Supporting Information

Base-Free Ni-Catalyzed Suzuki-Type Cross-Coupling Reactions of Epoxides with Boronic Acids

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1. General Information

1.1 Materials

The following chemicals were purchased and used as received: $NiBr_2$·diglyme (Aldrich, CAS: 312696-09-6), 4,4'-Di-tert-butyl-2,2'-bipyridine (dtbpy, CAS: 72914-19-3, Aldrich), Nickel(II) iodide (CAS: 13462-90-3, Alfa), $NiCl_2(PPh_3)_2$ (CAS: 14264-16-5, Adamas-beta), Cyclohexene oxide (CAS: 286-20-4, Adamas-beta), Isobutylene Oxide (CAS: 558-30-5, TCI), Cyclopentene oxide (CAS: 285-67-6, J&K), 2-hexyloxirane (CAS: 2984-50-1, Alfa), NaI (dry, anhydrous, Sinopharm Chemical Reagent Co., Ltd.), EtOH (Hengyue Chemical Technology Co., Ltd., 4 Å molecular sieves).

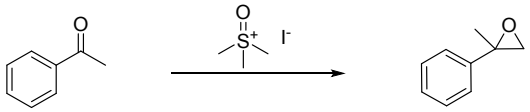
All the other reagents and solvents mentioned in this text were purchased from commercial sources and used without purification.

1.2 Analytical Methods

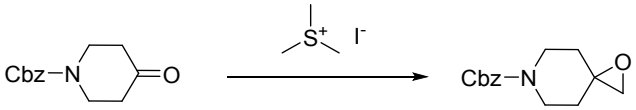
^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded on a Bruker 400 MHz spectrometer at 295 K in $CDCl_3$ unless otherwise noted. ^{19}F NMR were reported as 19F exp. comp. pulse decoupling (F19CPD) unless otherwise noted. Data for ^{1}H-NMR are reported as follows: chemical shift (δ ppm), multiplicity, integration, and coupling constant (Hz). Data for ^{13}C-NMR are reported in terms of chemical shift (δ ppm), multiplicity, and coupling constant (Hz). Gas chromatographic (GC) analysis was acquired on a Shimadzu GC-2014 Series GC System equipped with a flame-ionization detector. GC-MS analysis was performed on Thermo Scientific AS 3000 Series GC-MS System. HRMS ESI-mass data were acquired on Thermo LTQ Orbitrap XL instrument. Organic solutions were concentrated under reduced pressure on a Buchi rotary evaporator. Column chromatographic purification of products was accomplished using forced-flow chromatography on Silica Gel (200-300 mesh).

2. Preparation of Substrates

2.1 Synthesis of substrates



To a solution of potassium tertbutoxyde (20 mmol) in DMSO (20 mL) at room temperature was added trimethylsulfoxonium iodide (1.1 equiv.) and stirred for 30 min. A solution of acetophenone (20 mmol) in DMSO (15 mL) was added and stirred overnight. The reaction mixture was diluted with EtOAc and water and the layers were separated. The aqueous layer was back-extracted with EtOAc. The combined organic extracts were washed with brine and dried over Na_2SO_4. The solvent was removed under reduced pressure to provide the product. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46-7.35 (m, 4H), 7.33-7.28 (m, 1H), 3.01 (d, J = 5.3 Hz, 1H), 2.84 (d, J = 5.5 Hz, 1H), 1.76 (s, 3H).[1]



To a solution of dimethylsulfoxonium methylide, which was prepared under Ar from NaH of 60% dispersion in mineral oil (11.0 mmol) and trimethylsulfanium iodide (11.0 mmol) in 5 mL of anhydrous DMSO, was added benzyl 4-oxopiperidine-1-carboxylate (10.0 mmol) in 5 mL of DMSO dropwise. The resulting mixture was stirred at 55 ^{o}C for 6 h. The cooled reaction mixture was poured into water and extracted with EtOAc. The combined organic layers were washed with H_2O, brine and then dried over Na_2SO_4. The mixture was purified by column chromatography to afford the desired products.[1c]

2.2 Rferences

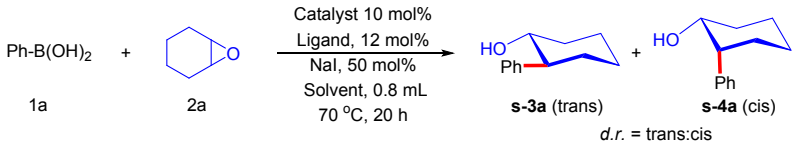
1. (a) C. Molinaro, A.-A. Guilbault and B. Kosjek, *Org. Lett.*, **2010**, 12, 3772-3775; (b) X.-L. Lu, Y.-T. Liu, Q.-X. Wang, M.-H. Shen and H.-D. Xu, *Org. Chem. Front.*, **2016**, 3, 725-729; (c) J. J. Cui, M. Tran-Dubé, H. Shen, M. Nambu, P.-P. Kung, M. Pairish, L. Jia, J. Meng, L. Funk, I. Botrous, M. McTigue, N. Grodsky, K. Ryan, E. Padrique, G. Alton, S. Timofeevski, S. Yamazaki, Q. Li, H. Zou, J. Christensen, B. Mroczkowski, S. Bender, R. S. Kania and M. P. Edwards, *J. Med. Chem.*, **2011**, 54, 6342-6363.

3. General Experimental Procedures

3.1 General procedure for Table 1

In air, Catalyst (10 mol%), Ligand (12 mol%), Phenylboronic (0.5 mmol) acid and NaI (50 mol%) were added to a schlenk tube equipped with a stir bar. The vessel was evacuated and filled with argon (three cycles). Solvent (0.8 mL), Base (1.5 equiv.) and cyclohexene oxide (0.25 mmol) were added in turn by syringe. The resulting reaction mixture was stirred vigorously at the mentioned temperature for the indicated amount of time. Benzophenone was added as internal standard. The product was yielded by GC.

Table S1. Optimization of the reaction conditions



Entry	Catalyst	Ligand	Base	Solvent	Yield% (*d.r.*)
1	$NiBr_2$·diglyme	dtbpy	LiO^tBu	DMAc	trace
2	$NiBr_2$·diglyme	dtbpy	LiO^tBu	DME	trace
3	$NiBr_2$·diglyme	dtbpy	LiO^tBu	THF	trace
4	$NiBr_2$·diglyme	dtbpy	K_3PO_4	DMAc	2
5	$NiBr_2$·diglyme	dtbpy	K_2CO_3	DMAc	19(7.5:1)
6	$NiBr_2$·diglyme	dtbpy	LiOMe	DMAc	6(8:1)
7	$NiBr_2$·diglyme	dtbpy	NaOAc	DMAc	7(8:1)
8	$NiBr_2$·diglyme	dtbpy	Et_3N	DMAc	trace
9	$NiBr_2$·diglyme	dtbpy	K_2CO_3	DME	13(7:1)
10	$NiBr_2$·diglyme	dtbpy	K_2CO_3	THF	16(7:1)
11	$NiBr_2$·diglyme	dtbpy	-	DMAc	30(8:1)
12	$NiBr_2$·diglyme	dtbpy	-	HO^tBu	47(9:1)
14	$NiBr_2$·diglyme	dtbpy	-	^{i}PrOH	65(8.5:1)
15	**$NiBr_2$·diglyme**	**dtbpy**	**-**	**EtOH**	**89(9:1)**
16	NiI_2	dtbpy	-	EtOH	29(8:1)
17	$NiCl_2(PPh_3)_2$	dtbpy	-	EtOH	20(7:1)
18	$NiBr_2$·diglyme	Phen	-	EtOH	25(8:1)
19[b]	-	dtbpy	-	EtOH	0
20[c]	$NiBr_2$·diglyme	dtbpy	-	EtOH	trace
21[d]	$NiBr_2$·diglyme	dtbpy	-	EtOH	trace
22[e]	$NiBr_2$·diglyme	dtbpy	-	EtOH	trace
23[f]	$NiBr_2$·diglyme	dtbpy	-	EtOH	2
24	$NiBr_2$·diglyme	dtbpy	-	MeOH	21(8:1)
25	$NiBr_2$·diglyme	dtbpy	-	HFIP	12(8:1)
26	$NiBr_2$·diglyme	dtbpy	-	H_2O	trace

27[d]	$NiBr_2$·diglyme	dtbpy	LiOMe	EtOH	3
28[d]	$NiBr_2$·diglyme	dtbpy	LiO^tBu	EtOH	trace
28[d]	$NiBr_2$·diglyme	dtbpy	K_2CO_3	EtOH	5

[a] **Reaction conditions**: 1a (0.5 mmol), 2a (0.25 mmol), Base (1.5 equiv.) in 0.8 mL solvent at 70 °C for 20 h. [b]no catalyst. [c] **Ph-Bpin** as substrate. [d] **Ph-B(neop)** as substrate. [e] **Ph-BMIDA** as substrate. [f] **Ph-BF_3K** as substrate. The yield was determined by GC using Benzophenone as internal standard. The *d.r.* ratio was determined by GC.

3.2 General procedure for Table 2

In air, $NiBr_2$·diglyme (10 mol%), dtbpy (12 mol%), Boronic acid (0.5 mmol) and NaI (50 mol%) were added to a schlenk tube equipped with a stir bar. The vessel was evacuated and filled with argon (three cycles). To these solids, EtOH (0.8 mL) and epoxy (0.25 mmol) were added in turn by syringe. The resulting reaction mixture was stirred vigorously at 70 °C for 20 h. The mixture was purified by column chromatography to afford the desired products. The *d.r.* ratio was determined by ^{1}H & GC.

3.3 General procedure for Table 3

In air, $NiBr_2$·diglyme (10 mol%), dtbpy (12 mol%), (E)-styrylboronic acid (0.5 mmol) and NaI (50 mol%) were added to a schlenk tube equipped with a stir bar. The vessel was evacuated and filled with argon (three cycles). EtOH (0.8 mL) and epoxy (0.25 mmol) were added in turn by syringe. The resulting reaction mixture was stirred vigorously at 70 °C for 20 h. The mixture was purified by column chromatography to afford the desired products.

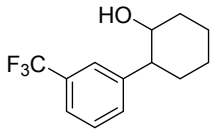
3.3 General procedure for Table 4

In air, $NiBr_2$·diglyme (10 mol%), dtbpy (12 mol%), Boronic acid (1.5 equiv.) and NaI (50 mol%) were added to a schlenk tube equipped with a stir bar. The vessel was evacuated and filled with argon (three cycles). EtOH (0.8 mL) and epoxy (0.3 mmol) were added in turn by syringe. The resulting reaction mixture was stirred vigorously at 70 °C for 20 h. The mixture was purified by column chromatography to afford the desired products.

3.3 General procedure for scheme 2

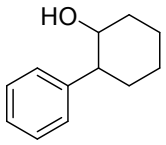
In air, $NiBr_2$·diglyme (10 mol%), dtbpy (12 mol%), (E)-styrylboronic acid (0.5 mmol) and NaI (50 mol%) were added to a schlenk tube equipped with a stir bar. The vessel was evacuated and filled with argon (three cycles). EtOH (0.8 mL) and 3,4-Epoxy-1-butene (0.25 mmol) were added in turn by syringe. The resulting reaction mixture was stirred vigorously at 70 °C for 20 h. The mixture was purified by column chromatography to afford the desired products.

4. Substrate Scope and Spectral Data



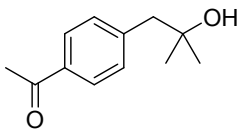
2-(3-(trifluoromethyl)phenyl)cyclohexan-1-ol

Prepared according to the general procedure, as a white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.47 (m, 2H), 7.46 – 7.40 (m, 2H), 3.68 (td, *J* = 10.1, 4.4 Hz, 1H), 2.57 – 2.45 (m, 1H), 2.17 – 2.06 (m, 1H), 1.92 – 1.83 (m, 2H), 1.81 – 1.73 (m, 1H), 1.57 – 1.28 (m, 5H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.95. ^{13}C NMR (101 MHz, $CDCl_3$) δ 144.64, 131.38 (q, *J* = 1.1 Hz), 130.95 (q, *J* = 32.0 Hz), 129.05, 124.54 (q, *J* = 3.8 Hz), 124.21 (q, *J* = 272.3 Hz), 123.59 (q, *J* = 3.8 Hz), 74.18, 52.97, 34.87, 33.37, 25.88, 24.97. HRMS (APCI) calcd for C13H15F3NaO (M+Na+): 267.0967; found: 267.0961.



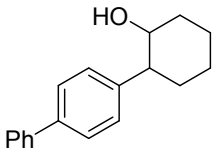
2-phenylcyclohexan-1-ol

Prepared according to the general procedure, as a sticky solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.28 (m, 2H), 7.27 – 7.19 (m, 3H), 3.64 (td, *J* = 10.1, 4.3 Hz, 1H), 2.51 – 2.25 (m, 1H), 2.15 – 1.99 (m, 1H), 1.89 – 1.79 (m, 2H), 1.77 – 1.68 (m, 1H), 1.64 (br s, 1H), 1.57 – 1.25 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.35, 128.75, 127.94, 126.81, 74.40, 53.23, 34.47, 33.35, 26.08, 25.09. HRMS (APCI) calcd for C12H16NaO (M+Na+): 199.1093; found: 199.1098.



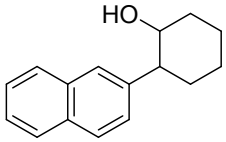
1-(4-(2-hydroxy-2-methylpropyl)phenyl)ethan-1-one

Prepared according to the general procedure, as a liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.3 Hz, 2H), 7.32 (d, *J* = 8.3 Hz, 2H), 2.83 (s, 2H), 2.58 (s, 3H), 1.24 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.01, 143.85, 135.42, 130.69, 128.15, 70.83, 49.68, 29.32, 26.56. HRMS (APCI) calcd for C12H16NaO2 (M+Na+): 215.1043; found: 215.1045.



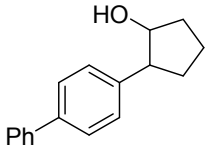
2-([1,1'-biphenyl]-4-yl)cyclohexan-1-ol

Prepared according to the general procedure, as a white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 – 7.52 (m, 4H), 7.48 – 7.39 (m, 2H), 7.38 – 7.31 (m, 3H), 3.71 (td, *J* = 10.1, 4.3 Hz, 1H), 2.49 (ddd, *J* = 13.2, 10.0, 3.5 Hz, 1H), 2.15 (dd, *J* = 6.0, 2.7 Hz, 1H), 1.96 – 1.83 (m, 2H), 1.79 (dd, *J* = 10.9, 4.6 Hz, 1H), 1.62 – 1.56 (m, 1H), 1.56 – 1.46 (m, 1H), 1.46 – 1.30 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.39, 140.91, 139.80, 128.76, 128.31, 127.52, 127.17, 127.04, 74.46, 52.89, 34.56, 33.36, 26.07, 25.09. HRMS (APCI) calcd for C18H20NaO (M+Na+): 275.1406; found: 275.1409.



2-(naphthalen-2-yl)cyclohexan-1-ol

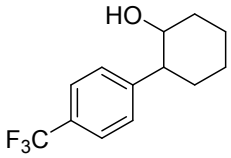
Prepared according to the general procedure, as a white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 – 7.75 (m, 3H), 7.70 (s, 1H), 7.51 – 7.35 (m, 3H), 3.75 (td, *J* = 10.1, 4.3 Hz, 1H), 2.59 (ddd, *J* = 13.2, 10.0, 3.6 Hz, 1H), 2.24 – 2.01 (m, 1H), 1.96 – 1.84 (m, 2H), 1.78 (dd, *J* = 10.9, 4.1 Hz, 1H), 1.69 – 1.55 (m, 2H), 1.53 – 1.30 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 140.75, 133.64, 132.64, 128.51, 127.67, 127.64, 126.73, 126.15, 125.97, 125.57, 74.29, 53.38, 34.51, 33.35, 26.11, 25.12. HRMS (APCI) calcd for C16H18NaO (M+Na+): 249.1250; found: 249.1253.



2-([1,1'-biphenyl]-4-yl)cyclopentan-1-ol

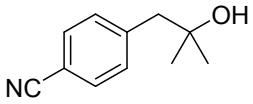
Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 – 7.48 (m, 4H), 7.45 – 7.35 (m, 2H), 7.34 – 7.27 (m, 3H), 4.16 (q, *J* = 7.2 Hz, 1H), 2.90 (dd, *J* = 17.1, 8.0 Hz, 1H), 2.26 – 2.05 (m, 2H), 1.93 – 1.62 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.51, 141.02, 139.42, 128.79, 127.88, 127.32, 127.15, 127.04, 80.45, 54.12, 34.07, 31.92, 21.82. HRMS (APCI) calcd for C17H18NaO (M+Na+): 261.1250;

found: 261.1256.



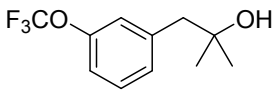
2-(4-(trifluoromethyl)phenyl)cyclohexan-1-ol

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (d, *J* = 8.1 Hz, 2H), 7.34 (d, *J* = 8.0 Hz, 2H), 3.67 – 3.54 (m, 1H), 2.55 – 2.41 (m, 1H), 2.13 – 1.98 (m, 1H), 1.78 (ddd, *J* = 39.7, 16.6, 4.1 Hz, 4H), 1.57 – 1.23 (m, 4H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.35. ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.98 (q, *J* = 1.1 Hz), 128.90 (q, *J* = 32.3 Hz), 128.23, 125.50 (q, *J* = 3.7 Hz), 124.29 (q, *J* = 271.8 Hz), 74.07, 52.94, 34.91, 33.32, 25.83, 24.95. HRMS (APCI) calcd for C13H15F3NaO (M+Na+): 267.0967; found: 267.0972.



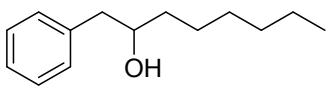
4-(2-hydroxy-2-methylpropyl)benzonitrile

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 8.2 Hz, 2H), 7.35 (d, *J* = 8.2 Hz, 2H), 2.82 (s, 2H), 1.61 (br s, 1H), 1.24 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.76, 131.79, 131.25, 119.01, 110.27, 70.85, 49.67, 29.41. HRMS (APCI) calcd for C11H13NNaO (M+Na+): 198.0889; found: 198.0887.



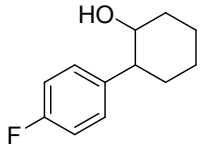
2-methyl-1-(3-(trifluoromethoxy)phenyl)propan-2-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (t, *J* = 7.8 Hz, 1H), 7.21 – 7.04 (m, 3H), 2.78 (s, 2H), 1.46 (br s, 1H), 1.23 (s, 6H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -57.77. ^{13}C NMR (101 MHz, $CDCl_3$) δ 149.08, 140.17, 129.35, 128.87, 122.99, 120.50 (q, *J* = 256.9 Hz), 118.95, 70.75, 49.35, 29.22. HRMS (APCI) calcd for C11H13F3NaO2 (M+Na+): 257.0760; found: 257.0765.



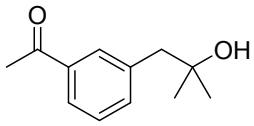
1-phenyloctan-2-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (t, *J* = 7.2 Hz, 2H), 7.25 – 7.20 (m, 3H), 3.81 (ddd, *J* = 13.0, 7.9, 4.5 Hz, 1H), 2.83 (dd, *J* = 13.5, 4.2 Hz, 1H), 2.64 (dd, *J* = 13.5, 8.4 Hz, 1H), 1.53 – 1.44 (m, 3H), 1.36 – 1.24 (m, 7H), 0.88 (t, *J* = 6.8 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 138.66, 129.43, 128.55, 126.43, 72.71, 44.06, 36.85, 31.84, 29.33, 25.74, 22.63, 14.10. (APCI) calcd for C14H22NaO (M+Na+): 229.1563; found: 229.1567.



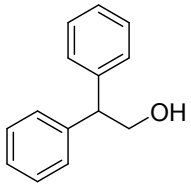
2-(4-fluorophenyl)cyclohexan-1-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.18 (m, 2H), 7.11 – 6.96 (m, 2H), 3.61 (td, *J* = 10.1, 4.3 Hz, 1H), 2.52 – 2.30 (m, 1H), 2.10 (ddd, *J* = 7.5, 4.6, 1.9 Hz, 1H), 1.88 – 1.80 (m, 2H), 1.79 – 1.73 (m, 1H), 1.53 – 1.25 (m, 4H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -116.34. ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.73 (d, *J* = 244.6 Hz), 139.02 (d, *J* = 3.1 Hz), 129.23 (d, *J* = 7.8 Hz), 115.50 (d, *J* = 21.0 Hz), 74.50, 52.42, 34.61, 33.50, 26.01, 25.03. HRMS (APCI) calcd for C12H15FNaO (M+Na+): 217.0999; found: 217.0991.



