γ -Hydroxy- α , β -Alkenenitriles: Chelation- Controlled Conjugate Additions

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15282-1530.

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Compound	4a	4b	4c	4d	4e	4f	4g	4h	4i	4j	4k	4l
Procedure	S2	S2	S2	S3	S3	S3	S4	S4	S4	S5	S5	S6
¹ H NMR	S9	11	S13	S15	S17	S19	S21	S23	S25	S27	S29	S32
¹³ C NMR	S10	S12	S14	S16	S18	S20	S22	S24	S26	S28	S30	S33
X-ray											S31	

Compound	4m	4n	1o	4o	1q
Procedure	S5	S6	S6	S6	S7
¹ H NMR	S34	S36	S38	S40	S42
¹³ C NMR	S35	S37	S39	S41	S43
X-ray					

General conjugate addition procedure: A THF solution of *t*-BuMgCl (1.0 equiv, 1-2 M) was added to a cold (-78 °C), THF solution (0.5-1 M) of the γ -hydroxy- α,β -alkenenitrile under nitrogen. After 5 min, a THF solution of RMgX (1.1 equiv, 1-3 M) was added, and cooling bath was removed. After 1.5 h, saturated, aqueous NH₄Cl was added, and the aqueous phase was extracted with EtOAc. The combined extracts were dried (Na₂SO₄), concentrated, and then purified by radial chromatography. A modified workup procedure was developed for water-soluble products where HOAc (3.2 equiv) was added after 1.5 h rather than saturated, aqueous

NH₄Cl. The solution was then diluted with EtOAc and the resulting mixture filtered through silica gel. The crude product was concentrated, and purified by radial chromatography.

4-Hydroxy-3-methylbutanenitrile (4a). The general procedure with an HOAc workup was employed with **1a**¹ (94.1 mg in 2 mL of THF), followed by radial chromatography (3:2 EtOAc/hexanes) to provide 83.2 mg of **4a** (74%) as an oil: IR (film) 3426, 2247 cm⁻¹; ¹H NMR δ 1.06 (d, *J* = 6.9 Hz, 3H), 1.98-2.10 (m, 2H), 2.38 (dd, *J* = 17, 7 Hz, 1H), 2.50 (dd, *J* = 17, 6 Hz, 1H), 3.47 (dd, *J* = 10.8, 8 Hz, 1H), 3.64 (dd, *J* = 10.8, 4.9 Hz, 1H); ¹³C NMR δ 15.9, 20.9, 32.9, 65.7, 118.7; MS *m/e* 99 (M).

3-(Hydroxymethyl)heptanenitrile (4b). The general procedure with an HOAc workup was employed with **1a**¹ (89.2 mg in 2 mL of THF), followed by radial chromatography (1:1 EtOAc/hexanes) to provide 119.7 mg of **4b** (80%) as an oil: IR (film) 3444, 2249 cm⁻¹; ¹H NMR δ 0.89 (t, *J* = 7 Hz, 3H), 1.23-1.46 (m, 6H), 1.83-1.91 (m, 1H), 2.16 (br s, 1H), 2.47 (d, *J* = 5.9 Hz, 2H), 3.51 (dd, *J* = 11, 7.5 Hz, 1H), 3.70 (dd, *J* = 11, 4.4 Hz, 1H); ¹³C NMR δ 13.8, 19.0, 22.6, 28.8, 29.8, 37.6, 63.7, 118.8; MS *m/e* 142 (M + H).

7-Chloro-3-(hydroxymethyl)heptanenitrile (4c). The general procedure with an HOAc workup was employed with **1a**¹ (104.0 mg in 2 mL of THF) using a THF solution of chlorobutylmagnesium bromide.² Purification by radial chromatography (2:3 EtOAc/hexanes) provided 17.0 mg (11%) of **4b** and 105.4 mg of **4c** (51%) as an oil. For **4c**: IR (film) 3441, 2249 cm⁻¹; ¹H NMR δ 1.39-1.55 (m, 4H), 1.68-1.84 (m, 2H), 1.90 (pent, *J* = 6 Hz, 1H), 1.99 (br s,

¹ Fleming, F. F.; Wang, Q.; Steward, O. W. *J. Org. Chem.* **2001**, 66, 2171.

