R	H	R	R	L	M	M	R
20	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	R	R	R	R	R	L	R	R	L	M	M	R
21	R	R	R	L	R	M	R	R	M	L	L	M	M	R	L	L	L	L	L	L	L	R	L	L	R	L	R	R	R	R	R	R	L	R	R	R	R	M	R
24	R	M	L	M	R	L	R	R	L	L	R	R	R	L	L	L	L	M	L	M	M	H	R	R	R	R	R	R	R	R	R	R	H	M	R	*L*	R	R	R
25	R	M	L	*R*	R	L	R	R	M	M	R	R	R	L	L	L	L	M	L	M	M	H	R	R	R	R	R	R	R	R	R	R	H	M	R	*L*	R	R	R
27	R	R	L	R	R	L	R	R	M	M	R	R	R	L	L	L	L	M	L	M	M	H	R	R	R	R	R	R	R	R	R	R	H	M	R	*L*	R	*R*	R
28	R	M	L	M	R	L	R	R	M	M	R	R	R	R	R	R	L	R	L	M	M	H	R	R	R	R	R	R	R	R	R	R	H	M	R	*M*	R	R	R
33	R	L	L	R	R	R	R	R	L	L	M	R	R	L	L	L	L	L	H	L	L	M	H	R	R	R	R	R	R	R	R	*L*	L	*L*	R	R	*L*	*L*	R
37	R	R	R	L	R	L	R	R	L	L	R	*L*	R	L	L	L	L	L	L	L	L	L	H	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
39	H	H	H	*H*	H	M	R	R	M	L	M	H	H	R	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L
40	H	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L
41	H	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	M	L	H	H	H	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L
47	H	H	M	M	H	M	R	R	R	M	H	H	H	*H*	L	L	L	M	L	H	H	H	L	L	*R*	L	R	R	R	R	R	L	L	L	R	*L*	R	R
48	H	H	M	*H*	H	H	R	R	R	M	H	H	H	L	L	L	L	M	L	H	H	H	L	L	L	L	R	R	R	R	R	R	L	L	L	M	*L*	R	R
55	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	L	L	L	L	M	L
56	*H*	H	L	L	*L*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	L	L	L	L	L	L	L	L	L	L	L	M	L
57	*H*	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	M	*L*
59	M	L	L	L	*R*	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L
60	H	H	L	L	R	R	R	R	M	M	M	R	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	R	L	M	R

Reactivity Chart 10. Protection for the Amino Group: Special —NH Protective Groups (*Continued*)

PG	I_2 78	PhSeX; PhSCl 79	Br_2; Cl_2 80	MnO_2/CH_2Cl_2 81	$NaIO_4$ pH 5–8 82	SeO_2 pH 2–4 83	SeO_2/Py 84	$K_3Fe(CN)_6$, pH 8 85	Pb(IV), 25° 86	Pb(IV), 80° 87	$Tl(NO_3)_3$ 88	150° 89	250° 90	350° 91	:CCl_2 92	N_2CHCO_2R/Cu 93	CH_2I_2/Zn(Cu) 94	R_3SnH/In· 95	Ni(CO)$_4$ 96	CH_2N_2 97	$SOCl_2$ 98	Ac_2O, 25° 99	Ac_2O, 80° 100	DCC 101	MeI 102	$Me_3O^+BF_4^-$ 103	1.LDA 2.MeI 104	1.K_2CO_3 2.MeI 105	RCHO 106	RCOCl 107	C^+/olefin 108