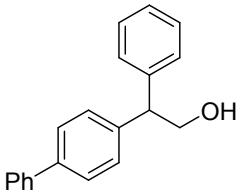
1-(3-(2-hydroxy-2-methylpropyl)phenyl)ethan-1-one

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 – 7.57 (m, 2H), 7.35 (m, 2H), 2.76 (s, 2H), 2.53 (s, 3H), 1.68 (br s, 1H), 1.16 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.44, 138.53, 137.02, 135.27, 130.17, 128.33, 126.59, 70.77, 49.46, 29.26, 26.69. HRMS (APCI) calcd for C12H16NaO2 (M+Na+): 215.1043; found: 215.1046.



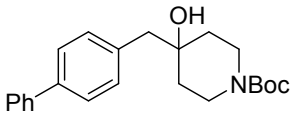
2,2-diphenylethan-1-ol

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 6.93 (m, 10H), 4.29 – 3.88 (m, 3H), 1.71 (br s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.43, 128.77, 128.37, 126.87, 66.17, 53.68. HRMS (APCI) calcd for C14H14NaO (M+Na+): 221.0937; found: 221.0933.



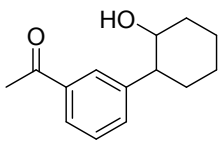
2-([1,1'-biphenyl]-4-yl)-2-phenylethan-1-ol

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 – 7.48 (m, 4H), 7.47 – 7.37 (m, 2H), 7.36 – 7.27 (m, 7H), 7.27 – 7.23 (m, 1H), 4.85 – 3.43 (m, 3H), 1.59 (br s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.38, 140.80, 140.53, 139.79, 128.84, 128.83, 128.78, 128.39, 127.50, 127.31, 127.09, 126.96, 66.18, 53.38. HRMS (APCI) calcd for C20H18NaO (M+Na+): 297.1250; found: 297.1257.



tert-butyl 4-([1,1'-biphenyl]-4-ylmethyl)-4-hydroxypiperidine-1-carboxylate

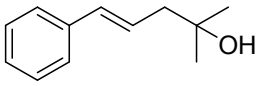
Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 – 7.47 (m, 4H), 7.46 – 7.39 (m, 2H), 7.36 – 7.30 (m, 1H), 7.27 – 7.22 (m, 2H), 3.86 (d, *J* = 13.1 Hz, 2H), 3.33 – 2.88 (m, 2H), 2.78 (s, 2H), 1.69 – 1.50 (m, 4H), 1.46 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.89, 140.75, 139.70, 135.23, 131.04, 128.84, 127.31, 127.08, 127.02, 79.46, 69.58, 48.93, 39.47, 36.67, 28.52. HRMS (APCI) calcd for C23H29NNaO3 (M+Na+): 390.2040; found: 390.2049.



1-(3-(2-hydroxycyclohexyl)phenyl)ethan-1-one

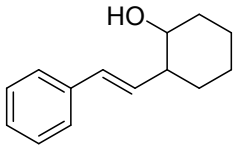
Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (s, 1H), 7.83 (dt, *J* = 7.3, 1.5 Hz, 1H), 7.49 – 7.37 (m, 2H), 3.73 (td, *J* = 10.1, 4.3 Hz, 1H), 2.62 (d, *J* = 4.1 Hz, 3H), 2.57 – 2.48 (m, 1H), 2.19 – 2.05 (m, 1H), 1.95 – 1.84 (m, 2H), 1.78 (dd, *J* = 11.1, 4.6 Hz, 1H), 1.57 – 1.22 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ

198.23, 144.25, 137.55, 132.81, 128.92, 127.49, 126.97, 74.25, 53.07, 34.87, 33.44, 26.70, 25.95, 25.02. HRMS (APCI) calcd for C14H18NaO2 (M+Na+): 241.1199; found: 241.1193.



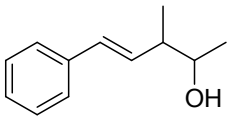
(E)-2-methyl-5-phenylpent-4-en-2-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.35 (m, 2H), 7.34 – 7.27 (m, 2H), 7.23 – 7.19 (m, 1H), 6.46 (d, *J* = 15.8 Hz, 1H), 6.35 – 6.24 (m, 1H), 2.39 (d, *J* = 7.5 Hz, 2H), 1.27 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.35, 133.70, 128.56, 127.28, 126.16, 125.79, 70.92, 47.36, 29.27. HRMS (APCI) calcd for C12H16NaO (M+Na+): 199.1093; found: 199.1096.



trans-2-((1E,3E)-4-phenylbuta-1,3-dien-1-yl)cyclohexan-1-ol

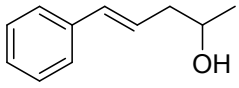
Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.34 (m, 2H), 7.31 (t, *J* = 7.5 Hz, 2H), 7.25 – 7.17 (m, 1H), 6.53 (d, *J* = 15.9 Hz, 1H), 6.07 (dd, *J* = 15.9, 8.9 Hz, 1H), 3.34 (td, *J* = 9.9, 4.4 Hz, 1H), 2.13 – 2.00 (m, 2H), 1.87 – 1.77 (m, 3H), 1.73 – 1.65 (m, 1H), 1.35 – 1.24 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.07, 132.16, 131.98, 128.56, 127.38, 126.18, 73.25, 50.59, 33.89, 31.44, 25.22, 24.82. HRMS (APCI) calcd for C14H18NaO (M+Na+): 225.1250; found: 225.1257.



(E)-3-methyl-5-phenylpent-4-en-2-ol

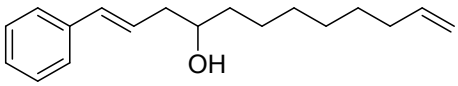
Prepared according to the general procedure, as a pale-yellow liquid. The *d.r.* ratio was determined to be 1.6:1 by ^{1}H NMR. ^{1}H NMR of a mixture of two diastereomers (400 MHz, $CDCl_3$) δ 7.40 – 7.35 (m, 2H), 7.33 – 7.28 (m, 2H), 7.24 – 7.18 (m, 1H), 6.47 (dd, *J* = 16.0, 12.1 Hz, 1H), 6.15 (ddd, *J* = 17.5, 16.0, 8.3 Hz, 1H), 3.82 – 3.51 (m, 1H), 2.53 – 2.19 (m, 1H), 1.62 (s, 1H), 1.26 – 1.16 (m, 3H), 1.14 – 1.05 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.53, 137.29, 132.23, 131.80, 130.91, 128.70, 128.68, 127.48, 127.35, 126.30, 126.26, 71.49, 71.40, 45.62, 44.55, 20.48, 20.37, 16.73, 15.65. HRMS (APCI) calcd for C12H16NaO

(M+Na+): 199.1093; found: 199.1087.



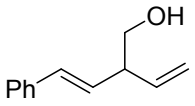
(E)-5-phenylpent-4-en-2-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (d, *J* = 7.3 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.21 (dd, *J* = 13.2, 6.0 Hz, 1H), 6.48 (d, *J* = 15.9 Hz, 1H), 6.29 – 6.16 (m, 1H), 3.93 (dd, *J* = 12.2, 6.2 Hz, 1H), 2.46 – 2.22 (m, 2H), 1.25 (d, *J* = 6.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.27, 133.18, 128.56, 127.30, 126.29, 126.13, 67.42, 42.93, 22.91. HRMS (APCI) calcd for C11H14NaO (M+Na+):185.0937; found 185.0941.



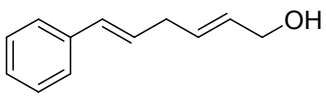
(E)-1-phenyldodeca-1,11-dien-4-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (d, *J* = 7.5 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.22 (t, *J* = 7.2 Hz, 1H), 6.48 (d, *J* = 15.8 Hz, 1H), 6.28 – 6.10 (m, 1H), 5.87 – 5.70 (m, 1H), 5.04 – 4.87 (m, 2H), 2.49 – 2.39 (m, 1H), 2.34 – 2.25 (m, 1H), 2.04 (dd, *J* = 13.6, 6.4 Hz, 3H), 1.55 – 1.46 (m, 3H), 1.43 – 1.28 (m, 8H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 139.16, 137.25, 133.13, 128.55, 127.27, 126.37, 126.10, 114.19, 71.16, 41.16, 36.89, 33.78, 29.49, 29.08, 28.85, 25.66. HRMS (APCI) calcd for C18H26NaO (M+Na+): 281.1876; found: 281.1872.



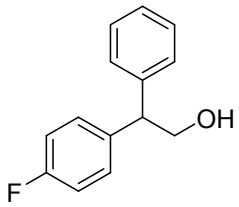
(E)-4-phenyl-2-vinylbut-3-en-1-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.34 (m, 2H), 7.35 – 7.27 (m, 2H), 7.27 – 7.18 (m, 1H), 6.50 (d, *J* = 16.0 Hz, 1H), 6.13 (dd, *J* = 16.0, 7.7 Hz, 1H), 5.88 – 5.63 (m, 1H), 5.34 – 5.13 (m, 2H), 3.65 (d, *J* = 6.8 Hz, 2H), 3.22 – 2.95 (m, 1H), 1.69 (br s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.38, 137.06, 132.25, 128.61, 128.58, 127.50, 126.24, 117.28, 65.24, 50.04. HRMS (APCI) calcd for C12H14NaO (M+Na+): 197.0937; found: 197.0933. The isolated product matched spectra previously reported in the literature. (***Ref.*** *J. Am. Chem. Soc.,* 2016, **138**, 3655-3658).



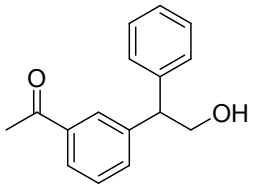
(2E,5E)-6-phenylhexa-2,5-dien-1-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.32 (m, 2H), 7.30 (t, *J* = 7.6 Hz, 2H), 7.20 (t, *J* = 7.2 Hz, 1H), 6.41 (d, *J* = 15.8 Hz, 1H), 6.28 – 6.15 (m, 1H), 5.84 – 5.64 (m, 2H), 4.14 (d, *J* = 5.1 Hz, 2H), 3.00 – 2.93 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.50, 130.96, 130.56, 130.28, 128.51, 128.03, 127.10, 126.04, 63.63, 35.49. HRMS (APCI) calcd for C12H14NaO (M+Na+): 197.0937; found: 197.0939. The isolated product matched spectra previously reported in the literature. (***Ref.*** *Org. Lett.*, 2019, **21**, 3606-3609).



2-(4-fluorophenyl)-2-phenylethan-1-ol

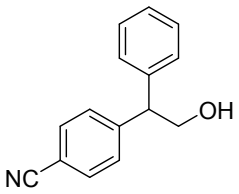
Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, CDCl3) δ 7.42 – 7.28 (m, 3H), 7.28 – 7.16 (m, 4H), 7.06 – 6.91 (m, 2H), 4.25 – 3.99 (m, 3H), 1.70 (br s, 1H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -116.14. ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.71 (d, *J* = 245.2 Hz), 141.27, 137.24 (d, *J* = 3.2 Hz), 129.81 (d, *J* = 7.9 Hz), 128.83, 128.27, 126.98, 115.52 (d, *J* = 21.2 Hz), 66.12, 52.82. HRMS (APCI) calcd for C14H13FNaO (M+Na+): 239.0843; found: 239.0840.



1-(3-(2-hydroxy-1-phenylethyl)phenyl)ethan-1-one

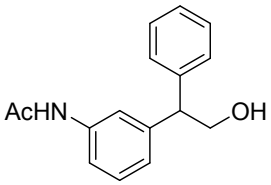
Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (t, *J* = 1.7 Hz, 1H), 7.80 (dt, *J* = 7.6, 1.5 Hz, 1H), 7.44 (ddd, *J* = 30.3, 10.7, 4.5 Hz, 2H), 7.34 – 7.28 (m, 2H), 7.28 – 7.21 (m, 3H), 4.30 – 4.22 (m, 1H), 4.21 – 4.15 (m, 2H), 2.56 (s, 3H), 1.91 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.40, 142.37, 140.95, 137.42, 133.28, 128.95, 128.87, 128.32, 127.96, 127.07, 127.03, 65.88, 53.50, 26.74. HRMS (APCI)

calcd for C16H16NaO2 (M+Na+): 263.1043; found: 263.1046.



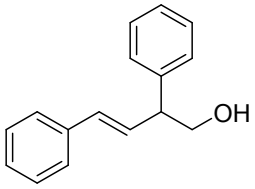
4-(2-hydroxy-1-phenylethyl)benzonitrile

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 – 7.54 (m, 2H), 7.42 – 7.30 (m, 4H), 7.29 – 7.17 (m, 3H), 4.33 – 4.05 (m, 3H), 1.75 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.38, 140.13, 132.42, 129.24, 129.02, 128.34, 127.38, 118.87, 110.54, 65.54, 53.52. HRMS (APCI) calcd for C15H13NNaO (M+Na+): 246.0889; found: 246.0885.



2-((1E,3E)-penta-1,3-dien-1-yl)cyclopentan-1-ol

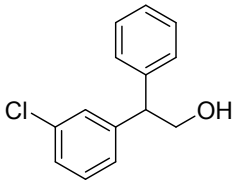
Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (br s, 1H), 7.45 – 7.35 (m, 2H), 7.33 – 7.18 (m, 6H), 6.99 (d, *J* = 7.6 Hz, 1H), 4.43 – 3.71 (m, 3H), 2.08 (s, 3H, -CH_3), 2.04 (br s, 3H, -OH). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.90, 142.55, 141.30, 138.27, 129.27, 128.71, 128.29, 126.85, 124.34, 119.89, 118.52, 65.89, 53.51, 24.46. HRMS (APCI) calcd for C16H17NNaO2 (M+Na+): 278.1151; found: 278.1156.



(E)-2,4-diphenylbut-3-en-1-ol

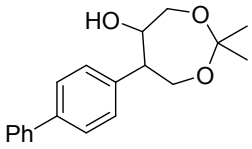
Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.32 (m, 4H), 7.32 – 7.25 (m, 4H), 7.24 – 7.19 (m, 2H), 6.52 (d, *J* = 16.0 Hz, 1H), 6.37 (dd, *J* = 15.9, 7.8 Hz, 1H), 3.97 – 3.80 (m, 2H), 3.69 (q, *J* = 7.3 Hz, 1H), 1.65 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 140.87, 136.99, 132.19, 129.75, 128.89, 128.61, 128.06, 127.57, 127.07, 126.32, 66.43, 51.87. HRMS (APCI) calcd for C16H16NaO (M+Na+):

247.1093; found: 247.1096.



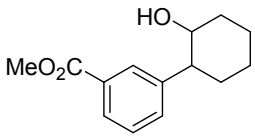
2-(3-chlorophenyl)-2-phenylethan-1-ol

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.27 (m, 4H), 7.26 – 7.17 (m, 4H), 7.13 (d, *J* = 7.1 Hz, 1H), 4.24 – 3.92 (m, 3H), 1.96 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.69, 140.73, 134.53, 129.95, 128.90, 128.51, 128.33, 127.13, 127.03, 126.59, 65.86, 53.30. HRMS (APCI) calcd for C14H13ClNaO (M+Na+): 255.0547; found: 255.0542.



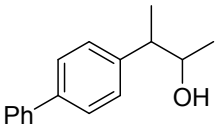
6-([1,1'-biphenyl]-4-yl)-2,2-dimethyl-1,3-dioxepan-5-ol

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 – 7.51 (m, 4H), 7.43 (ddd, *J* = 8.5, 4.4, 1.9 Hz, 2H), 7.39 – 7.30 (m, 3H), 4.52 (dt, *J* = 7.9, 6.0 Hz, 1H), 4.08 – 3.91 (m, 3H), 3.71 (t, *J* = 8.0 Hz, 1H), 3.16 – 2.95 (m, 1H), 1.71 (d, *J* = 24.7 Hz, 1H), 1.35 (d, *J* = 2.6 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 140.76, 140.16, 137.33, 129.40, 128.80, 127.56, 127.29, 127.06, 109.03, 67.15, 64.42, 49.84, 26.51, 25.53. HRMS (APCI) calcd for C19H22NaO3 (M+Na+): 321.1461; found: 321.1463.



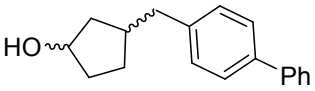
methyl 3-(2-hydroxycyclohexyl)benzoate

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 – 7.83 (m, 2H), 7.54 – 7.29 (m, 2H), 3.90 (s, 3H), 3.75 – 3.64 (m, 1H), 2.60 – 2.40 (m, 1H), 2.21 – 2.00 (m, 1H), 1.85 (ddd, *J* = 8.5, 7.1, 2.6 Hz, 2H), 1.81 – 1.74 (m, 1H), 1.60 – 1.18 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.16, 144.03, 132.83, 130.49, 128.80, 128.72, 128.02, 74.19, 52.96, 52.15, 34.79, 33.43, 25.96, 25.03. HRMS (APCI) calcd for C14H18NaO3 (M+Na+): 257.1148; found: 257.1143.



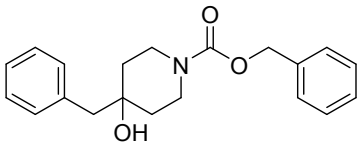
3-([1,1'-biphenyl]-4-yl)butan-2-ol

Prepared according to the general procedure, as a pale-yellow liquid. The *d.r.* ratio was determined to be 1.8:1 by ^{1}H NMR. ^{1}H NMR of a mixture of two diastereomers (400 MHz, $CDCl_3$) δ 7.53 – 7.43 (m, 4H), 7.35 (M, 2H), 7.27 – 7.17 (m, 3H), 4.02 – 3.63 (m, 1H), 2.79 – 2.47 (m, 1H), 1.30 – 1.20 (m, 3H), 1.19 – 0.99 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.39, 142.74, 140.96, 140.91, 139.69, 139.39, 128.82, 128.53, 128.34, 127.37, 127.30, 127.24, 127.17, 127.07, 127.05, 125.92, 72.44, 72.38, 47.64, 46.84, 21.13, 20.76, 17.95, 16.06. HRMS (APCI) calcd for C16H18NaO (M+Na+): 249.1250; found: 249.1255.



3-([1,1'-biphenyl]-4-ylmethyl)cyclopentan-1-ol

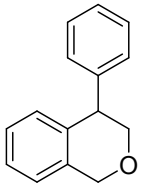
Prepared according to the general procedure, as a pale-yellow solid. The *d.r.* ratio was determined to be 1.2:1 by ^{1}H NMR. ^{1}H NMR of a mixture of two diastereomers (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 7.6 Hz, 2H), 7.50 (d, *J* = 7.9 Hz, 2H), 7.42 (t, *J* = 7.5 Hz, 2H), 7.31 (t, *J* = 7.3 Hz, 1H), 7.26 – 7.19 (m, 2H), 4.56 – 4.15 (m, 1H), 2.81 – 2.54 (m, 2H), 2.21 – 2.07 (m, 1H), 2.05 – 1.87 (m, 1H), 1.85 – 1.64 (m, 2H), 1.55 – 1.38 (m, 2H), 1.36 – 1.16 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.13, 140.98, 140.88, 138.70, 129.24, 128.81, 128.76, 127.24, 127.04, 127.02, 127.00, 126.94, 73.71, 73.62, 42.53, 42.31, 42.20, 41.68, 40.34, 39.24, 35.44, 35.16, 30.39, 30.24. HRMS (APCI) calcd for C18H20NaO (M+Na+): 275.1406; found: 275.1403.



benzyl 4-benzyl-4-hydroxypiperidine-1-carboxylate

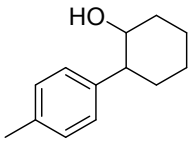
Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.22 (m, 8H), 7.17 (d, *J* = 7.1 Hz, 2H), 5.12 (s, 2H), 3.95 (br s, 2H), 3.16 (br s, 2H), 2.75 (s, 2H), 1.71 – 1.34 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.29, 136.89, 135.89, 130.55, 128.52, 128.50, 128.00, 127.89, 126.92, 69.36, 67.07, 49.31, 39.94, 36.63. HRMS

(APCI) calcd for C20H23NNaO3 (M+Na+): 348.1570; found: 348.1573.