² Bernady, K. F.; Poletto, J. F.; Nocera, J.; Mirando, P.; Schaub, R. E.; Weiss, M. J. *J. Org. Chem.* **1980**, 45, 4702.

1H), 2.49 (d, $J = 5.9$ Hz, 2H), 3.54 (t, $J = 6.4$ Hz, 2H), 3.55 (dd, $J = 10.9, 7.2$ Hz, 1H), 3.72 (dd, $J = 10.9, 4.4$ Hz, 1H); ^{13}C NMR δ 19.0, 24.0, 29.4, 32.3, 37.6, 44.6, 63.6, 118.6; MS m/e 176 ($\text{M} + \text{H}$); HRMS (ESI) calcd for ($\text{M} + \text{Na}^+$) $\text{C}_8\text{H}_{14}\text{ClNO}$ 198.0656, found 198.0652.

3-Cyclopentyl-4-hydroxybutanenitrile (4d). The general procedure with an HOAc workup was employed with **1a**¹ (65.1 mg in 2 mL of THF), followed by radial chromatography (1:1 EtOAc/hexanes) to provide 94.3 mg of **4d** (79%) as an oil: IR (film) 3471, 2246 cm^{-1} ; ^1H NMR δ 1.07-1.18 (m, 2H), 1.48-1.90 (m, 8H), 2.23 (s, 1H), 2.47 (dd, $J = 17, 6.2$ Hz, 1H), 2.63 (dd, $J = 17, 4.4$ Hz, 1H), 3.56 (ddd, $J = 11, 7.7, 4.6$ Hz, 1H), 3.81 (dt, $J = 11, 4$ Hz, 1H); ^{13}C NMR δ 18.2, 24.6, 25.0, 30.5, 30.8, 40.5, 43.3, 62.9, 119.0; MS m/e 154 ($\text{M} + \text{H}$); HRMS (ESI) calcd for ($\text{M} + \text{H}$) $\text{C}_9\text{H}_{16}\text{NO}$ 154.1226, found 154.1237.

5-(1,3-Dioxolan-2-yl)-3-(hydroxymethyl)pentanenitrile (4e). The general procedure with an NH_4Cl workup was employed with **1a**¹ (82.7 mg in 2 mL of THF), the appropriate Grignard reagent,³ and followed by radial chromatography (2:3 EtOAc/hexanes) to provide 142.7 mg of **4e** (78%) as an oil: IR (film) 3436, 2247 cm^{-1} ; ^1H NMR δ 1.53-1.81 (m, 5H), 1.90-2.02 (m, 1H), 2.49 (d, $J = 6.1$ Hz, 2H), 3.60 (ddd, $J = 11, 6.6, 5$ Hz, 1H), 3.74 (dt, $J = 11, 4.3$ Hz, 1H), 3.83-4.04 (m, 4H), 4.86 (t, $J = 4.4$ Hz, 1H); ^{13}C NMR δ 18.9, 24.1, 30.5, 37.3, 63.0, 64.7, 103.8, 118.6; MS m/e 186 ($\text{M} + \text{H}$); HRMS (ESI) calcd for ($\text{M} + \text{Na}^+$) $\text{C}_9\text{H}_{15}\text{NO}_3$ 208.0944, found 208.0939.

³ Wilson, S. R.; Zucker, P. A. *J. Org. Chem.* **1988**, 53, 4682.

3-Phenyl-4-hydroxybutanenitrile (4f) The general procedure with an HOAc workup was employed with **1a**¹ (93.3 mg in 2 mL of THF), followed by radial chromatography (1:1 EtOAc/hexanes) to provide 136.6 mg of **4f** (76%) as an oil: IR (film) 3441, 2226 cm⁻¹; ¹H NMR δ 1.68 (s, 1H), 2.73 (dd, J = 17, 7.7 Hz, 1H), 2.86 (dd, J = 17, 6 Hz, 1H), 3.19 (pent, J = 7 Hz, 1H), 3.83-3.96 (m, 2H), 7.25-7.41 (m, 5H); ¹³C NMR δ 20.4, 44.2, 65.1, 118.5, 127.4, 127.8, 129.0, 138.7; MS m/e 162 (M + H).