	L. OXIDANTS											N.						O. MISCELLANEOUS												P.		
1	L	R	R	R	R	R	R	R	R	R	R	L	L	M	R	R	R	L	R	L	L	L	L	L	R	R	L	R	L	*L*	R
2	L	M	R	R	R	R	R	R	R	R	R	L	L	M	L	L	L	R	L	R	L	L	L	*L*	R	R	R	R	L	L	R
3	L	L	R	R	R	M	L	R	R	R	R	L	L	R	L	L	L	L	L	L	L	L	L	L	R	R	M	R	L	L	R
5	L	L	L	L	L	L	L	L	L	L	L	R	R	R	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	*R*	L
6	L	L	R	R	R	M	L	R	R	R	R	L	L	M	L	L	L	L	L	L	L	L	L	L	R	R	L	R	L	L	R
8	L	L	R	R	R	R	M	R	R	R	R	L	L	M	L	L	L	L	L	L	L	L	*L*	L	R	R	L	R	L	L	R
9	L	L	R	R	R	M	L	R	R	R	R	L	L	H	L	L	L	L	L	L	L	L	L	L	R	R	L	R	L	L	R
12	L	L	R	R	R	M	L	R	R	R	R	L	L	H	L	L	L	L	L	L	L	L	L	L	R	R	L	R	L	L	R
13	L	L	*M*	*L*	*L*	*L*	L	*L*	*L*	*L*	*L*	L	M	H	L	L	L	L	L	L	L	L	L	L	M	R	L	M	L	L	R
14	L	L	R	R	R	R	M	R	R	R	R	L	L	M	L	L	L	L	L	*L*	L	L	L	L	R	R	*L*	R	L	L	R
16	L	L	R	R	R	M	L	R	R	R	R	L	L	R	L	L	L	L	L	L	L	L	L	L	M	R	L	M	L	L	R
17	L	L	R	R	R	R	M	R	R	R	R	L	L	M	L	L	L	L	L	L	L	L	L	L	R	R	L	R	L	L	R
18	L	L	R	R	R	M	L	R	R	R	R	L	L	M	L	L	L	L	L	L	L	L	L	L	R	R	L	R	L	L	R
19	L	L	R	R	R	M	L	R	R	R	R	L	L	M	L	L	L	L	L	L	L	L	L	L	M	R	L	R	L	L	R
20	L	L	R	R	R	M	L	R	R	R	R	L	L	M	L	L	L	L	M	L	L	R	R	L	R	R	L	R	L	L	R
21	L	L	R	R	R	R	M	R	R	R	R	R	R	R	L	L	L	M	M	M	H	*H*	H	L	R	R	L	R	L	R	R
24	R	R	R	R	R	R	R	R	R	R	R	L	M	H	R	R	R	L	L	L	R	R	R	*L*	M	R	L	M	L	L	R
25	R	R	R	R	R	R	M	R	R	R	R	L	M	H	R	R	R	R	L	L	L	*L*	H	L	M	R	*L*	M	L	L	R
27	R	R	R	R	R	M	M	R	R	R	R	L	M	H	R	R	R	R	L	L	L	M	R	*L*	M	R	L	M	L	L	R
28	R	R	R	R	R	R	M	R	R	R	R	L	M	H	R	R	R	R	L	M	R	R	R	R	M	R	R	R	L	R	R
33	L	*R*	R	L	R	R	R	M	R	R	R	L	L	M	R	R	R	L	L	L	L	M	H	*L*	L	R	R	L	L	L	R
37	R	R	R	R	R	R	R	R	R	R	R	L	R	R	R	R	R	R	L	R	L	M	H	*L*	M	R	R	M	R	R	R
39	L	L	L	L	L	L	L	L	L	L	L	H	R	R	L	L	L	L	L	L	H	H	H	L	L	R	L	L	L	R	R
40	L	L	L	L	L	M	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	R	R	L	R	L	L	M
41	L	L	L	L	R	M	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	R	R	L	R	L	*L*	M
47	R	L	R	*R*	R	R	L	R	R	R	R	L	M	H	*H*	L	L	*H*	L	L	*L*	M	R	L	R	R	R	R	L	L	R
48	R	L	R	R	R	M	L	M	R	R	R	L	M	R	L	L	L	L	L	L	*L*	R	R	L	R	R	R	R	L	L	R
55	L	L	L	L	L	M	L	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	R	R	R	R	L	L	M
56	L	L	L	L	L	M	L	L	L	L	L	L	M	H	L	L	L	L	L	L	*L*	L	L	*L*	L	R	R	R	L	L	M
57	L	R	*M*	L	L	R	M	L	L	L	L	L	M	H	L	L	L	L	L	L	L	L	L	L	L	R	R	M	L	L	M
59	L	L	L	L	L	L	L	L	L	L	L	L	M	R	L	L	L	L	L	L	L	L	L	L	L	R	R	R	L	*L*	M
60	L	R	R	L	L	R	R	L	L	L	L	L	M	H	L	L	L	R	L	R	R	R	R	L	M	R	R	R	L	L	M