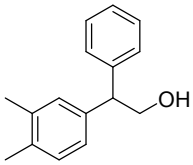
4-phenylisochromane

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.26 (m, 2H), 7.26 – 7.15 (m, 4H), 7.11 (t, *J* = 7.4 Hz, 1H), 7.04 (d, *J* = 7.5 Hz, 1H), 6.94 (d, *J* = 7.7 Hz, 1H), 4.89 (q, *J* = 15.0 Hz, 2H), 4.16 (q, *J* = 5.0 Hz, 2H), 3.89 (dd, *J* = 12.7, 8.4 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.11, 136.43, 134.89, 129.64, 129.06, 128.55, 126.79, 126.77, 126.46, 124.19, 72.22, 68.56, 44.51. HRMS (APCI) calcd for C15H15O (M+H+): 211.1117; found: 211.1119. The isolated product matched spectra previously reported in the literature. (***Ref.*** *Angew. Chem., Int. Ed., 2018,* ***57****, 319 – 323*).



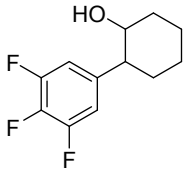
2-(p-tolyl)cyclohexan-1-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 – 7.01 (m, 4H), 3.92 – 3.39 (m, 1H), 2.44 – 2.35 (m, 1H), 2.33 (s, 3H), 2.14 – 2.07 (m, 1H), 1.89 – 1.80 (m, 2H), 1.78 – 1.72 (m, 1H), 1.56 – 1.25 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 140.14, 136.39, 129.49, 127.77, 74.49, 52.80, 34.41, 33.39, 26.11, 25.09, 21.03. HRMS (APCI) calcd for C13H18NaO (M+Na+): 213.1250; found: 213.1253.



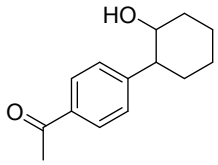
2-(3,4-dimethylphenyl)-2-phenylethan-1-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.15 (m, 5H), 7.08 (d, *J* = 7.7 Hz, 1H), 7.05 – 6.95 (m, 2H), 4.22 – 4.03 (m, 3H), 2.23 (s, 3H), 2.22 (s, 3H), 1.51 (br s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.71, 138.72, 136.97, 135.17, 130.01, 129.69, 128.72, 128.25, 126.73, 125.55, 66.22, 53.33, 19.93, 19.39. HRMS (APCI) calcd for C16H18NaO (M+Na+): 249.1250; found: 249.1256.



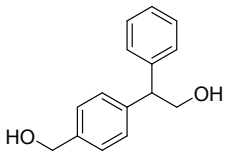
2-(3,4,5-trifluorophenyl)cyclohexan-1-ol

Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.01 – 6.72 (m, 2H), 3.57 (td, *J* = 10.0, 4.3 Hz, 1H), 2.54 – 2.30 (m, 1H), 2.19 – 2.02 (m, 1H), 2.00 – 1.65 (m, 3H), 1.55 – 1.19 (m, 5H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -134.46, -134.51, -163.32, -163.37, -163.43. ^{13}C NMR (101 MHz, $CDCl_3$) δ 151.23 (ddd, *J* = 249.7, 9.8, 4.1 Hz), 140.14 (td, *J* = 6.6, 4.6 Hz), 138.40 (dt, *J* = 249.8, 15.3 Hz), 111.67 (dd, *J* = 15.4, 5.5 Hz), 74.12, 52.42, 34.98, 33.24, 25.70, 24.86. HRMS (APCI) calcd for C12H13F3NaO (M+Na+): 253.0811; found: 253.0815.



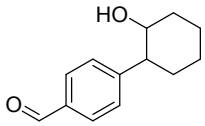
1-(4-(2-hydroxycyclohexyl)phenyl)ethan-1-one

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 – 7.77 (m, 2H), 7.66 – 7.30 (m, 2H), 3.83 – 3.66 (m, 1H), 2.63 – 2.44 (m, 4H), 2.26 – 2.09 (m, 1H), 1.96 – 1.74 (m, 3H), 1.57 – 1.29 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.79, 149.50, 135.74, 128.78, 128.09, 74.11, 53.17, 34.87, 33.22, 26.56, 25.86, 24.99. HRMS (APCI) calcd for C14H18NaO2 (M+Na+): 241.1199; found: 241.1197.



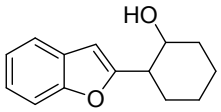
2-(4-(hydroxymethyl)phenyl)-2-phenylethan-1-ol

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.16 (m, 9H), 4.64 (s, 2H), 4.27 – 4.11 (m, 3H), 1.77 (br s, 1H), 1.63 (br s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.30, 140.93, 139.41, 128.76, 128.53, 128.27, 127.46, 126.88, 66.09, 65.05, 53.35. HRMS (APCI) calcd for C15H16NaO2 (M+Na+): 251.1043; found: 251.1046.



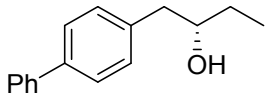
4-(2-hydroxycyclohexyl)benzaldehyde

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.98 (s, 1H), 7.85 (d, *J* = 8.3 Hz, 2H), 7.43 (d, *J* = 8.3 Hz, 2H), 3.83 – 3.60 (m, 1H), 2.64 – 2.42 (m, 1H), 2.29 – 2.04 (m, 1H), 1.94 – 1.75 (m, 3H), 1.63 – 1.27 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.93, 151.12, 135.20, 130.19, 128.57, 74.14, 53.37, 34.93, 33.22, 25.82, 24.97. HRMS (APCI) calcd for C13H16NaO2 (M+Na+): 227.1043; found: 227.1041.



2-(benzofuran-2-yl)cyclohexan-1-ol

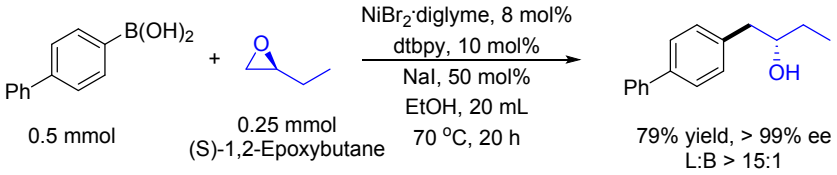
Prepared according to the general procedure, as a pale-yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 – 7.48 (m, 1H), 7.43 (ddd, *J* = 3.2, 1.9, 0.9 Hz, 1H), 7.26 – 7.13 (m, 2H), 6.51 (d, *J* = 0.6 Hz, 1H), 3.87 – 3.48 (m, 1H), 2.77 – 2.58 (m, 1H), 2.13 (ddd, *J* = 7.6, 4.7, 1.5 Hz, 1H), 2.03 (ddd, *J* = 13.2, 6.0, 2.8 Hz, 1H), 1.89 – 1.77 (m, 2H), 1.74 – 1.59 (m, 1H), 1.47 – 1.27 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 160.27, 154.68, 128.51, 123.57, 122.68, 120.54, 111.00, 102.71, 72.68, 46.36, 34.29, 30.10, 25.36, 24.60. HRMS (APCI) calcd for C14H16NaO2 (M+Na+): 239.1043; found: 239.1046.



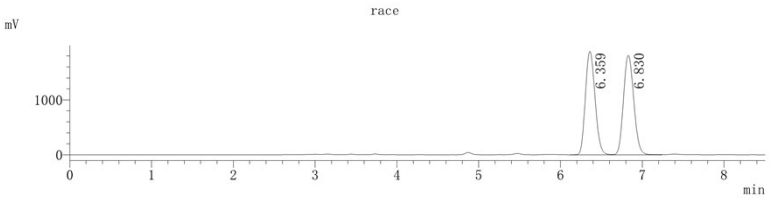
(S)-1-([1,1'-biphenyl]-4-yl)butan-2-ol

Prepared according to the general procedure, as a pale-yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (dd, *J* = 15.1, 7.8 Hz, 4H), 7.43 (t, *J* = 7.5 Hz, 2H), 7.31 (dd, *J* = 19.9, 7.5 Hz, 3H), 4.01 – 3.55 (m, 1H), 2.87 (dd, *J* = 13.6, 3.9 Hz, 1H), 2.69 (dd, *J* = 13.5, 8.4 Hz, 1H), 1.66 – 1.34 (m, 3H), 1.01 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 140.95, 139.41, 137.80, 129.89, 128.80, 127.30, 127.19, 127.05, 74.08, 43.22, 29.71, 10.13. HRMS (APCI) calcd for C16H18NaO (M+Na+): 249.1250; found: 249.1252.

Scheme S1. Experiment of chiral epoxide



Chiralpak AD-H column, λ = 214 nm, n-hexane/i-PrOH (90:10)



Peak[#]	RetTime[min]	Height[uV]	Width[min]	Area[uV*s]	Area[%]
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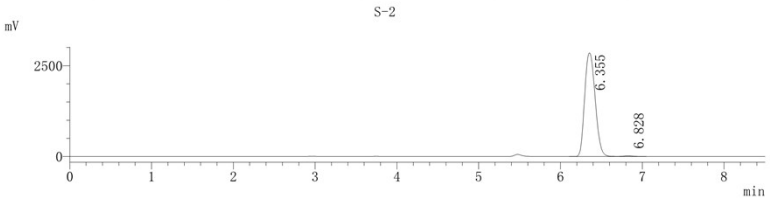
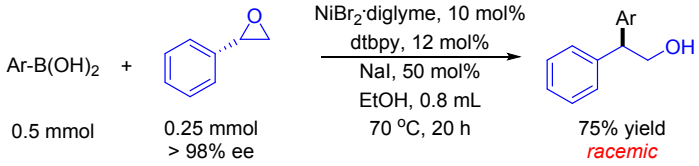
2	6.830	1809488	0.137	15842481	50.567

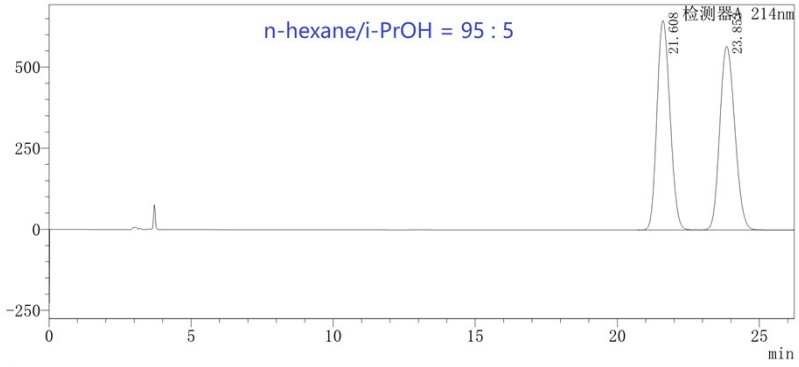


Peak[#]	RetTime[min]	Height[uV]	Width[min]	Area[uV*s]	Area[%]
1	6.355	2851615	0.141	25413108	99.448
2	6.828	17484	0.122	141007	0.552

Scheme S2. Mechanism experiment of chiral epoxide



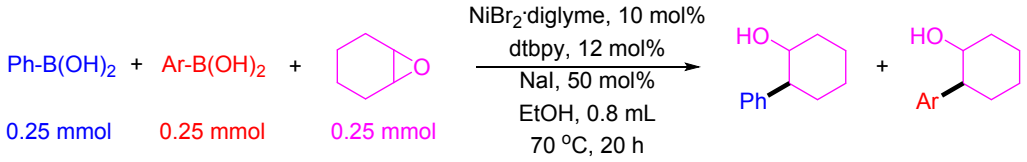
Chiralpak OJ-H column, λ = 214 nm

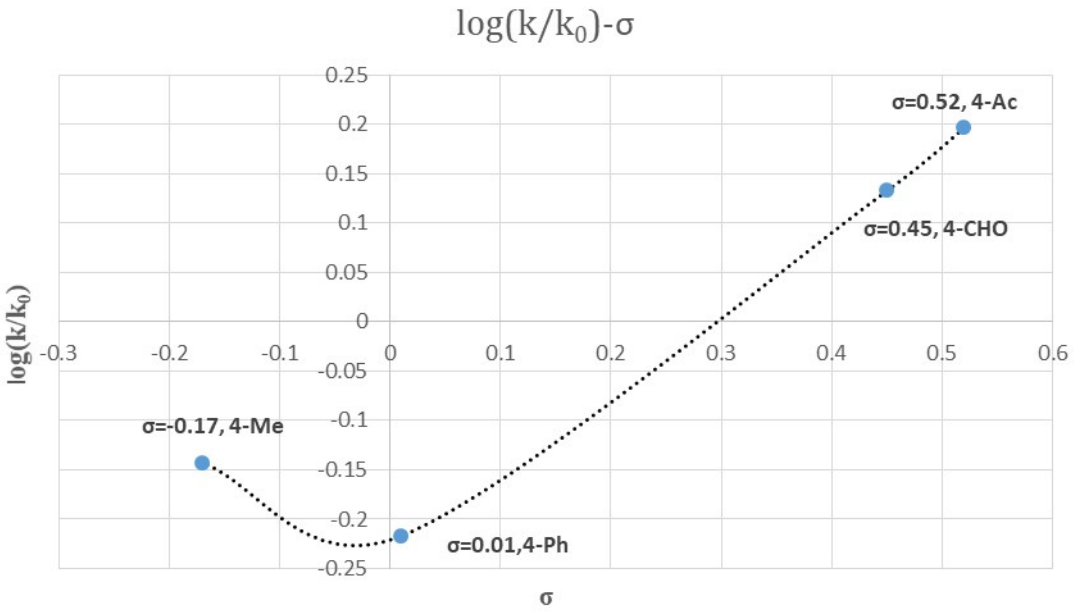


〈峰表〉
检测器A 214nm

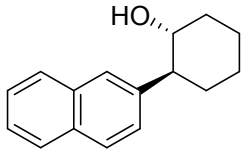
峰号	保留时间	面积	高度	浓度	浓度单位	标记	化合物名
1	21.608	20701170	645992	49.805			
2	23.853	20863295	566018	50.195		V	
总计		41564465	1212010				

Scheme S3. Hammett analysis of the reaction



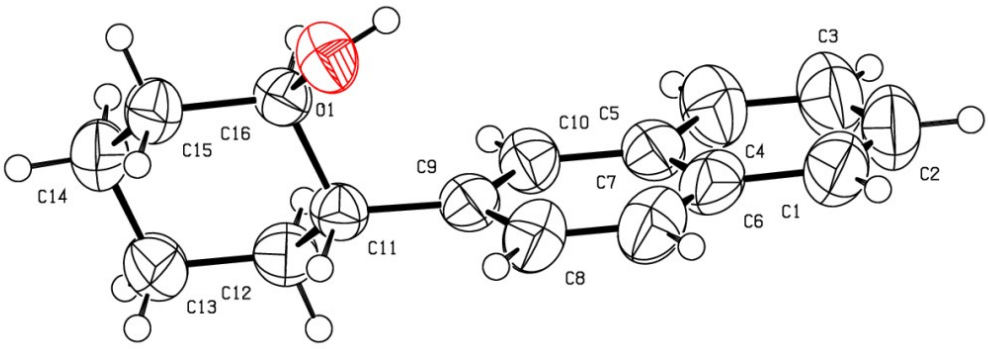


Scheme S4. X-ray diffraction analysis

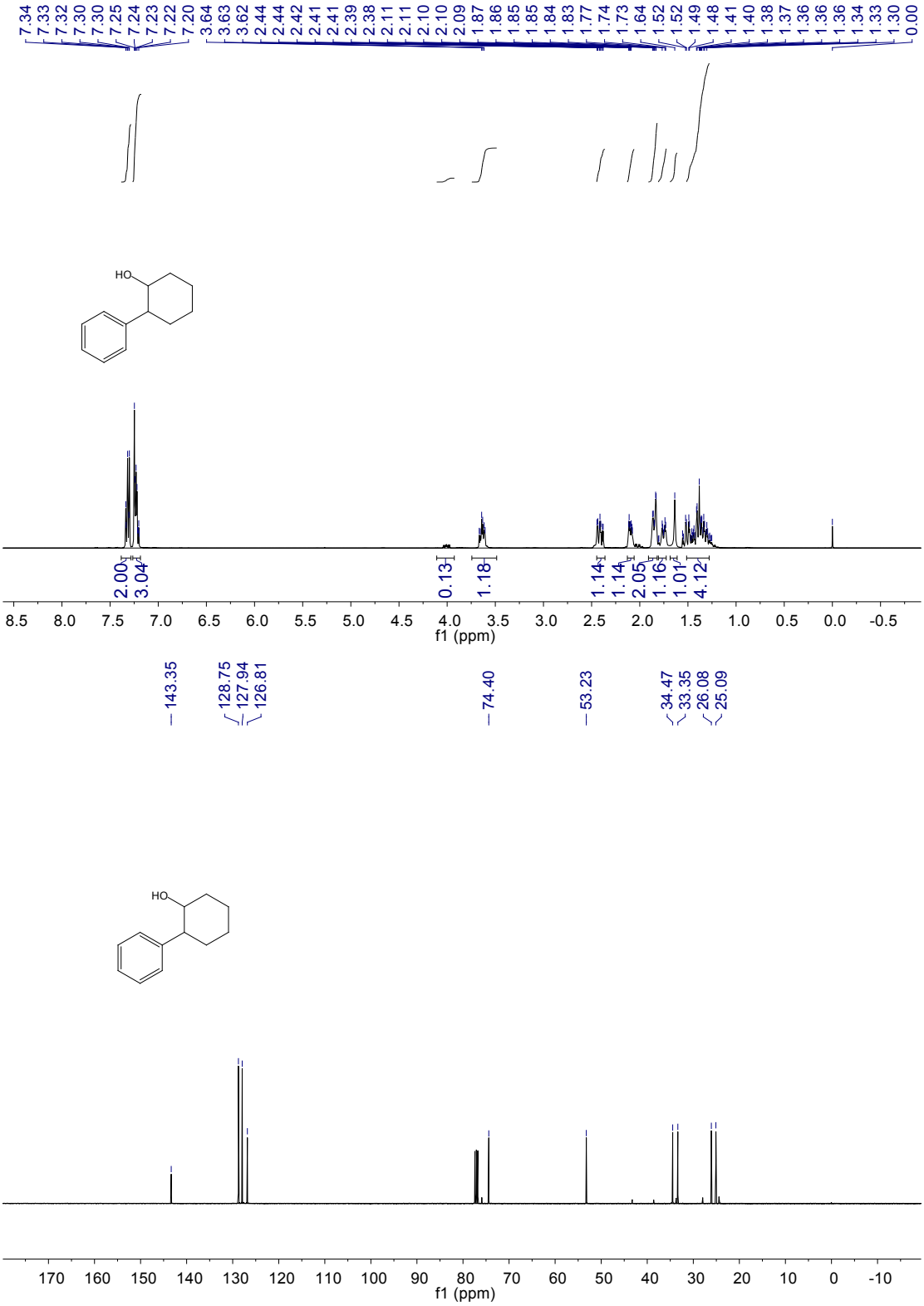


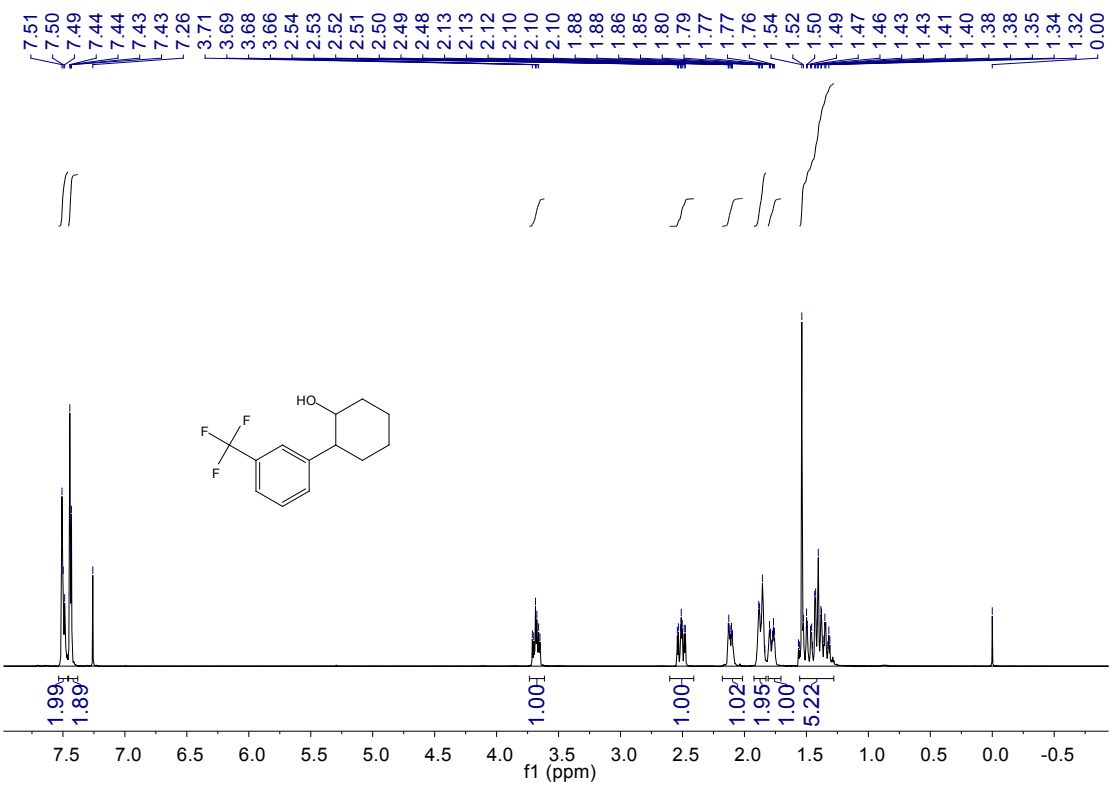
(3g)