3-(Hydroxymethyl)pent-4-enenitrile (4g). The general procedure with an HOAc workup was employed with **1a**¹ (110.2 mg in 3 mL of THF), followed by radial chromatography (1:2 EtOAc/hexanes) to provide 92.7 mg of **4g** (63%) as an oil: IR (film) 3423, 2242 cm⁻¹; ¹H NMR δ 1.81 (t, J = 5 Hz, 1H), 2.50 (dd, J = 17.5, 8 Hz, 1H), 2.54-2.70 (m, 2H), 3.63 (dt, J = 11, 6.0 Hz, 1H), 3.72 (dt, J = 11, 5 Hz, 1H), 5.26 (dt, J = 17, 1 Hz, 1H), 5.28 (dt, J = 11, 1 Hz, 1H), 5.75 (ddd, J = 17, 11, 7 Hz, 1H); ¹³C NMR δ 18.9, 42.0, 63.5, 118.2, 118.4, 135.2; MS m/e 112 (M + H).

3-(Hydroxymethyl)-5-phenylpent-4-ynenitrile (4h). The general procedure with an NH₄Cl workup was employed with **1a**¹ (86.7 mg in 2 mL of THF) using PhC $\equiv$ CMgCl prepared by reacting 1.7 equiv of phenylacetylene and 1.5 equiv of methyl magnesium chloride at rt for 1 h. After radial chromatography (1:2 EtOAc/hexanes) 118.7 mg of **4h** (62%) was obtained as an oil: IR (film) 3420, 2249 cm⁻¹; ¹H NMR δ 2.41 (br s, 1H), 2.70 (dd, J = 16.6, 7 Hz, 1H), 2.78 (dd, J = 16.6, 6.0 Hz, 1H), 3.12 (pent, J = 6 Hz, 1H), 3.65-3.95 (m, 2H), 7.22-7.50 (m, 5H); ¹³C NMR δ 20.0, 32.1, 63.4, 84.7, 85.6, 117.7, 122.1, 128.2, 128.4, 131.6; MS m/e 186 (M + H); HRMS (ESI) calcd for (M+) C₁₂H₁₁NO 185.0835, found 185.0822.

4-Hydroxy-3-methyl-3-phenylbutanenitrile (4i). The general procedure with an NH_4Cl workup was employed with **1i**¹ (63.6 mg in 2 mL of THF), and PhMgCl (2.2 equiv), followed by radial chromatography (2:3 EtOAc/hexanes) to provide 72.1 mg of **4i** (63%): IR (film) 3444, 2248 cm^{-1} ; ^1H NMR δ 1.50 (s, 3H), 1.87 (s, 1 H), 2.81 (s, 2H), 3.73 (s, 2H), 7.27-7.42 (m, 5H); ^{13}C NMR δ 22.6, 26.6, 42.3, 69.9, 118.1, 125.9, 127.3, 128.8, 142.0; MS m/e 176 (M + H); HRMS (ESI) calcd for $(\text{M}+\text{Na}^+)$ $\text{C}_{11}\text{H}_{13}\text{NONa}$ 198.0889, found 198.0897.

(±)-(2S,1R,3R)-3-Hydroxy-2-methylcyclohexanecarbonitrile (4j). The general procedure with an NH_4Cl workup was employed with **1j**¹ (16.1 mg in 2 mL of THF) and MeMgCl (2.5 equiv), followed by radial chromatography (2:3 EtOAc/hexanes) to provide 10.9 mg (60%) of **4j** as an oil: IR (film) 3451, 2239 cm^{-1} ; ^1H NMR δ 1.17 (d, $J = 6.9$ Hz, 3H), 1.29-1.86 (m, 7H), 2.05-2.10 (m, 1H), 2.62 (td, $J = 11, 3$ Hz, 1H), 3.91 (br s, 1H); ^{13}C NMR δ 16.4, 18.5, 29.4, 30.2, 32.3, 38.8, 68.9, 122.5; MS m/e 140 (M + H).