CCDC Deposition Number: 1967481



5. NMR Spectra




7.51
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7.44
7.44
7.43
7.43
7.26
3.71
3.69
3.68
3.66
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2.53
2.52
2.51
2.50
2.49
2.48
2.13
2.12
2.10
2.10
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1.88
1.86
1.85
1.80
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1.77
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1.50
1.49
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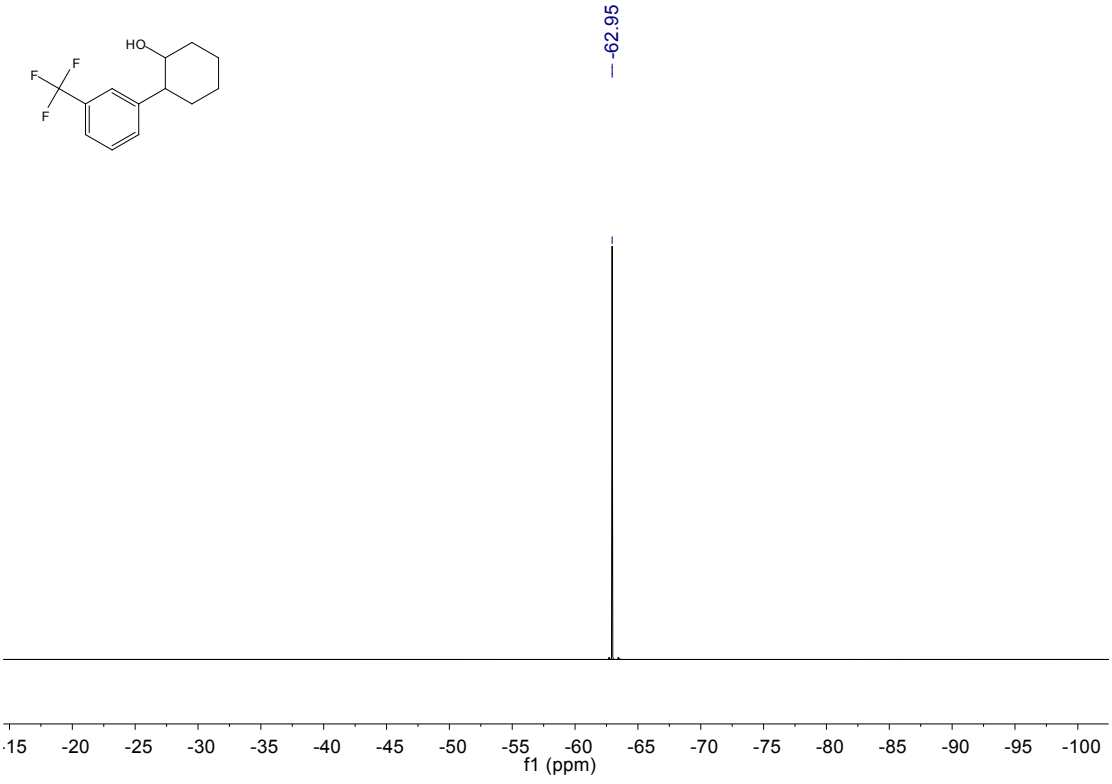
1.46
1.43
1.43
1.41
1.40
1.38
1.38
1.35
1.34
1.32
0.00
HO
F
F
F
1.99
1.89
1.00
1.00
1.02
1.95
1.00
5.22
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


HO
F
F
F
-62.95
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
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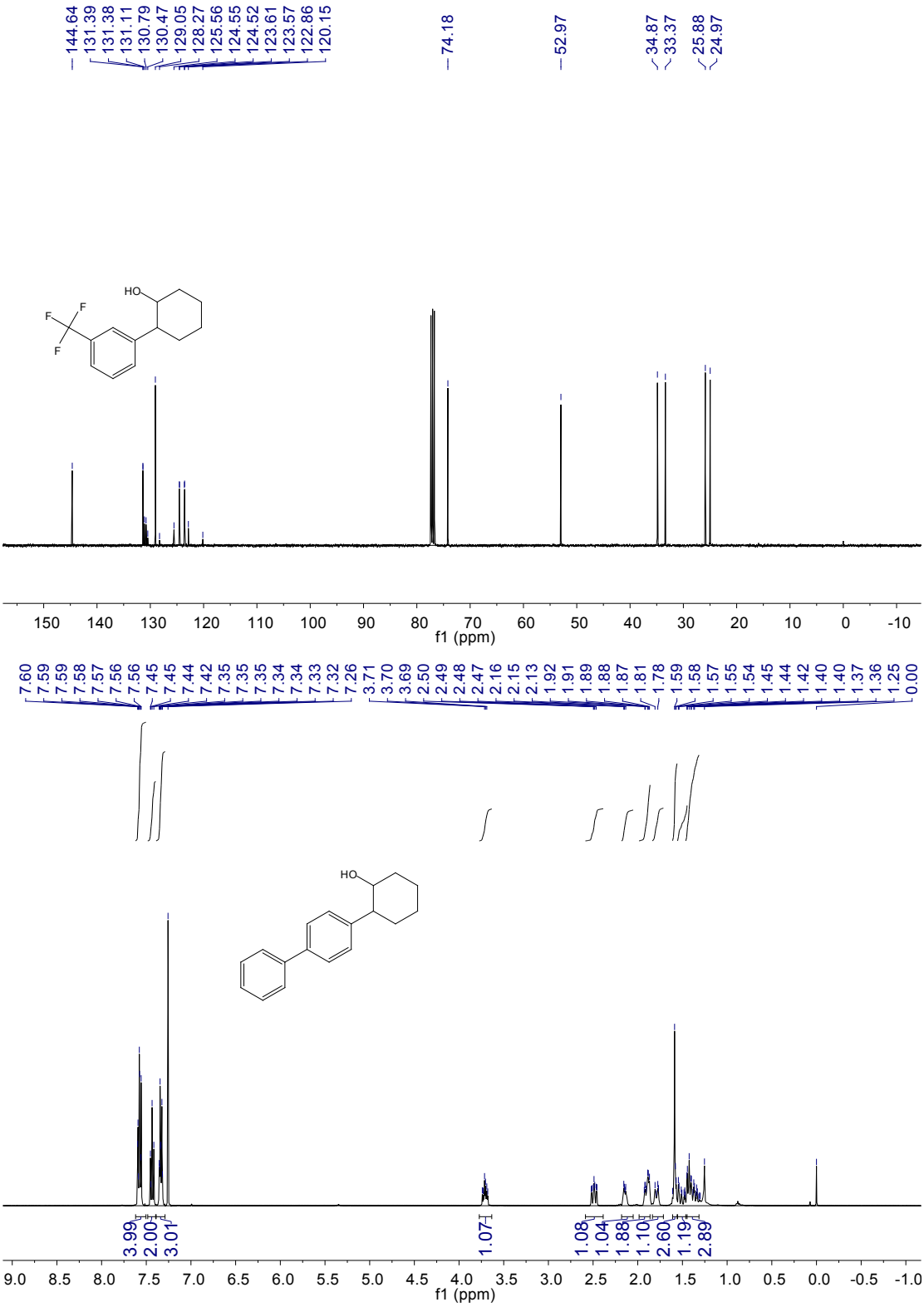
-75
-80
-85
-90
-95
-100
f1 (ppm)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125.56
124.55
124.52
123.61
123.57
122.86
120.15
74.18
52.97
34.87
33.37
25.88
24.97
HO
F
F
F
f1 (ppm)
7.60
7.59
7.59
7.58
7.57
7.56
7.56
7.45
7.45
7.44
7.42
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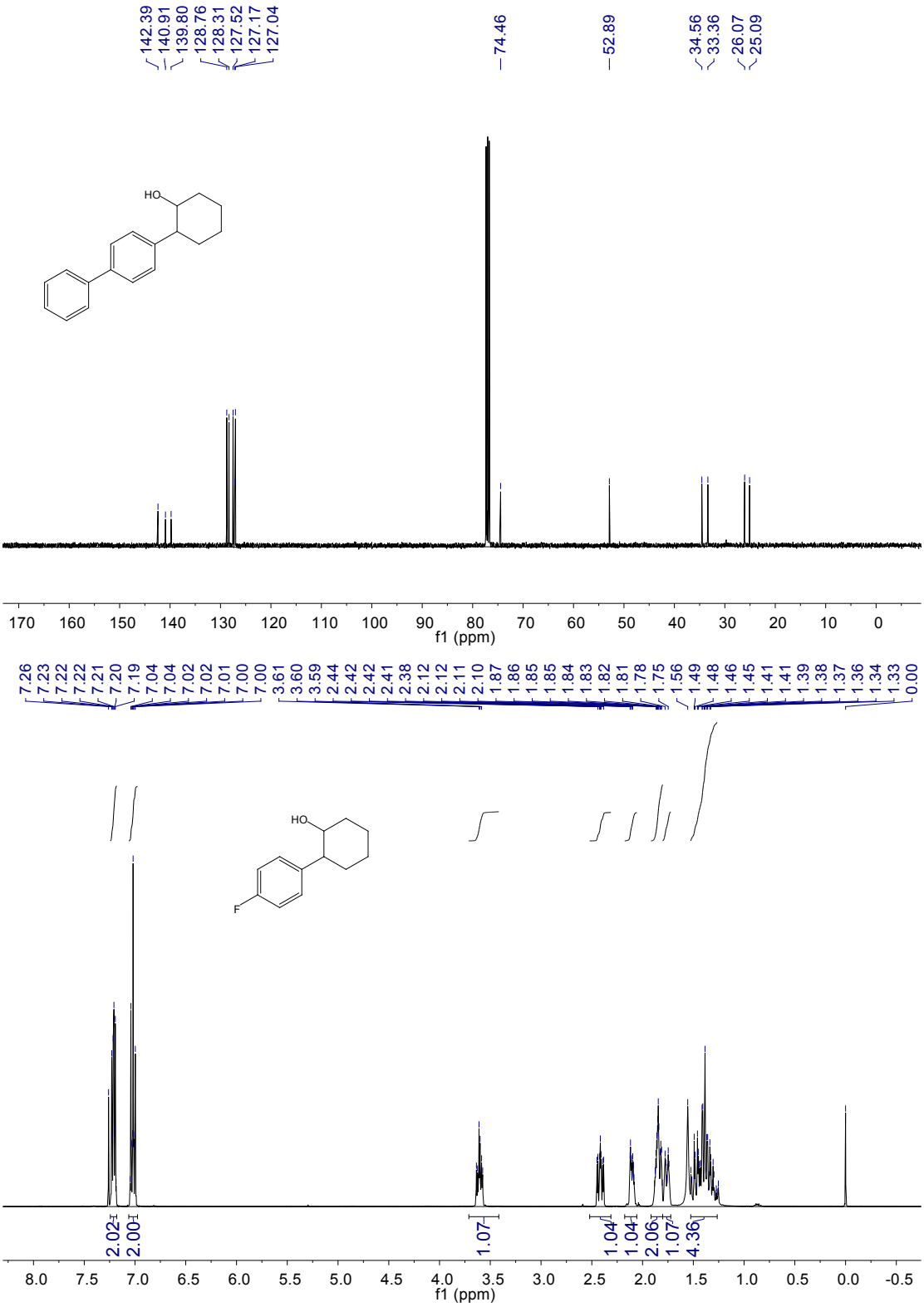
7.32
7.26
3.71
3.70
3.69
2.50
2.49
2.48
2.47
2.16
2.15
2.13
1.92
1.91
1.89
1.88
1.87
1.81
1.78
1.59
1.58
1.57
1.55
1.54
1.45
1.44
1.42
1.40
1.40
1.37
1.36
1.25
0.00
HO
3.99
2.00
3.01
1.07
1.08
1.04
1.88
1.10
2.60
1.19
2.89
f1 (ppm)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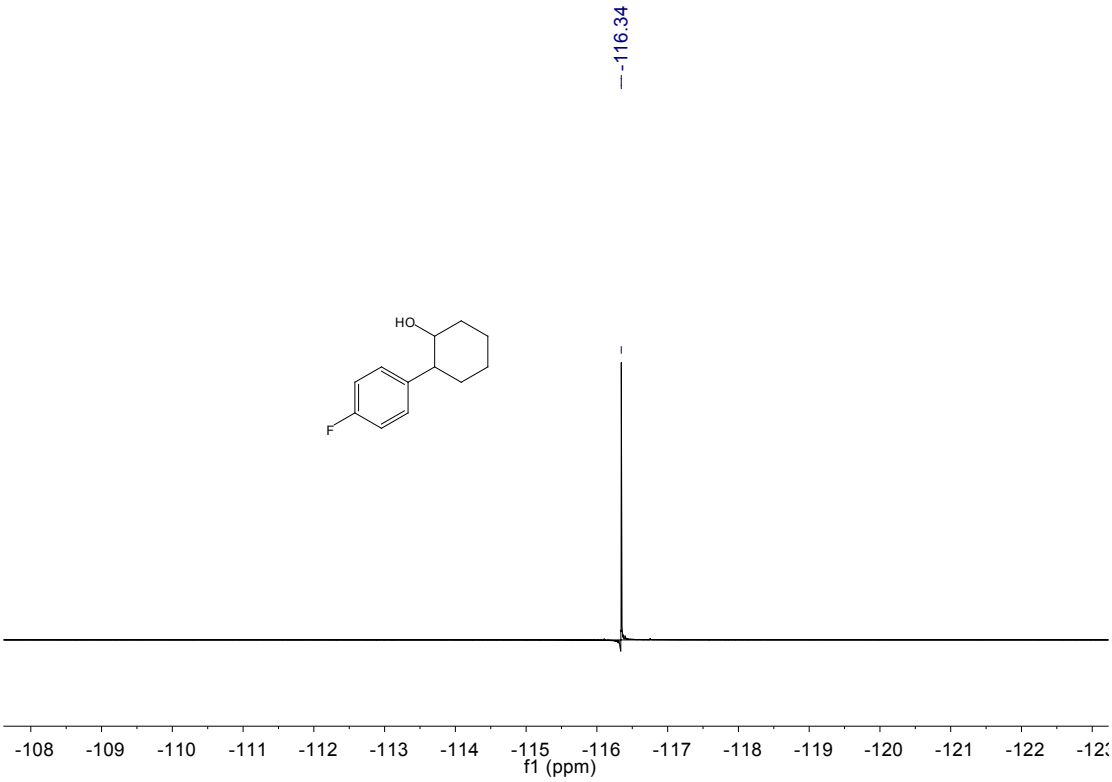
140.91
139.80
128.76
128.31
127.52
127.17
127.04
74.46
52.89
34.56
33.36
26.07
25.09
HO
f1 (ppm)
7.26
7.23
7.22
7.22
7.21
7.20
7.19
7.04
7.04
7.02
7.02
7.01
7.00
7.00
3.61
3.60
3.59
2.44
2.42
2.42
2.41
2.38
2.12
2.12
2.11
2.10
1.87
1.86
1.85
1.85
1.84
1.83
1.82
1.81
1.78
1.75
1.56
1.49
1.48
1.46
1.45
1.41
1.41
1.39
1.38
1.37
1.36
1.34
1.33
0.00
HO
F
2.02
2.00
1.07
1.04
1.04
2.06
1.07
4.36
f1 (ppm)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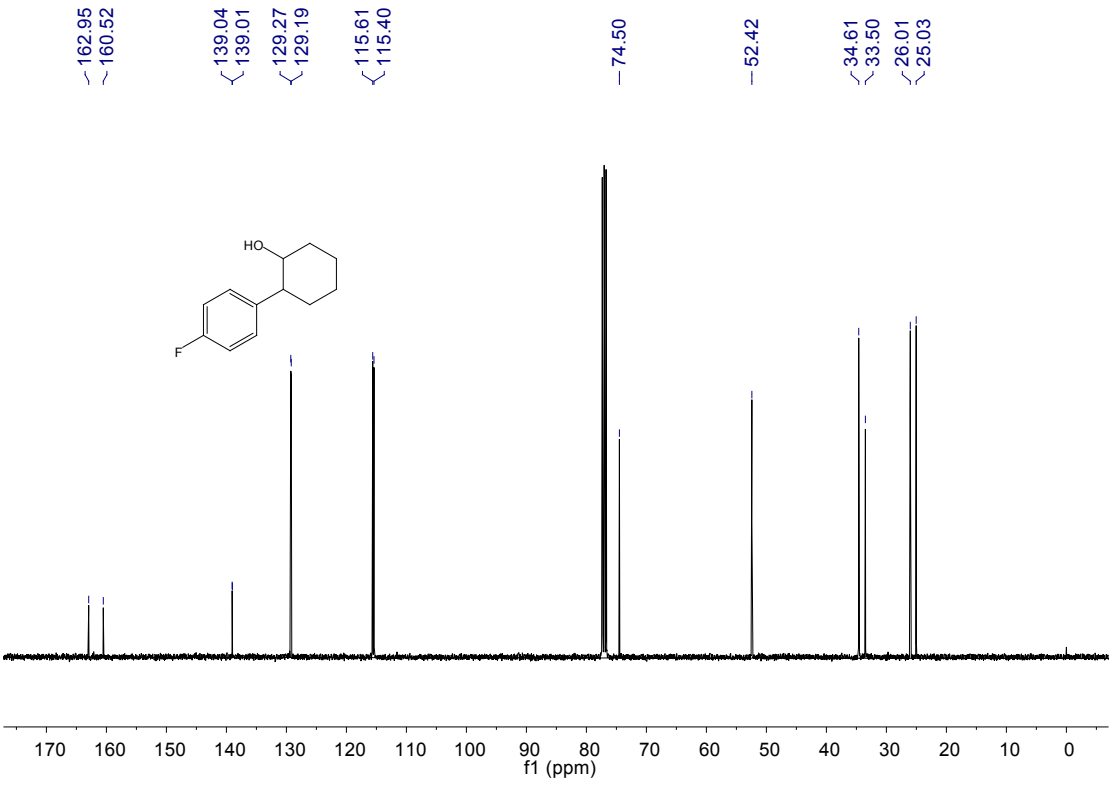
HO
F
-108 -109 -110 -111 -112 -113 -114 -115 -116 -117 -118 -119 -120 -121 -122 -123
f1 (ppm)