(±)-(1R,3R)-3-Hydroxy-2-phenylcyclohexanecarbonitrile (4k). The general procedure with an NH_4Cl workup was employed with **1j**¹ (29.2 mg in 2 mL of THF), followed by radial chromatography (1:2 EtOAc/hexanes) to provide 40.6 mg (86%) of **4k** as a crystalline solid (m.p. 115-116 °C) whose structure was unambiguously determined by x-ray crystallography: IR (film) 3455, 2239 cm^{-1} ; ^1H NMR δ 1.44 (d, $J = 1.7$ Hz, 1H), 1.61-1.85 (m, 4H), 1.97-2.03 (m, 1H), 2.27-2.32 (m, 1H), 2.94 (dd, $J = 12, 2.0$ Hz, 1H), 3.33 (td, $J = 12, 4$ Hz, 1H), 4.00 (s, 1H), 7.25-7.43 (m, 5H); ^{13}C NMR δ 18.4, 27.2, 30.3, 31.9, 51.0, 69.4, 122.0, 127.7, 127.9, 129.0,

139.6; MS *m/e* 201 (M); HRMS (ESI) calcd for (M+Na⁺) C₁₃H₁₅NONa 224.1046, found 224.1046.

(±)-(1*R*,3*R*)-3-hydroxy-3-methyl-2-phenylcyclohexanecarbonitrile (4l). The general procedure with an NH₄Cl workup was employed with **1l**⁴ (18.0 mg in 2 mL of THF) and phenylmagnesium chloride (1.5 equiv), followed by radial chromatography (1:3 EtOAc/hexanes) to provide 20.2 mg (72%, waxy solid) of **4l** as an inseparable 9:1 ratio of diastereomers at the nitrile-bearing carbon: IR (film) 3484, 2240 cm⁻¹; MS *m/e* 216 (M+H); HRMS (ESI) calcd for (M+Na⁺) C₁₄H₁₇NONa 238.1202, found 238.1197. For the equatorial nitrile: ¹H NMR δ 0.98 (s, 3H), 1.24 (s, 1H), 1.44-2.27 (m, 6H), 2.67 (d, *J* = 12.1 Hz, 1H), 3.29 (td, *J* = 12, 3.3 Hz, 1H), 7.27-7.62 (m, 5H); ¹³C NMR δ 20.4, 29.8, 30.4, 30.5, 30.8, 39.0, 70.1, 122.0, 127.8, 128.6, 138.2; For the axial nitrile: ¹H NMR δ 1.00 (s, 3H), 1.44-2.27 (m, 7H), 2.56-2.58 (m, 1H), 2.98-3.02 (br s, 1H), 7.27-7.62 (m, 5H); ¹³C NMR δ 18.5, 30, 31, 32.1, 40.4, 53.1, 71.4, 123, 127.6, 128, 129.4, 139.3. Repeating the procedure with **1l**⁴ (16.4 mg in 2 mL of THF) and phenyllithium (1.8 equiv), followed by radial chromatography (1:3 EtOAc/hexanes) similarly provided 20.0 mg (78%) of **4l** as a 9:1 ratio of diastereomers at the nitrile-bearing carbon.

(±)-2-((1*S*,2*S*)-2-Hydroxy-1-phenylcyclohexyl)ethanenitrile (4m). The general procedure with an NH₄Cl workup was employed with **1m**¹ (56.1 mg in 2 mL of THF) and PhMgCl (2.5 equiv) at rt overnight, followed by radial chromatography (1:3 EtOAc/hexanes) to provide 50.8 mg of **4m** (58%): IR (film) 3473, 2249 cm⁻¹; ¹H NMR δ 1.30-2.18 (m, 9H), 2.79 (ABq, *J* = 17

⁴ Fleming, F. F.; Zhang, Z. *unpublished results*.

Hz, Δ = 59 Hz, 2H), 4.18 (d, J = 6.4 Hz, 1H), 7.24-7.56 (m, 5H); ^{13}C NMR δ 21.3, 21.9, 24.1, 29.4, 31.8, 45.3, 73.0, 118.5, 126.4, 127.2, 128.9, 142.2; MS m/e 216 ($M + H$).