162.95
160.52
139.04
139.01
129.27
129.19
115.61
115.40
74.50
52.42
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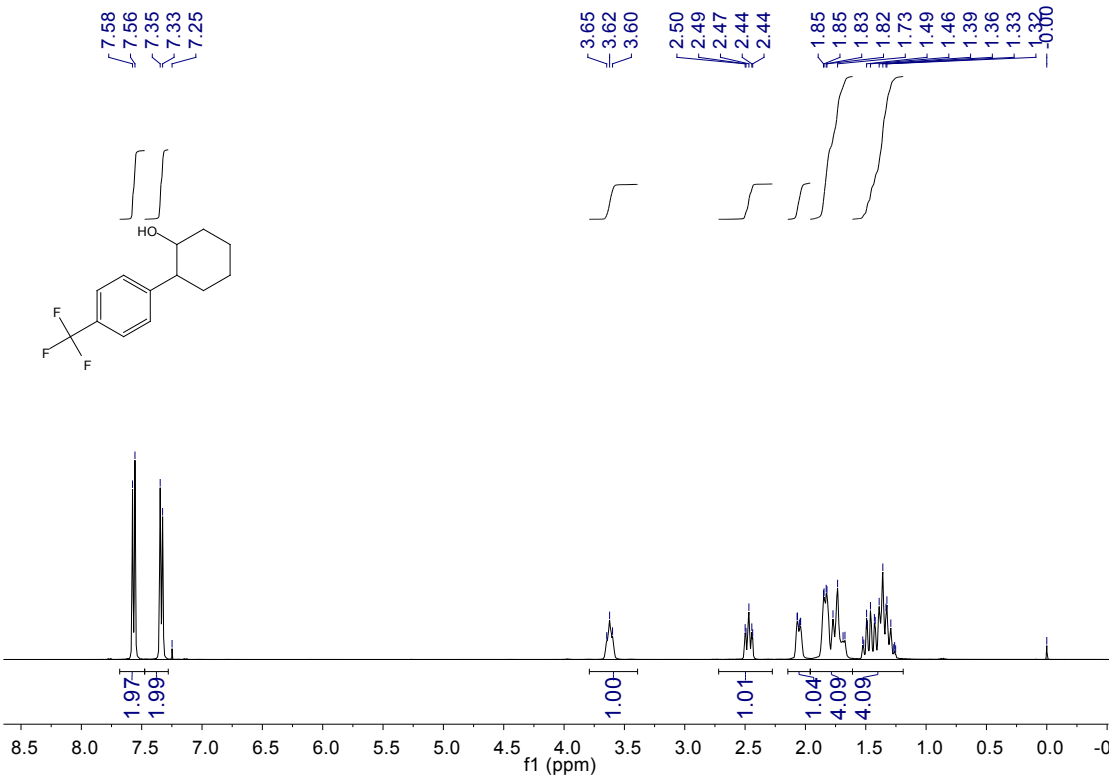
33.50
26.01
25.03
HO
F
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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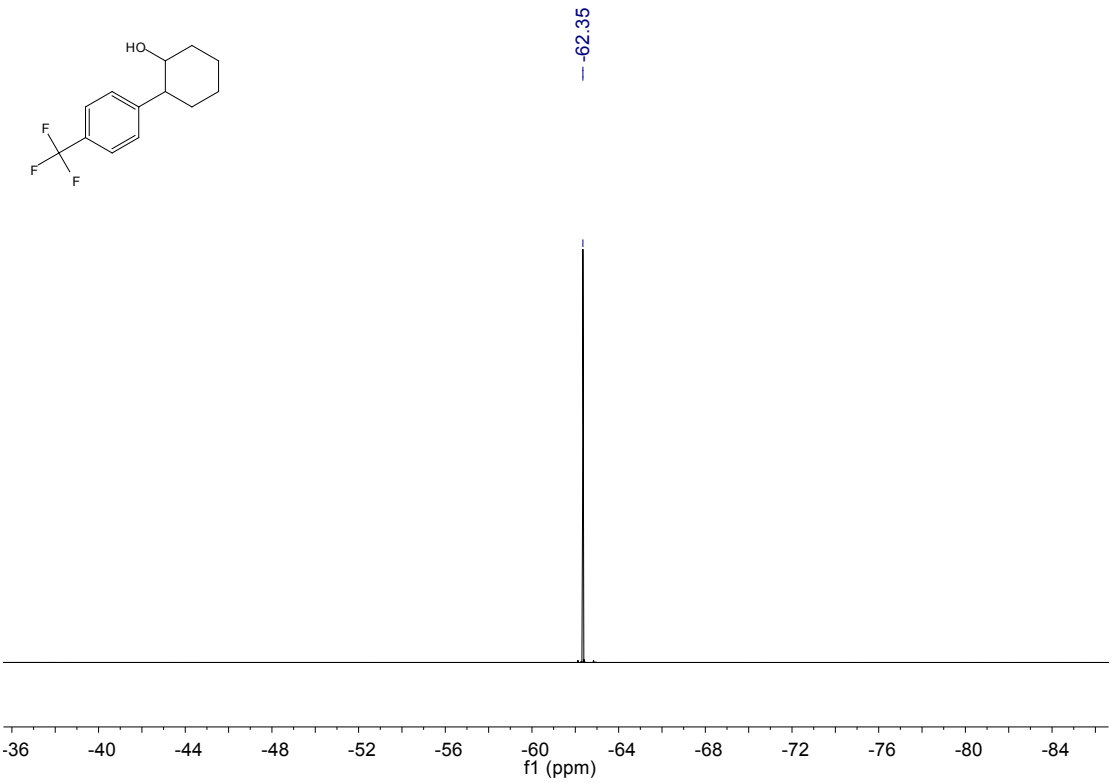
7.56
7.35
7.33
7.25
3.65
3.62
3.60
2.50
2.49
2.47
2.44
2.44
1.85
1.85
1.83
1.82
1.73
1.49
1.46
1.39
1.36
1.33
1.32
0.00
HO
F
F
F
1.97
1.99
1.00
1.01
1.04
4.09
4.09
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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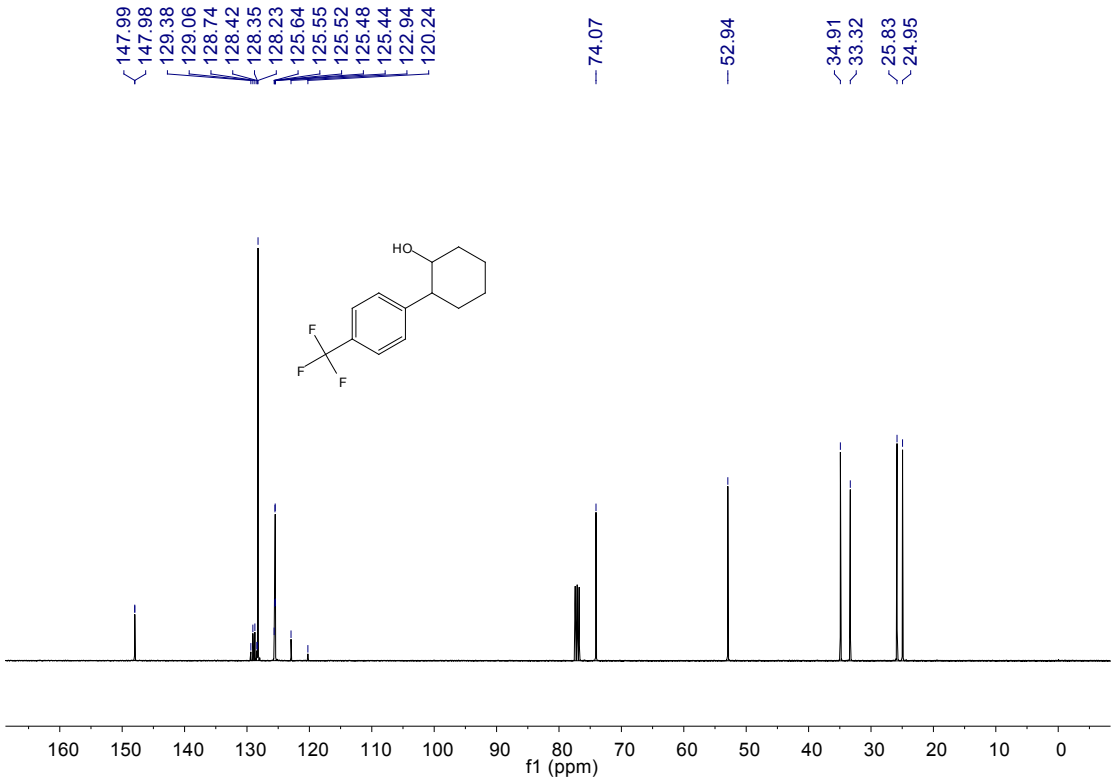
HO
F
F
F
-36
-40
-44
-48
-52
-56
-60
-64
-68
-72
-76
-80
-84
f1 (ppm)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147.98
129.38
129.06
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128.42
128.35
128.23
125.64
125.55
125.52
125.48
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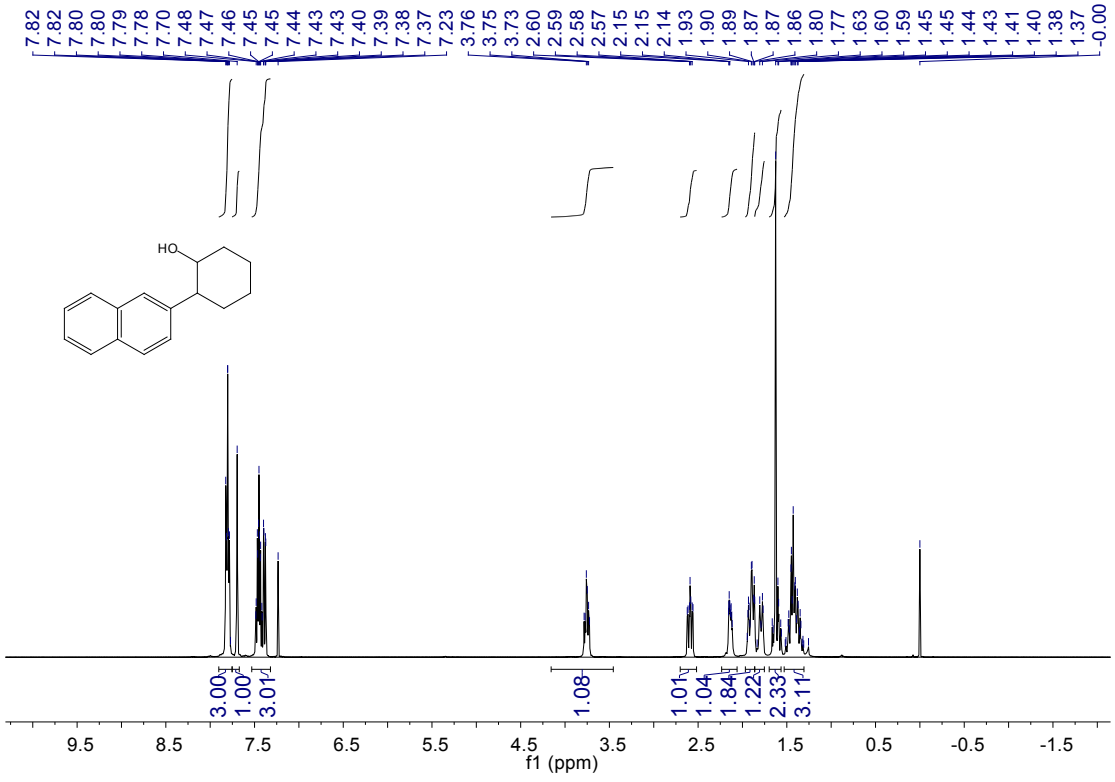
122.94
120.24
74.07
52.94
34.91
33.32
25.83
24.95
HO
F
F
F
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.78
7.70
7.48
7.47
7.46
7.45
7.45
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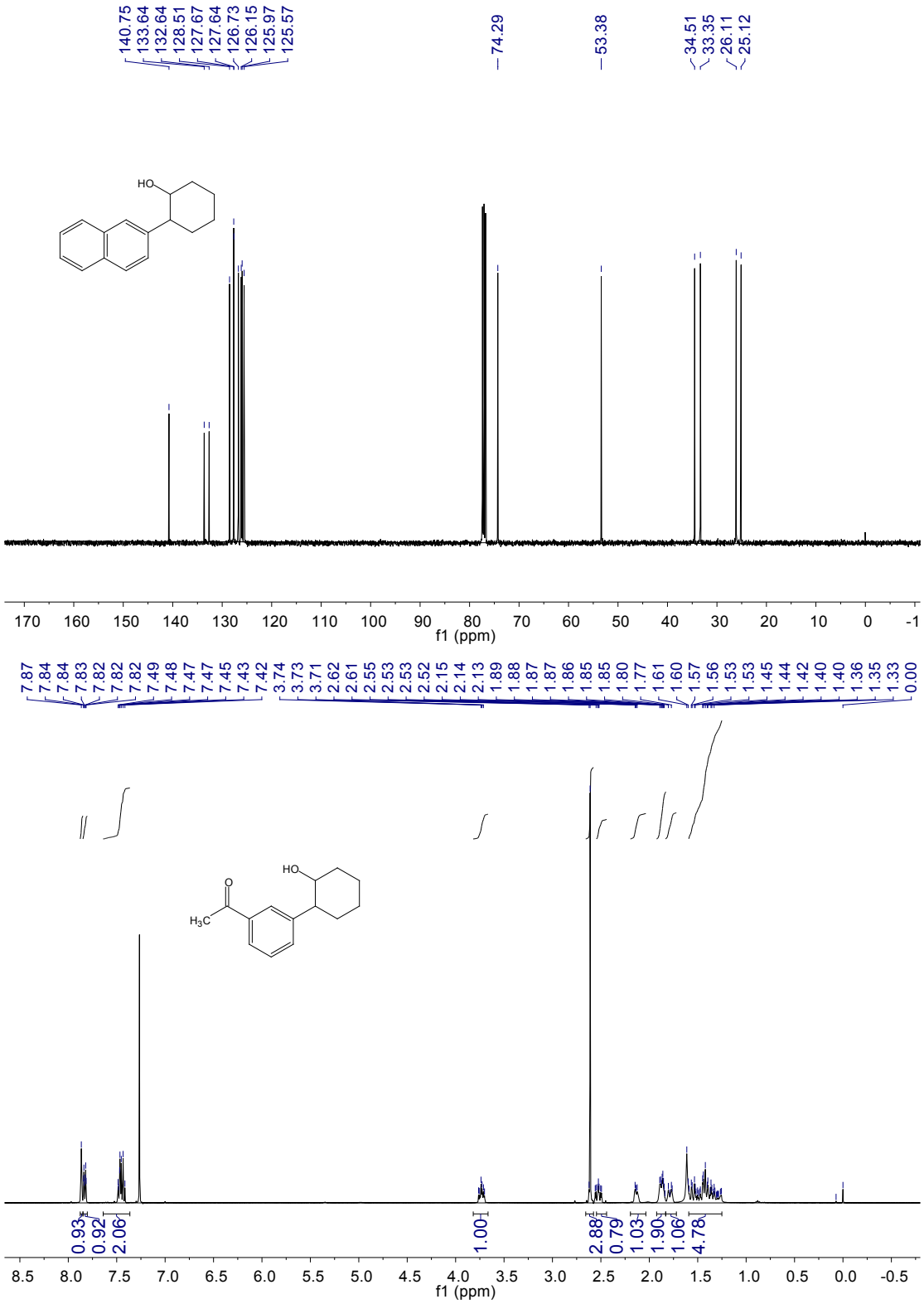
7.43
7.43
7.40
7.39
7.38
7.37
7.23
3.76
3.75
3.73
2.60
2.59
2.58
2.57
2.15
2.15
2.14
1.93
1.90
1.89
1.87
1.87
1.86
1.80
1.77
1.63
1.60
1.59
1.45
1.45
1.44
1.43
1.41
1.40
1.38
1.37
-0.00
HO
3.00
1.00
3.01
1.08
1.01
1.04
1.84
1.22
2.33
3.11
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
f1 (ppm)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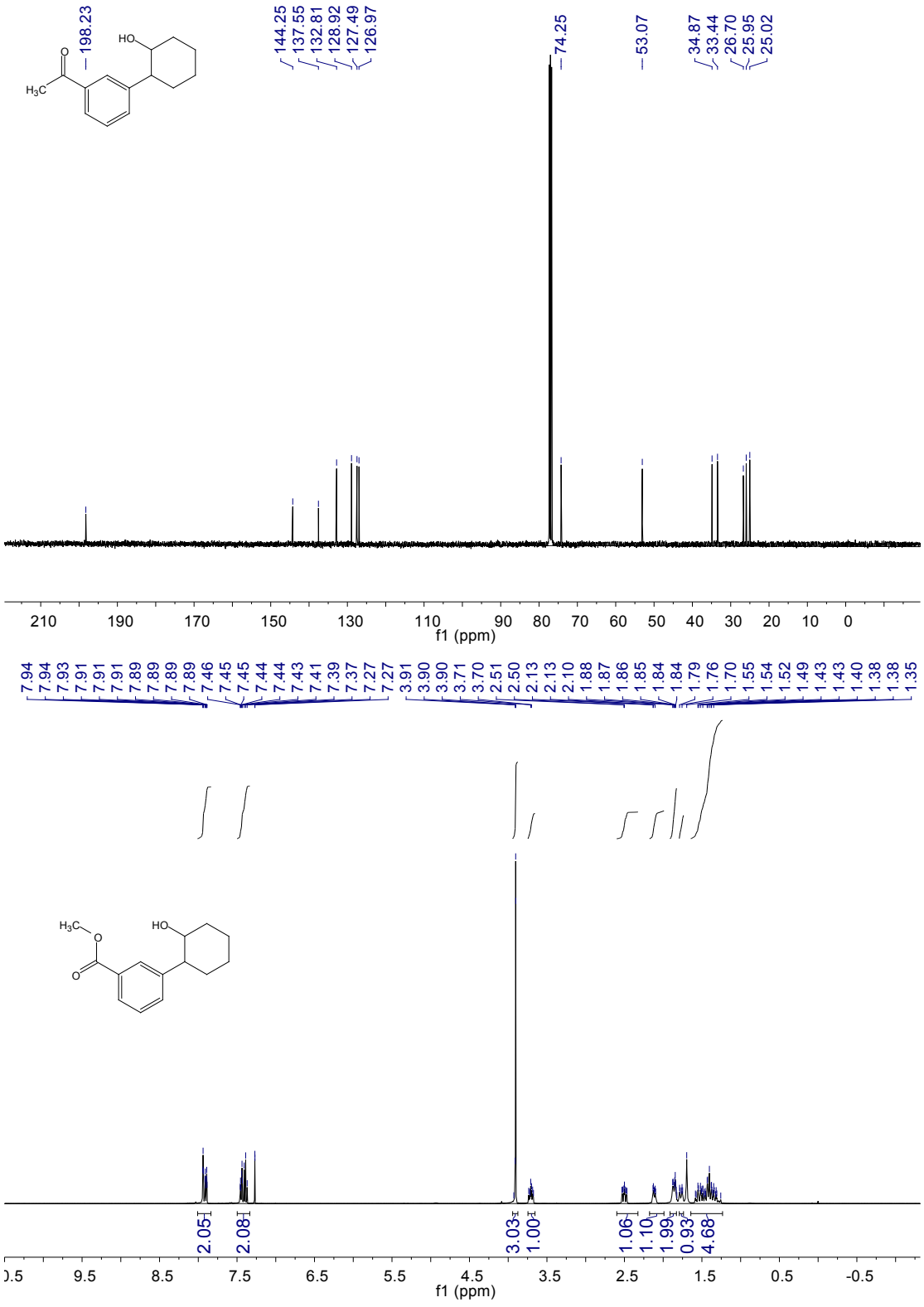
133.64
132.64
128.51
127.67
127.64
126.73
126.15
125.97
125.57
74.29
53.38
34.51
33.35
26.11
25.12
HO
f1 (ppm)
7.87
7.84
7.84
7.83
7.82
7.82
7.82
7.49
7.48
7.47
7.47
7.45
7.43
7.42
3.74
3.73
3.71
2.62
2.61
2.55
2.53
2.53
2.52
2.15
2.14
2.13
1.89
1.88
1.87
1.87
1.86
1.85
1.85
1.80
1.77
1.61
1.60
1.57
1.56
1.53
1.53
1.45
1.44
1.42
1.40
1.40
1.36
1.35
1.33
0.00
HO
O
H3C
0.93
0.92
2.06
1.00
2.88
0.79
1.03
1.90
1.06
4.78
f1 (ppm)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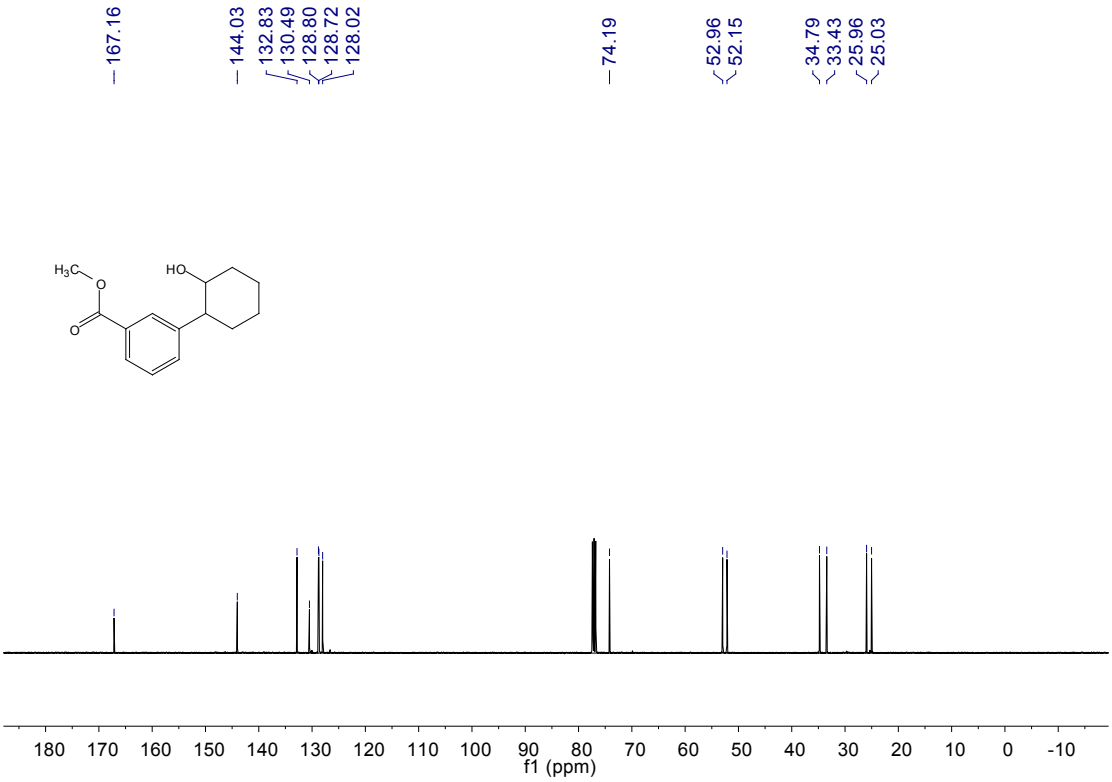
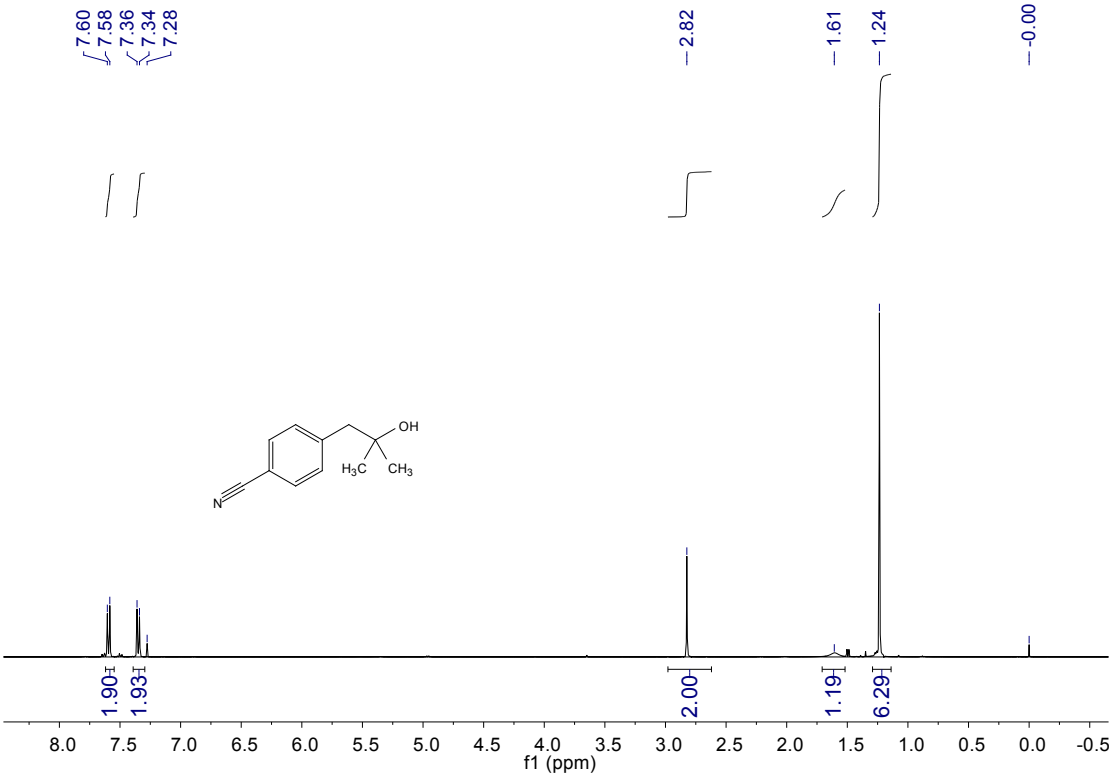
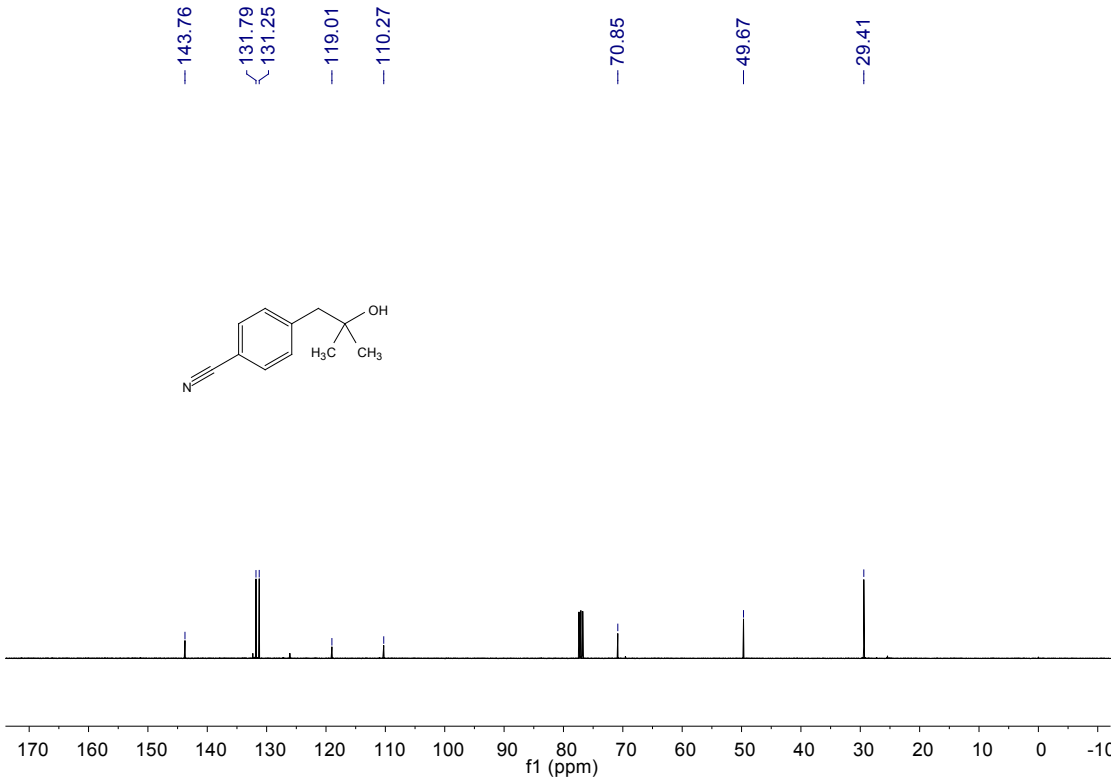
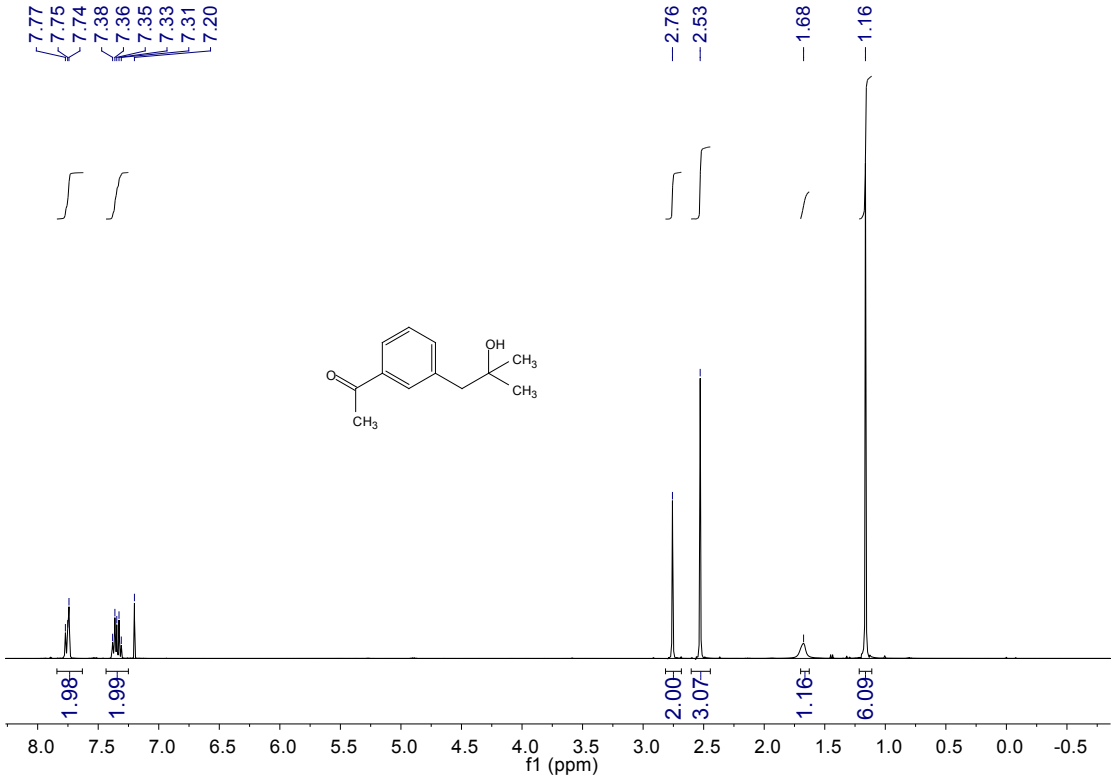
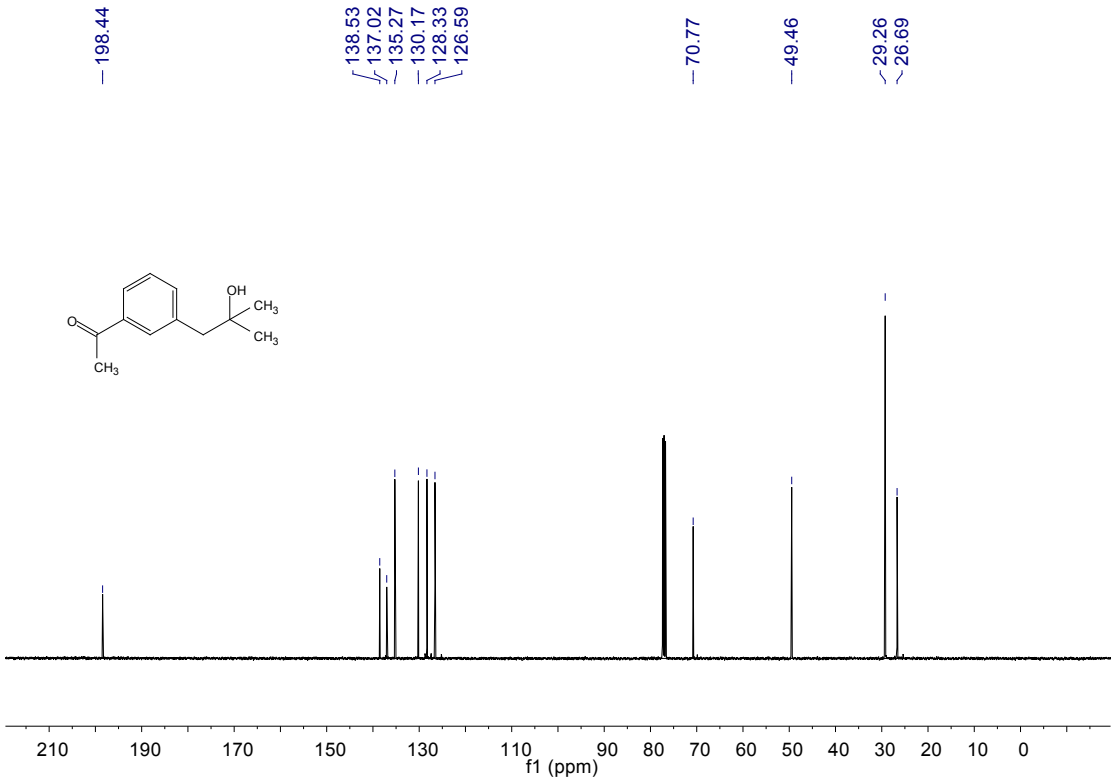
144.25
137.55
132.81
128.92
127.49
126.97
74.25
53.07
34.87
33.44
26.70
25.95
25.02
f1 (ppm)
2.05
2.08
3.03
1.00
1.06
1.10
1.99
0.93
4.68
f1 (ppm)

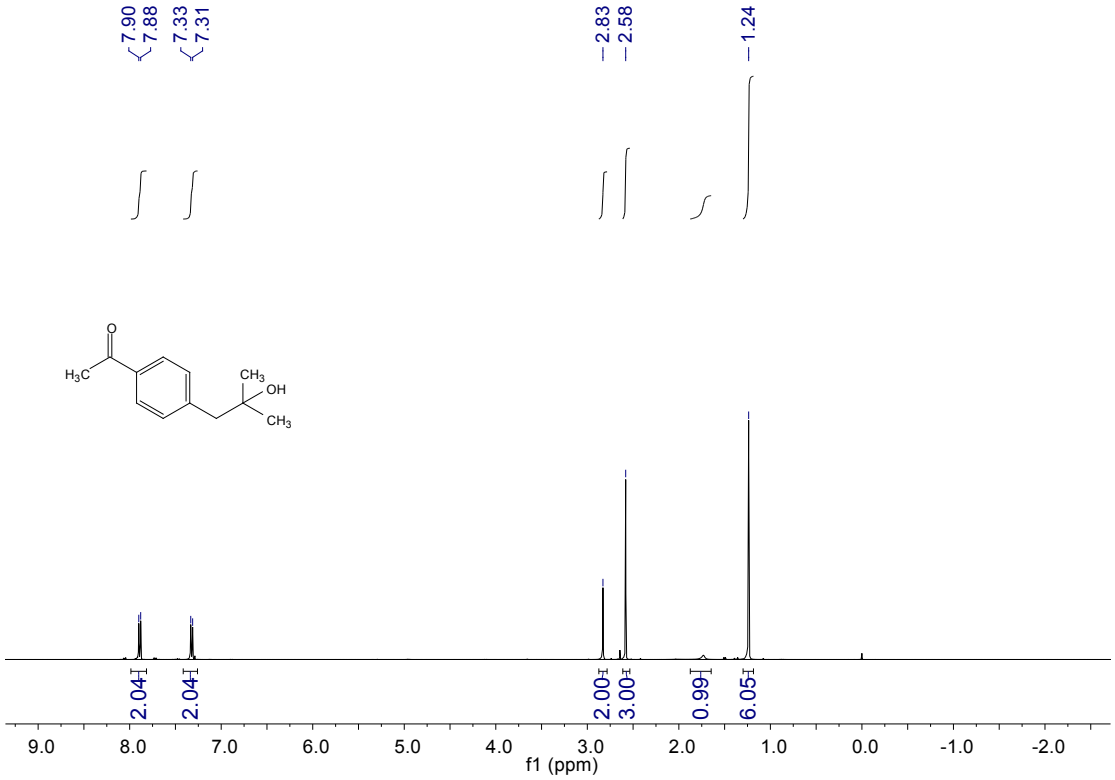

167.16
144.03
132.83
130.49
128.80
128.72
128.02
74.19
52.96
52.15
34.79
33.43
25.96
25.03
H3C
O
HO
O
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

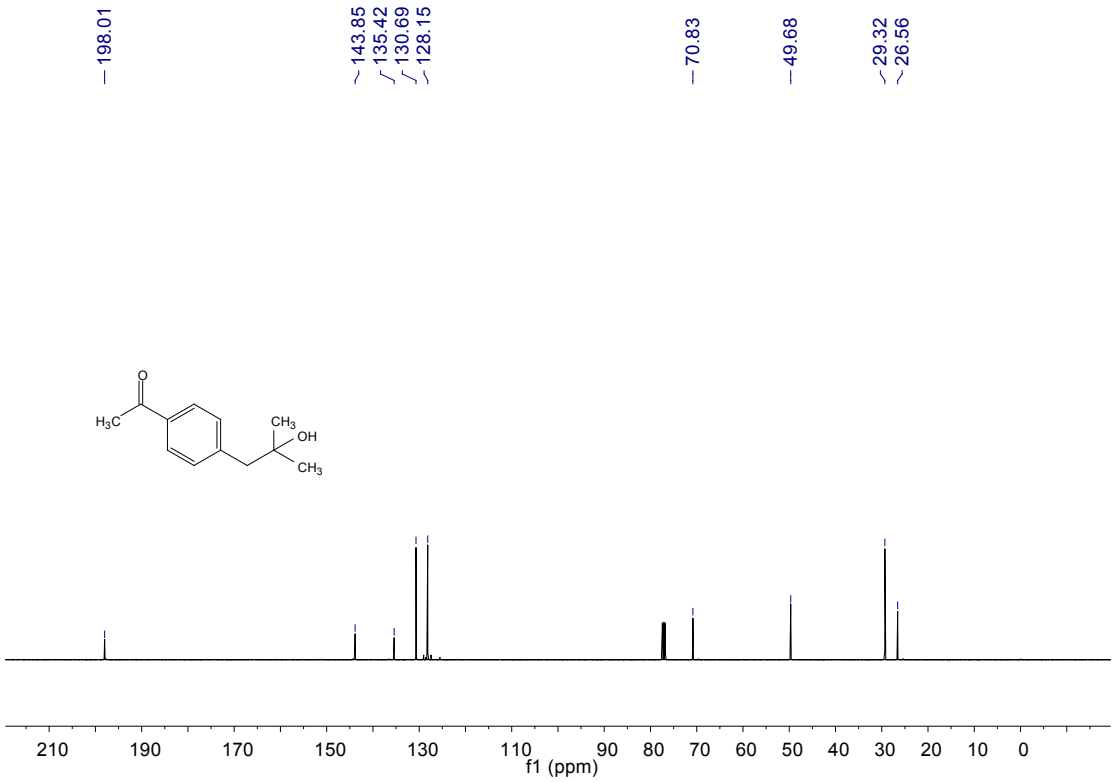

7.60
7.58
7.36
7.34
7.28
2.82
1.61
1.24
0.00
OH
H3C
CH3
N
1.90
1.93
2.00
1.19
6.29
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


143.76
131.79
131.25
119.01
110.27
70.85
49.67
29.41
OH
H3C
CH3
N
f1 (ppm)


7.77
7.75
7.74
7.38
7.36
7.35
7.33
7.31
7.20
2.76
2.53
1.68
1.16
OH
CH3
CH3
O
CH3
1.98
1.99
2.00
3.07
1.16
6.09
f1 (ppm)