(2E)-2-D-4-Hydroxybut-2-enenitrile (1o) and **($\pm$)-(2R)-2-D-3-(hydroxymethyl)-4,4-dimethylpentanenitrile (4o)**. The general procedure was employed with **1a**¹ (104.3 mg in 3 mL of THF) and *t*-BuMgCl (3.0 equiv) except that the reaction was stirred overnight and quenched with D₂O before saturated NH₄Cl was added. Radial chromatography (1:3 EtOAc/hexanes) to provide 19.3 mg (18%) of **1o** and 106.0 mg (59%) of **4o** as an oil. For **1o**: IR (film) 3413, 2228, 1626 cm⁻¹; ^1H NMR δ 2.21 (br s, 1H), 4.33 (d, J = 3 Hz, 2H), 6.79-6.83 (m, 1H); ^{13}C NMR δ 61.5, 98.4 (t, $J_{\text{D-C}}$ = 27 Hz), 117.3, 153.3; MS m/e 85 ($M + H$). For **4o**: IR (film) 3421, 2247 cm⁻¹; ^1H NMR δ 0.97 (s, 9H), 1.64-1.72 (m, 1H), 1.89 (br s, 1H), 2.49-2.54 (m, 1H), 3.67 (dd, J = 11, 8 Hz, 1H), 3.92 (dd, J = 11, 4 Hz, 1H); ^{13}C NMR δ 15.1 (t, $J_{\text{D-C}}$ = 20 Hz), 27.9, 32.5, 47.4, 61.6, 120.3; MS m/e 143 ($M + H$).

3-(Hydroxymethyl)-4,4-dimethylpentanenitrile (4n). The general procedure with an NH₄Cl workup was employed with **1a**¹ (67.4 mg in 2 mL of THF), followed by radial chromatography (1:2 EtOAc/hexanes) to provide mainly recovered **1a** and 26.3 mg of **4n** (23%) as an oil: IR (film) 3422, 2242 cm⁻¹; ^1H NMR δ 0.97 (s, 9H), 1.64-1.73 (m, 1H), 1.91 (br s, 1H), 2.49 (dd, J = 17, 6.3 Hz, 1H), 2.55 (dd, J = 17, 5.7 Hz, 1H), 3.67 (dd, J = 10.9, 7.9 Hz, 1H), 3.92 (dd, J = 10.9, 3.9 Hz, 1H); ^{13}C NMR δ 15.2, 27.8, 32.4, 47.5, 61.5, 120.3; MS m/e 142 ($M + H$).

(2E)-4-(Methoxymethoxy)pent-2-enenitrile (1q). Neat MOMCl (0.25 mL, 0.33 mmol) was added to a rt, THF (3 mL) solution of (2E)-4-hydroxypent-2-enenitrile¹ (160.1 mg, 1.65 mmol)

and triethylamine (0.46 mL, 0.33 mmol). After 2 h, the solution was concentrated, diluted with ether, washed successively with water and saturated, aqueous NaCl, dried (Na₂SO₄), and concentrated to afford 227.5 mg (98%) of pure **1p** as an oil: IR (film) 2227 cm⁻¹; ¹H NMR δ 1.29 (d, J = 6.7 Hz, 3H), 3.36 (s, 3H), 4.32 (pd, J = 6.7, 1.6 Hz, 1H), 4.63 (ABq, Δ = 14, J = 7 Hz, 2H), 5.59 (dd, J = 16.0, 1.6 Hz, 1H), 6.66 (dd, J = 16.0, 5.0 Hz, 1H); ¹³C NMR δ 20.2, 55.5, 71.2, 94.7, 99.3, 117.0, 155.5; MS m/e 140 (M-1).

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TD 16384
SM 17857.143
HZ/PT 2.180

PR 4.0
RD 3.000
AG .459
RG 200
NS 3525
TE 287

F1 22400
D2 4004.452
DP 20H BB

LB .100
GB .100
CX 25.00
CY 10.00
F1 220.004P
F2 -.004P
HZ/CN 664.150
PPM/CN 8.800
SR -1399.02

138.686

138.870
137.840
137.429

118.536

77.466
76.889
76.867

68.071

44.159

20.388

WQZY9903.191
DATE 19-3-99

SF 300.133
Q1 210.0
Q1 4800.000
SI 16384
TD 16384
SW 4504.505
HZ/PT .550
PM 5.0
RD 2.500
AQ 1.819
RG 4
NS 64
TE 297
FW 5700
D2 5684.205
DP 4L P0
LB 0.0
GB .100
CX 25.00
CY 10.00
F1 10.004P
F2 -.198P
HZ/CM 122.444
PPM/CM 3367.75
SR