198.44
138.53
137.02
135.27
130.17
128.33
126.59
70.77
49.46
29.26
26.69
OH
CH3
CH3
O
CH3
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.90
7.88
7.33
7.31
2.83
2.58
1.24
O
H3C
CH3
OH
CH3
2.04
2.04
2.00
3.00
0.99
6.05
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
f1 (ppm)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143.85
135.42
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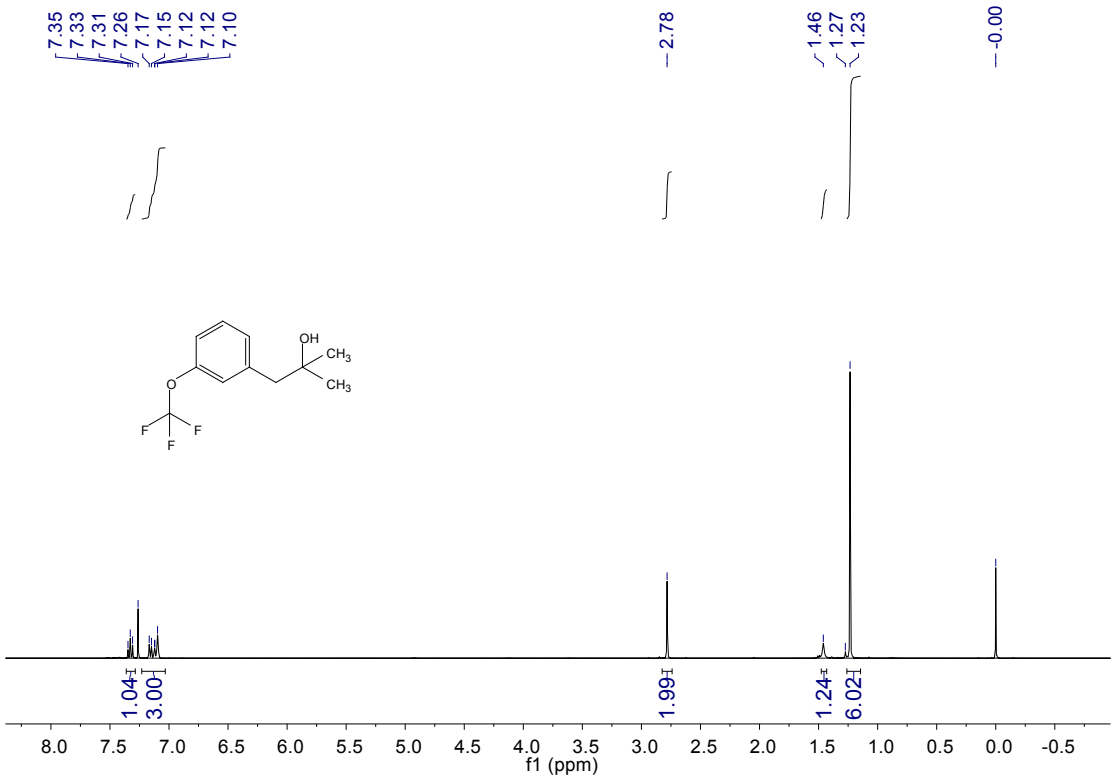
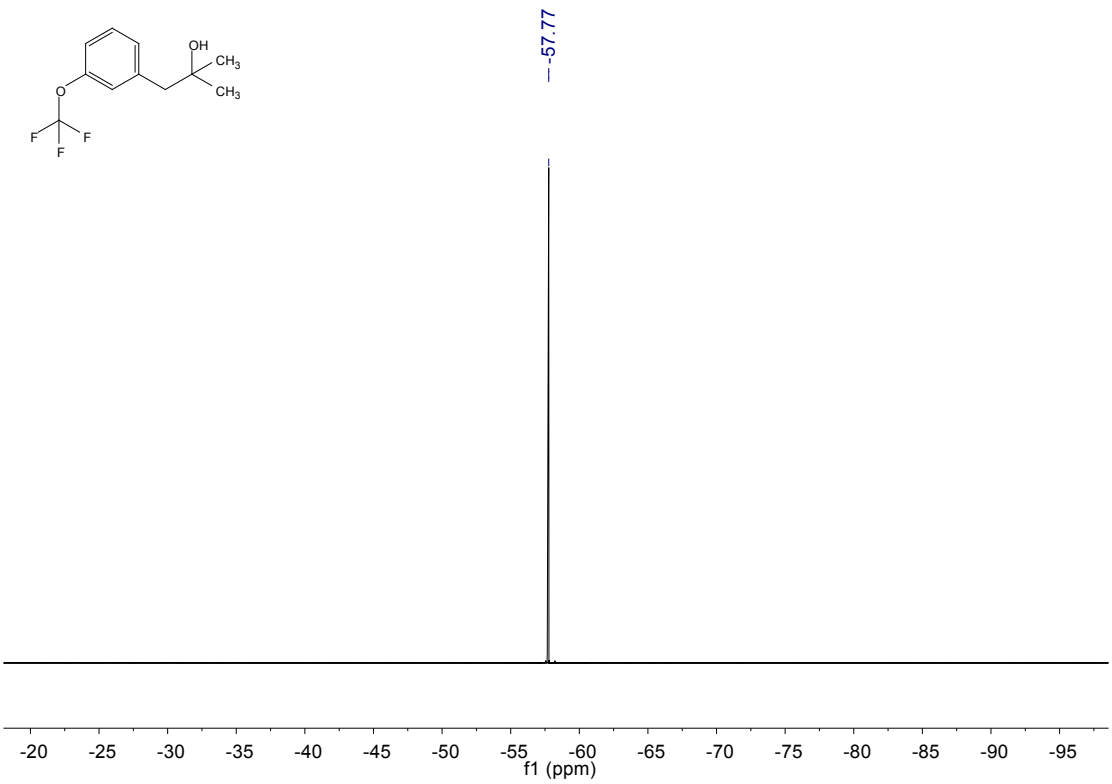
128.15
70.83
49.68
29.32
26.56
O
H3C
CH3
OH
CH3
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.35
7.33
7.31
7.26
7.17
7.15
7.12
7.12
7.10
2.78
1.46
1.27
1.23
0.00
OH
CH3
CH3
O
F
F
F
1.04
3.00
1.99
1.24
6.02
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


OH
CH3
CH3
O
F
F
F
-57.77
-20
-25
-30
-35
-40
-45
-50
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-60
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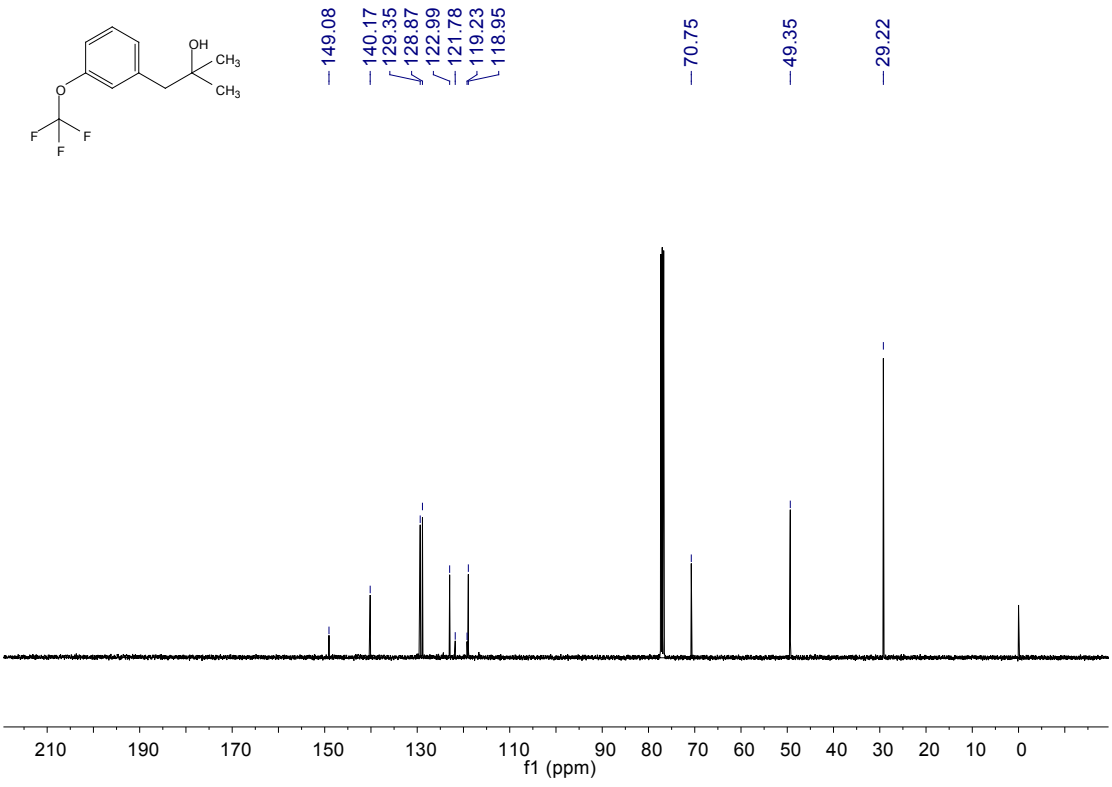
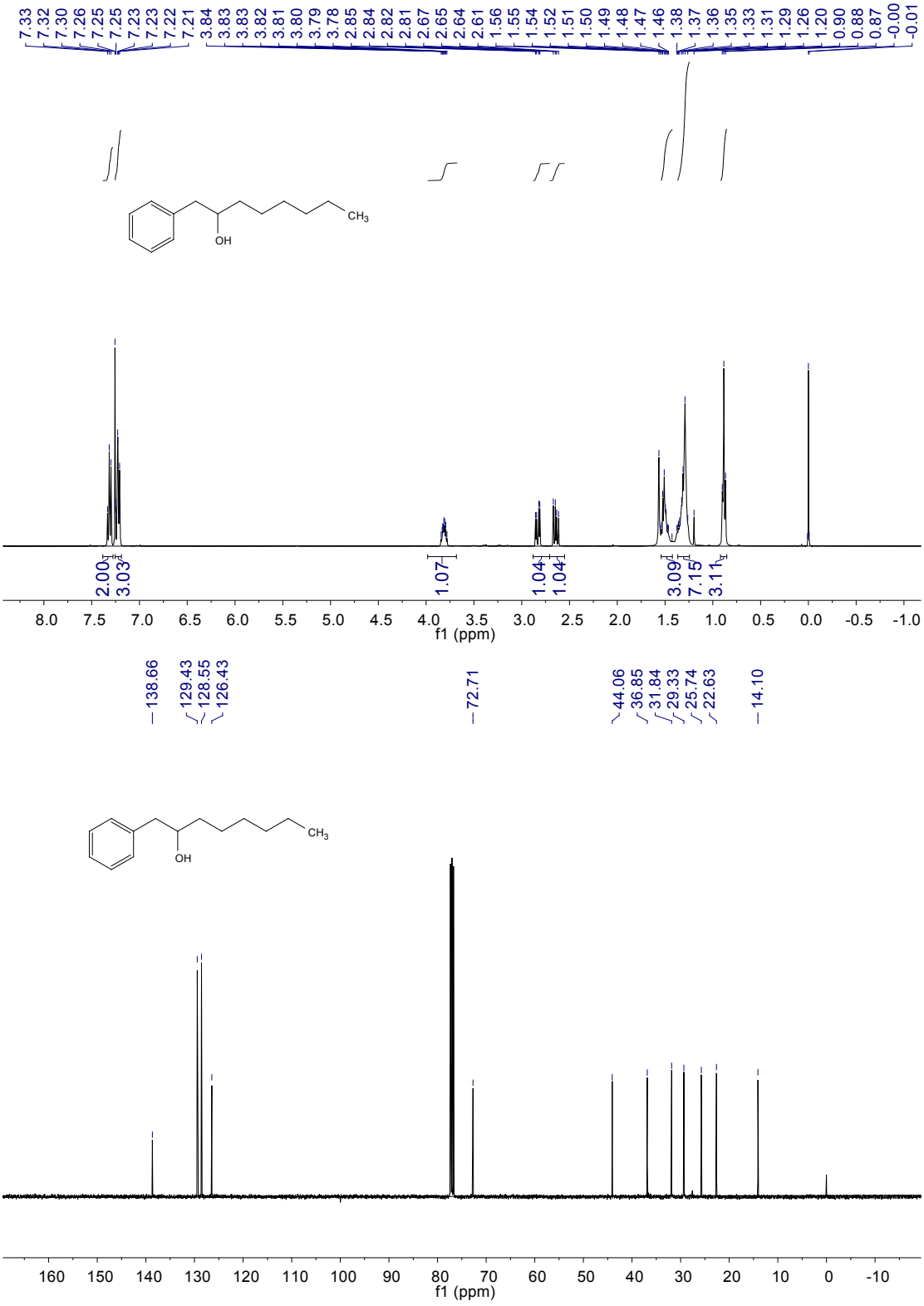
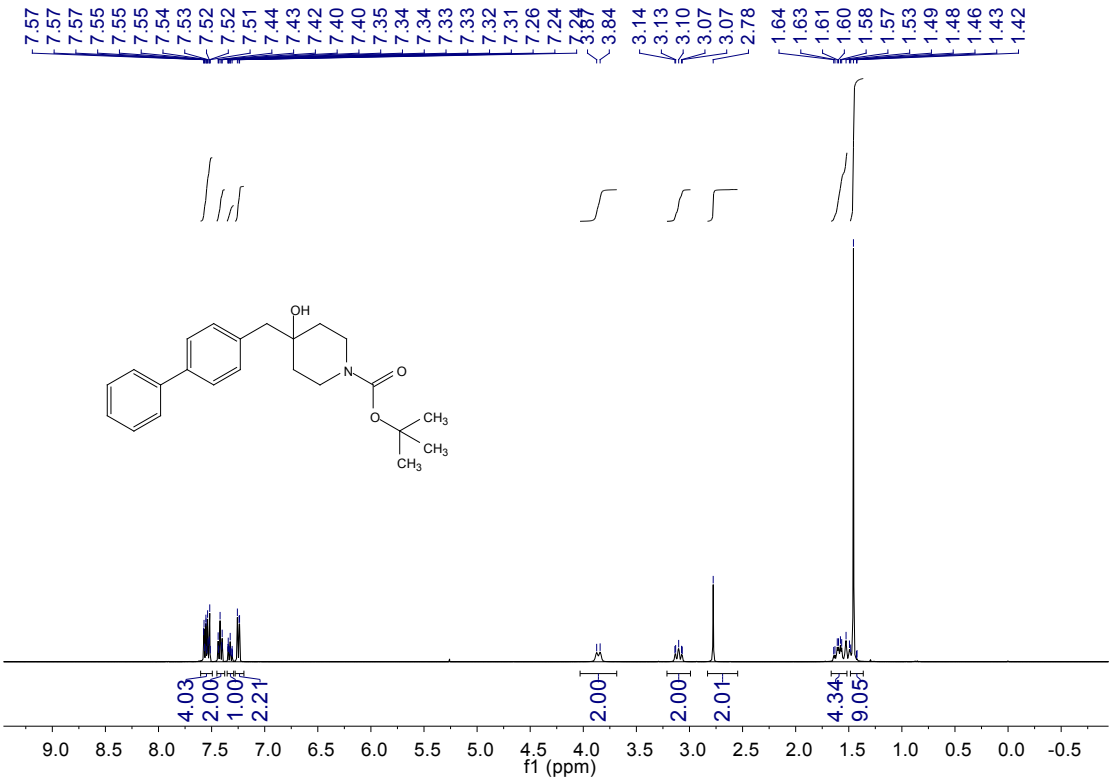
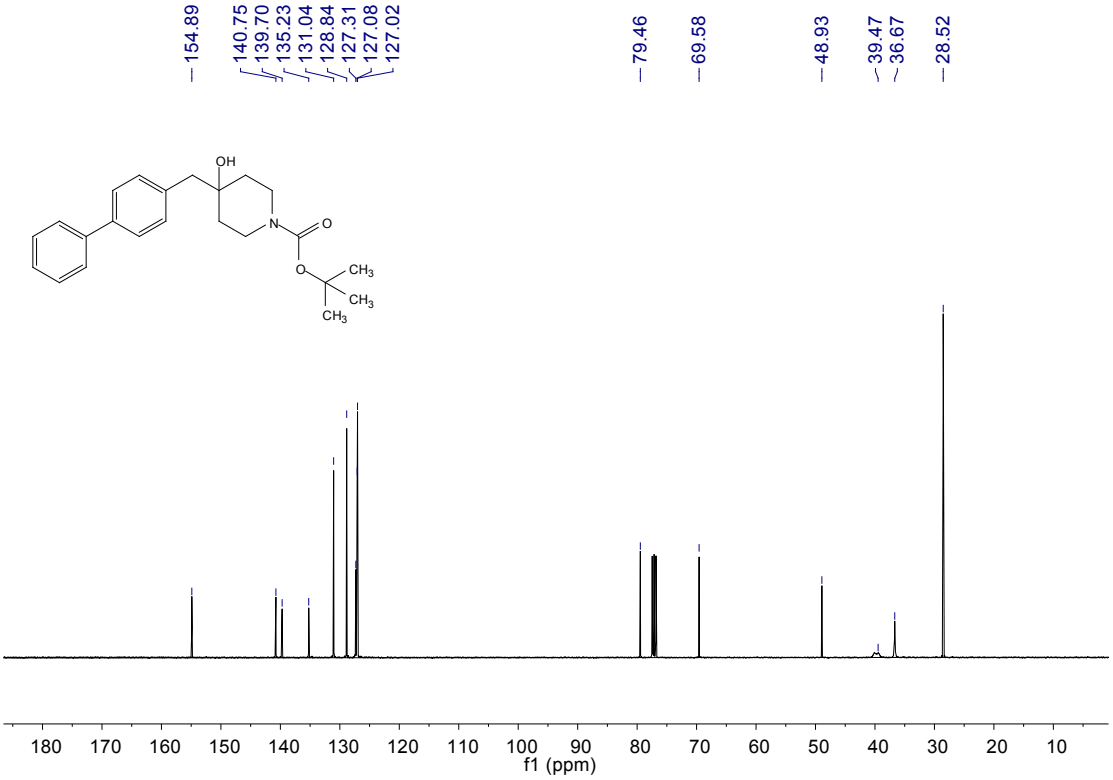
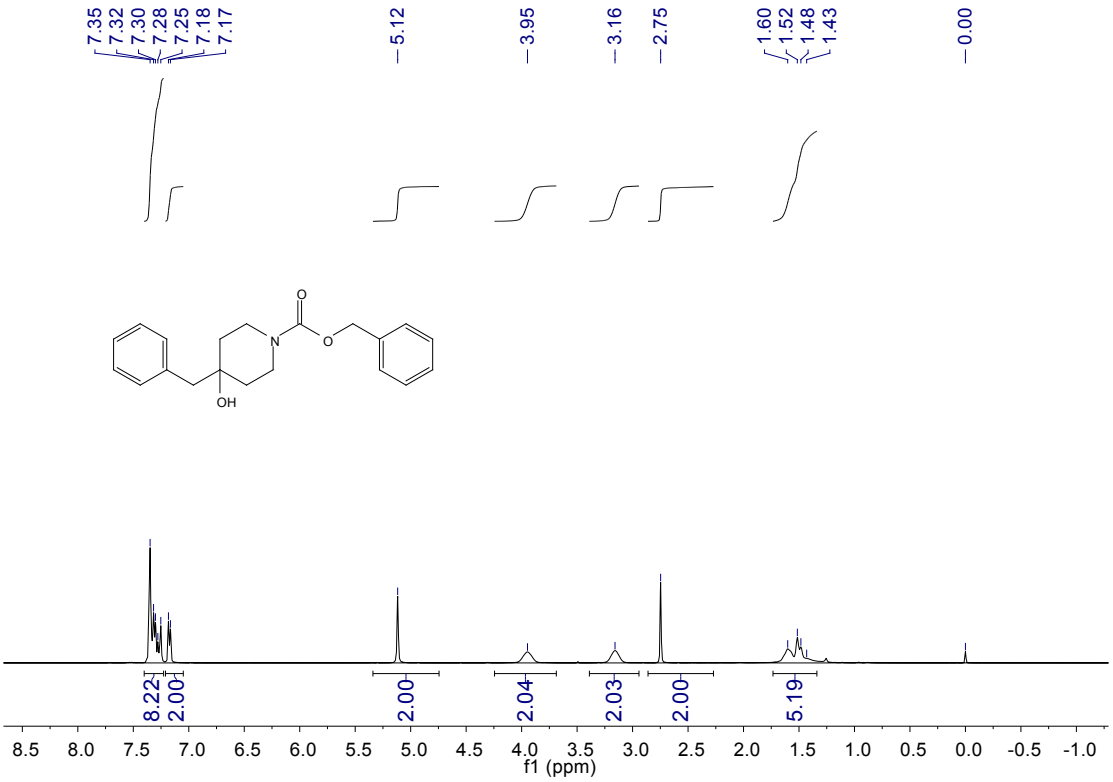
-70
-75
-80
-85
-90
-95
f1 (ppm)

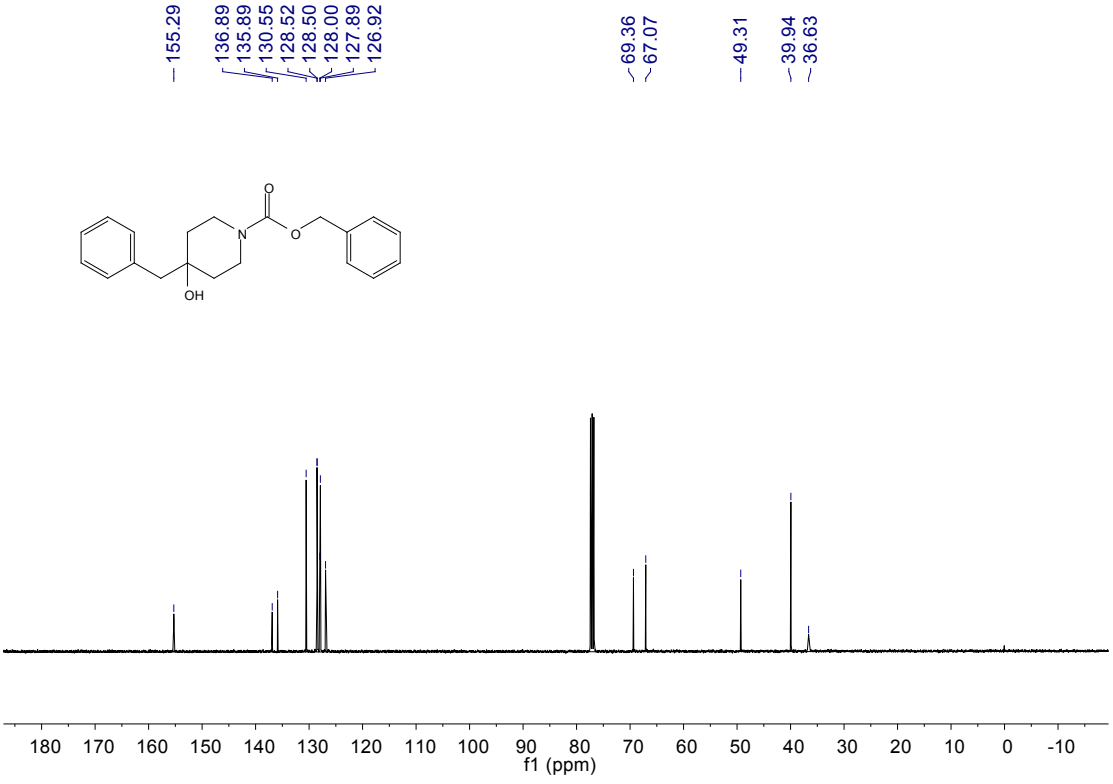

OH
CH3
CH3
O
F
F
F
149.08
140.17
129.35
128.87
122.99
121.78
119.23
118.95
70.75
49.35
29.22
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