RE

F: 001
DATE: 22-1-99
TIME: 18:34

SA: NO TEMP 101
SOLVENT: CDCl3
SF: 78.0
SY: 78.0
O1: 6147.202
O2: 16284
O3: 16284
O4: 16284
O5: 16284
O6: 16284
O7: 16284
O8: 16284
O9: 16284
O10: 16284
O11: 16284
O12: 16284
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O95: 16284
O96: 16284
O97: 16284
O98: 16284
O99: 16284
O100: 16284

PN: 4.0
RD: 3.000
AG: 200
NS: 3384
TE: 287

FN: 23400
O2: 4004.482
DP: 20H 88

LB: 200
GB: 150
CK: 28.00
CY: 17.00
F1: 220.004P
F2: 220.004P
F3: 220.004P
F4: 220.004P
F5: 220.004P
F6: 220.004P
F7: 220.004P
F8: 220.004P
F9: 220.004P
F10: 220.004P
F11: 220.004P
F12: 220.004P
F13: 220.004P
F14: 220.004P
F15: 220.004P
F16: 220.004P
F17: 220.004P
F18: 220.004P
F19: 220.004P
F20: 220.004P
F21: 220.004P
F22: 220.004P
F23: 220.004P
F24: 220.004P
F25: 220.004P
F26: 220.004P
F27: 220.004P
F28: 220.004P
F29: 220.004P
F30: 220.004P
F31: 220.004P
F32: 220.004P
F33: 220.004P
F34: 220.004P
F35: 220.004P
F36: 220.004P
F37: 220.004P
F38: 220.004P
F39: 220.004P
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F48: 220.004P
F49: 220.004P
F50: 220.004P
F51: 220.004P
F52: 220.004P
F53: 220.004P
F54: 220.004P
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F57: 220.004P
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F69: 220.004P
F70: 220.004P
F71: 220.004P
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F73: 220.004P
F74: 220.004P
F75: 220.004P
F76: 220.004P
F77: 220.004P
F78: 220.004P
F79: 220.004P
F80: 220.004P
F81: 220.004P
F82: 220.004P
F83: 220.004P
F84: 220.004P
F85: 220.004P
F86: 220.004P
F87: 220.004P
F88: 220.004P
F89: 220.004P
F90: 220.004P
F91: 220.004P
F92: 220.004P
F93: 220.004P
F94: 220.004P
F95: 220.004P
F96: 220.004P
F97: 220.004P
F98: 220.004P
F99: 220.004P
F100: 220.004P

WQZY9903.191
DATE 22-3-99

SF	300.133
SY	210.0
O1	4800.000
SI	16384
TD	16384
SM	4504.505
HZ/PT	.550
PM	5.0
RD	2.500
AG	1.819
RG	2
NS	64
TE	297
FM	5700
O2	5684.205
DP	4L P0
LB	0.0
GB	0.0
CX	25.00
CY	0.0
F1	10.001P
F2	-1.198P
HZ/CM	122.444
PPM/CM	.408
SR	3367.75

PPM

M02Y9903.222
DATE 22-3-99

SF 75.469
SY 75.0
O1 6147.202
SI 16384
TD 16384
SM 17857.143
HZ/PT 2.180

PN 4.0
RD 3.000
AQ .459
RG 200
NS 474
TE 297

FW 22400
O2 4004.452
DP 20H BB

LB .100
GB .100
CX 25.00
CY 10.00
F1 220.004P
F2 .004P
HZ/CM 664.150
PPM/CM 8.800
SR -1390.30

131.648
129.740
122.116
117.899

85.635
84.681
77.423
76.887

63.373

32.084

19.983

WQZM9907.301
DATE 30-7-99
TIME 10:08

SOLVENT CDCl₃
SF 300.133
SY 210.0
O1 4800.000
SI 16384
TD 16384
SM 4504.505
HZ/PT .550

PM 5.0
RD 2.500
AQ 1.819
RG 4
NS 8
TE 297

FW 5700
O2 5684.205
DP 4L P0

LB 0.0
GB 0.0
CX 25.00
CY 10.00
F1 10.001P
F2 -.198P
HZ/CM 122.444
PPM/CM .408
SR 3367.75

PPM

MAGN908.021
DATE 1-8-89
TIME 8:22

SA.NO TEMP 101
SOLVENT CDCl3
SF 75.0
SY 75.0
O1 6147.202
S1 16384
TD 16384
SK 17857.143
HZ/PT 2.180
RX 4.0
RD 3.000
AG .459
RG 200
NS 16257
TE 287
FM 22400
C2 4004.452
DP 20H B8
LB 4.000
BB 25.100
CY 9.000
F1 220.004P
F2 00.04P
HZ/CN 664.150
PPM/CN 8.800
SR -1399.02

141.984

128.828
127.347
126.873

118.140

77.454
76.865
76.869
69.902

42.287

26.578

22.648

FFQMA007.062
 DATE 6-7-0
 SF 300.133
 SY 210.0
 O1 4800.000
 SI 16384
 TD 16384
 SM 4504.505
 HZ/PT .350
 PM 5.0
 RD 2.500
 AQ 1.819
 RG 4
 NS 8
 TE 297
 FW 5700
 O2 5684.205
 DP 4L P0
 LB 0.0
 GB 0.0
 CX 20.50
 CY 13.00
 F1 10.001P
 F2 -.198P
 HZ/CM 149.322
 PPM/CM 498
 SR 3367.75

 FFQMA007.071
 DATE 7-7-0
 SF 75.469
 SY 75.0
 O1 6147.202
 SI 16384
 TD 16384
 SM 17857.143
 HZ/PT 2.180
 PM 4.0
 RD 3.000
 AQ .459
 RG 200
 NS 6977
 TE 297
 FW 22400
 O2 4004.452
 DP 20H BB
 LB 0.0
 GB 0.0
 CX 20.50
 CY 5.00
 F1 220.004P
 F2 -.004P
 HZ/CM 809.939
 PPM/CM 10.732
 SR -1405.56

 FFGMA007.131
 DATE 12-7-0
 SF 300.133
 SY 210.0
 O1 4800.000
 S1 16384
 TD 16384
 SM 4504.505
 HZ/PT .550
 PM 5.0
 RD 2.500
 AG 1.819
 RG 20
 NS 8
 TE 297
 FM 5700
 O2 5684.205
 DP 4L P0
 LB 0.0
 GB 0.0
 CX 20.50
 CY 5.00
 F1 10.001P
 F2 -198P
 HZ/CM 149.322
 PPM/CM .498
 SR 3367.75

FFQM006.161
DATE 15-6-0
SF 75.469
SY 75.0
01 6147.202
SI 16384
TD 16384
SM 17857.143
HZ/PT 2.180
PM 4.0
RD 3.000
AG .459
RG 200
NS 3697
TE 297
FM 22400
02 4004.452
DP 20H BB
LB 2.000
GB 0.0
CX 20.50
CY 1.00
F1 220.004P
F2 -.004P
HZ/CM 809.939
PPM/CM 10.732
SR -1403.38

FFZY032.001
DATE 17-3-1

SF	300.133
SY	210.0
O1	4800.000
SI	8192
TD	8192
SW	4504.505
HZ/PT	1.100
PW	5.0
PD	2.500
RG	.909
NS	8
TE	297
FW	5700
O2	5684.205
DP	4L P0
LB	0.0
GB	0.0
CX	25.00
CY	15.00
F1	10.001P
F2	.200P
HZ/CM	122.466
PPM/CM	.408
SR	3367.75

B J K R
 FFQM0103.151
 DATE 15-3-1
 SF 300.133
 SY 210.0
 O1 4800.000
 SI 8192
 TD 8192
 SW 4504.505
 HZ/PT 1.100
 PW 5.0
 RD 2.500
 AG .909
 RG 4
 NS 8
 TE 297
 FW 5700
 F2 5684.205
 DP 4L P0
 LB 0.0
 GB 0.0
 CX 20.50
 CY 10.00
 F1 10.001P
 F2 200P
 HZ/CM 149.349
 BPM/CM 498
 SR 3367.75

FFQM0103.161
DATE 16-3-1

SF 75.469
SY 75.0
O1 6147.202
S1 16384
TD 16384
SW 17857.143
HZ/PT 2.180

PW 4.0
RD 3.000
AQ .459
RG 200
NS 16409
TE 297

FW 22400
O2 4004.452
DP 20H BB

LB 0.0
GB 0.0
CX 20.50
CY 15.00
F1 220.004P
F2 - .004P
HZ/CW 809.939
PPM/CW 10.732
SR -1403.38

WQZY9903.091
DATE 9-3-99

SF	300.133
SY	210.0
O1	4800.000
SI	16384
TD	16384
SM	4504.505
HZ/PT	.550
PM	5.0
RD	2.500
AG	1.819
RG	2
NS	8
TE	297
FM	5700
O2	5684.205
DP	4L P0
LB	0.0
GB	0.0
CX	25.00
CY	0.0
F1	10.001P
F2	-1.98P
HZ/CM	122.444
PPM/CM	408
SR	3367.75

PPM

MQZY9903.093
DATE 9-3-99

SF 75.469
SY 75.0
O1 6147.202
SI 16384
TD 16384
SM 17857.143
HZ/PT 2.180

PM 4.0
RD 3.000
AQ .459
RG 200
NS 381
TE 297

FW 22400
O2 4004.452
DP 20H BB

LB 0.0
GB 0.0
CX 25.00
CY 10.00
F1 220.004P
F2 -.004P
HZ/CM 664.150
PPM/CM 8.800
SR -1401.20

120.267
77.408
76.999
76.566
61.488
47.480
32.433
27.838
15.230

~~B
J
K
R~~

FFGWO105.076
DATE 7-5-1

SF	300.133
SY	210.0
O1	4800.000
SI	8192
TD	8192
SW	4504.505
HZ/PT	1.100
PM	5.0
RD	2.500
AG	.909
RG	10
NS	8
TE	297
FW	5700
O2	5684.205
DP	4L P0
LB	0.0
GB	0.0
CX	25.00
CY	8.00
F1	10.001P
F2	122.466
HZ/CM	.408
PPM/CM	3367.75
SR

FFQW0105.074
DATE 7-5-1

SF 300.133
SY 210.0
O1 4800.000
SI 8192
TD 8192
SM 4504.505
HZ/PT 1.100
PM 5.0
RD 2.500
AQ .909
RG 2
NS 8
TE 297
FW 5700
O2 5684.205
DP 4L P0
LB 0.0
GB 0.0
CX 25.00
CY 6.00
F1 10.001P
F2 .200P
HZ/CM 122.466
PPM/CM .408
SR 3367.75

PPM

FFQM0105.092
DATE 9-5-1

SF 75.469
SY 75.0
Q1 6147.202
SI 16384
TD 16384
SW 17857.143
HZ/PT 2.180

PW 4.0
RD 3.000
AG 459
RG 200
NS 7195
TE 297

FW 22400
O2 4004.452
DP 20H BB

LB 0.0
GB 0.0
CX 25.00
CY 10.00
F1 220.004P
F2 -004P
HZ/CM 664.150
PPM/CM 8.800
SR -1403.38

120.272

77.433
77.004
76.595

61.575

47.395

32.461

27.900

15.334
15.073
14.788

FFQMA007.282
DATE 28-7-0
SF 300.133
SY 210.0
O1 4800.000
SI 16384
TD 16384
SM 4504.505
HZ/PT .550
PM 5.0
RD 2.500
AQ 1.819
RG 4
NS 6
TE 297
FW 5700
O2 5684.205
DP 4L P0
LB 0.0
GB 0.0
CX 20.50
CY 6.00
F1 10.001P
F2 -1.98P
HZ/CM 149.332
PPM/CM .498
SR 3367.75

FFQ04N007 291	DATE 29-7-0	BLINER
SF	75.469	
O1	75.0	
ST	6147.202	
ST	16384	
TD	16384	
Hz/Pt	17857.143	
Hz/Pt	2.180	
PM	4.0	
AD	3.000	
RG	200.455	
NS	29300	
TE	297	
FM	23400	
CM	4004.452	
DP	204.88	
B	200	
GB	1.500	
CX	20.50	
CY	2.0	
E1	220.004P	
F1	0.004P	
HZ/CM	809.935	
CM/CM	10.732	
SRP/CM	1403.38	