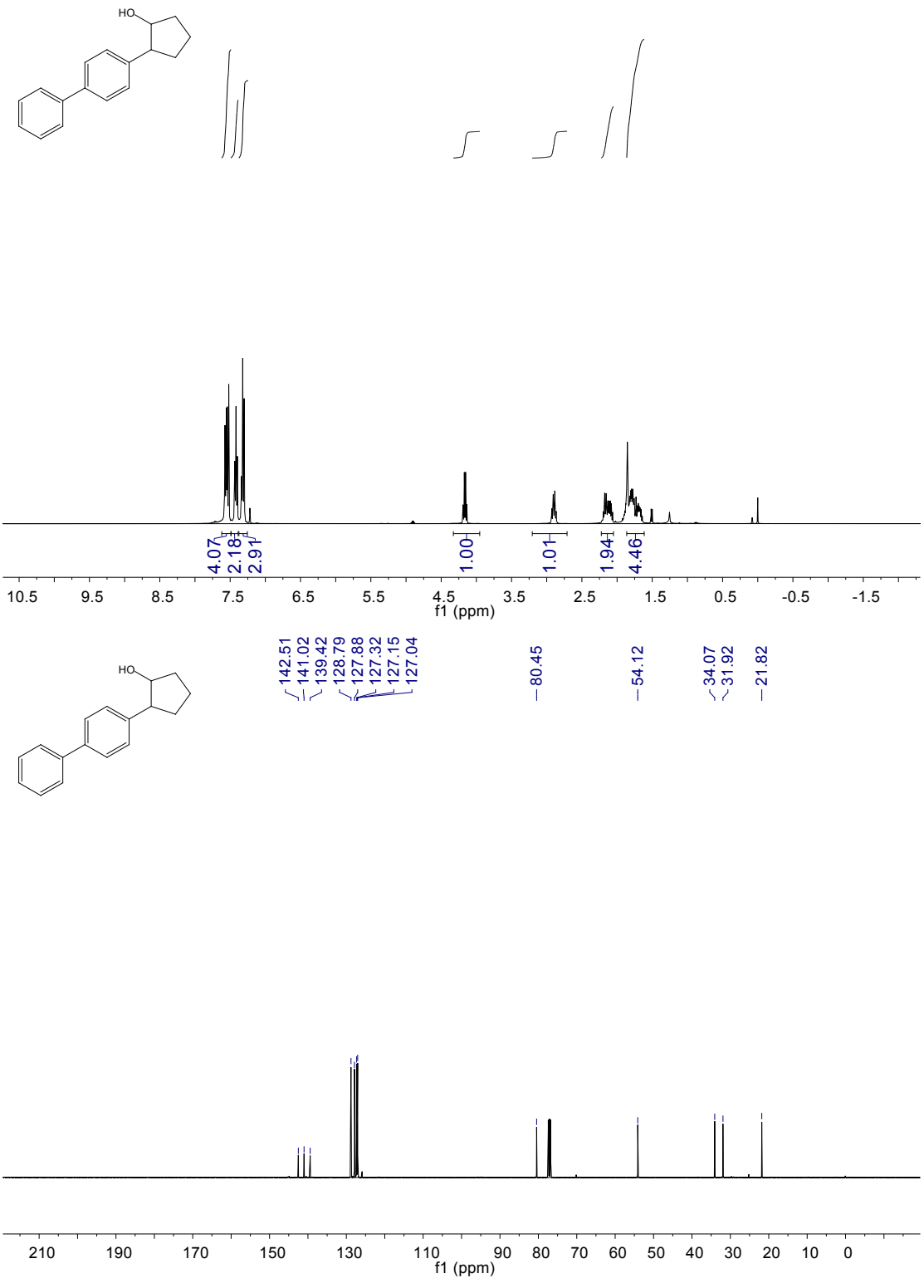

7.33
7.32
7.30
7.26
7.25
7.25
7.23
7.23
7.22
7.21
3.84
3.83
3.83
3.82
3.81
3.80
3.79
3.78
2.85
2.84
2.82
2.81
2.67
2.65
2.64
2.61
1.56
1.55
1.54
1.52
1.51
1.50
1.49
1.48
1.47
1.46
1.38
1.37
1.36
1.35
1.33
1.31
1.29
1.26
1.20
0.90
0.88
0.87
-0.00
-0.01
CH3
OH
2.00
3.03
1.07
1.04
1.04
3.09
7.15
3.11
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)
138.66
129.43
128.55
126.43
72.71
44.06
36.85
31.84
29.33
25.74
22.63
14.10
CH3
OH
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

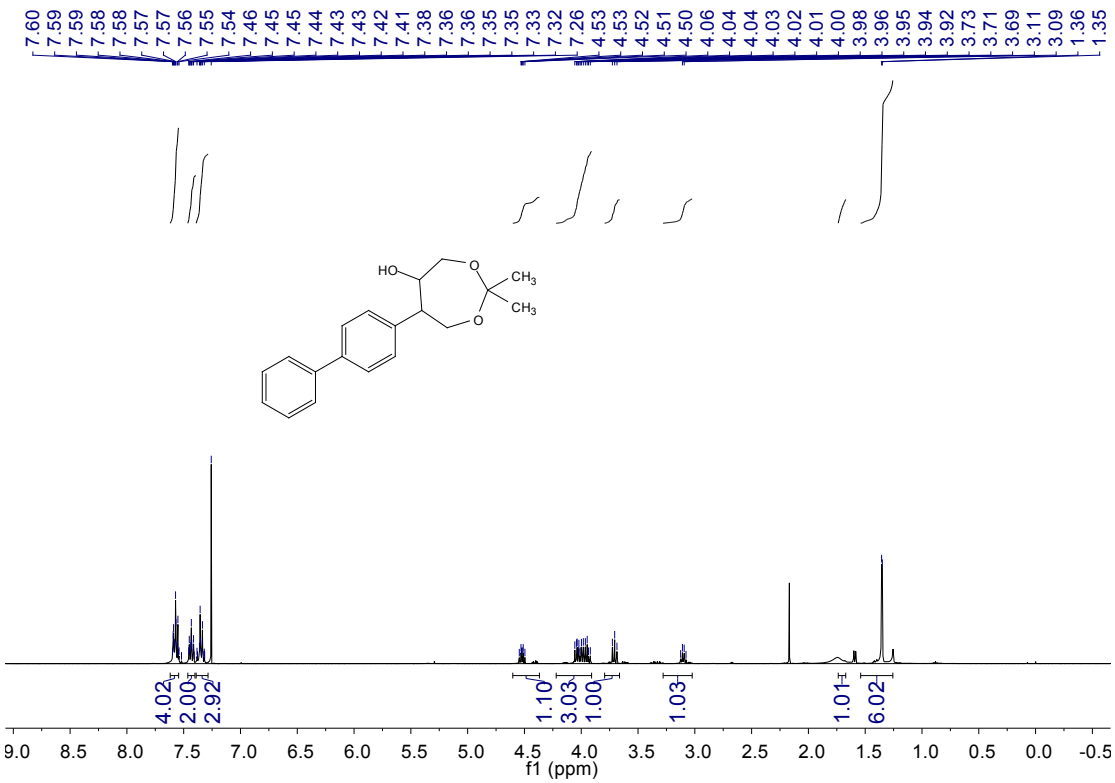

7.57 7.57 7.57 7.55 7.55 7.55 7.54 7.53 7.52 7.52 7.51 7.44 7.43 7.42 7.40 7.40 7.35 7.34 7.34 7.33 7.33 7.32 7.31 7.26 7.24 3.87 3.84 3.14 3.13 3.10 3.07 3.07 2.78 1.64 1.63 1.61 1.60 1.58 1.57 1.53 1.49 1.48 1.46 1.43 1.42
OH
N
O
O
CH3
CH3
CH3
4.03 2.00 1.00 2.21 2.00 2.00 2.01 4.34 9.05
f1 (ppm)

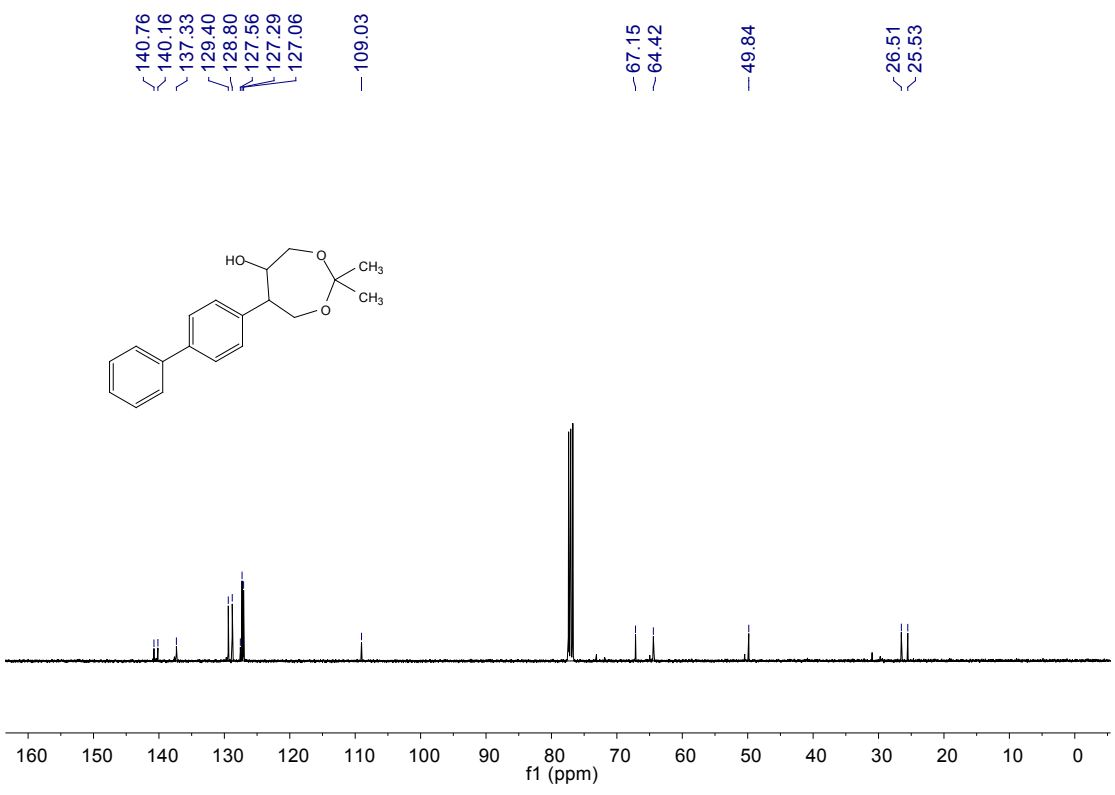

154.89 140.75 139.70 135.23 131.04 128.84 127.31 127.08 127.02 79.46 69.58 48.93 39.47 36.67 28.52
OH
N
O
O
CH3
CH3
CH3
f1 (ppm)


7.35
7.32
7.30
7.28
7.25
7.18
7.17
5.12
3.95
3.16
2.75
1.60
1.52
1.48
1.43
0.00
O
N
O
OH
8.22
2.00
2.00
2.04
2.03
2.00
5.19
f1 (ppm)


155.29
136.89
135.89
130.55
128.52
128.50
128.00
127.89
126.92
69.36
67.07
49.31
39.94
36.63
O
N
O
OH
f1 (ppm)


HO
4.07
2.18
2.91
1.00
1.01
1.94
4.46
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
f1 (ppm)
HO
142.51
141.02
139.42
128.79
127.88
127.32
127.15
127.04
80.45
54.12
34.07
31.92
21.82
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.60 7.59 7.59 7.58 7.58 7.57 7.57 7.56 7.55 7.54 7.46 7.45 7.45 7.44 7.43 7.43 7.42 7.41 7.38 7.36 7.36 7.35 7.35 7.33 7.32 7.26 4.53 4.53 4.52 4.51 4.50 4.06 4.04 4.04 4.03 4.02 4.01 4.00 3.98 3.96 3.95 3.94 3.92 3.73 3.71 3.69 3.11 3.09 1.36 1.35
HO
O
CH3
CH3
O
4.02
2.00
2.92
1.10
3.03
1.00
1.03
1.01
6.02
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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137.33
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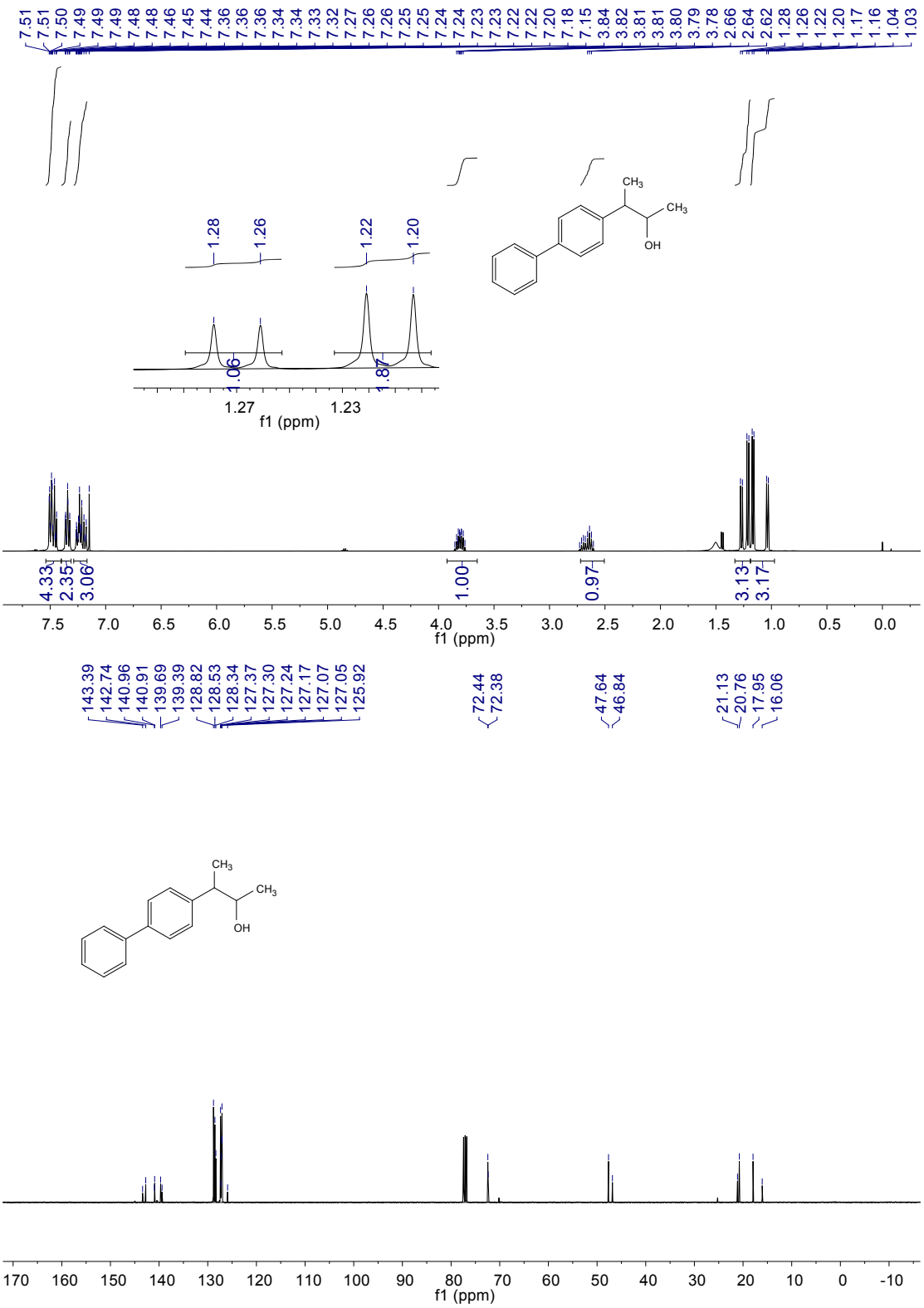
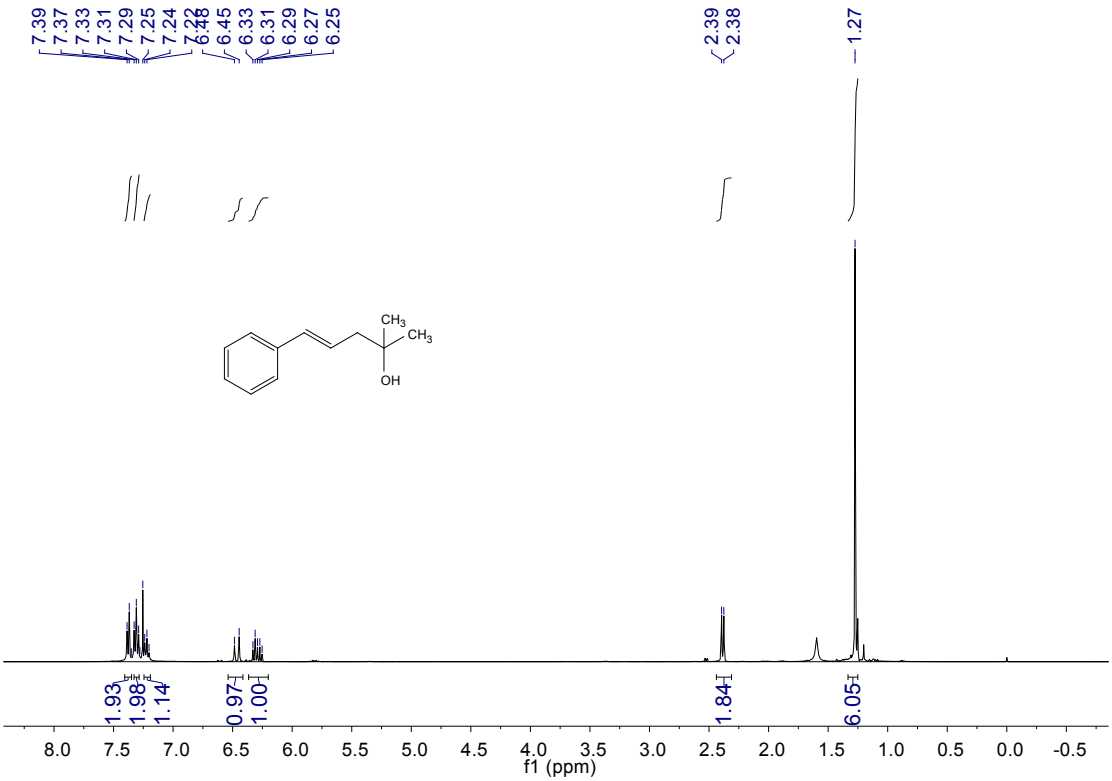
127.56
127.29
127.06
109.03
67.15
64.42
49.84
26.51
25.53
HO
O
CH3
CH3
O
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.51 7.51 7.50 7.49 7.49 7.49 7.48 7.48 7.46 7.45 7.44 7.36 7.36 7.34 7.34 7.33 7.32 7.27 7.26 7.26 7.25 7.25 7.24 7.24 7.23 7.23 7.22 7.22 7.20 7.18 7.15 3.84 3.82 3.81 3.81 3.80 3.79 3.78 2.66 2.64 2.62 1.28 1.26 1.22 1.20 1.17 1.16 1.04 1.03
CH3
CH3
OH
1.28 1.26 1.22 1.20
1.06 1.87
1.27 1.23
f1 (ppm)
4.33 2.35 3.06 1.00 0.97 3.13 3.17
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
143.39 142.74 140.96 140.91 139.69 139.39 128.82 128.53 128.34 127.37 127.30 127.24 127.17 127.07 127.05 125.92 72.44 72.38 47.64 46.84 21.13 20.76 17.95 16.06
CH3
CH3
OH
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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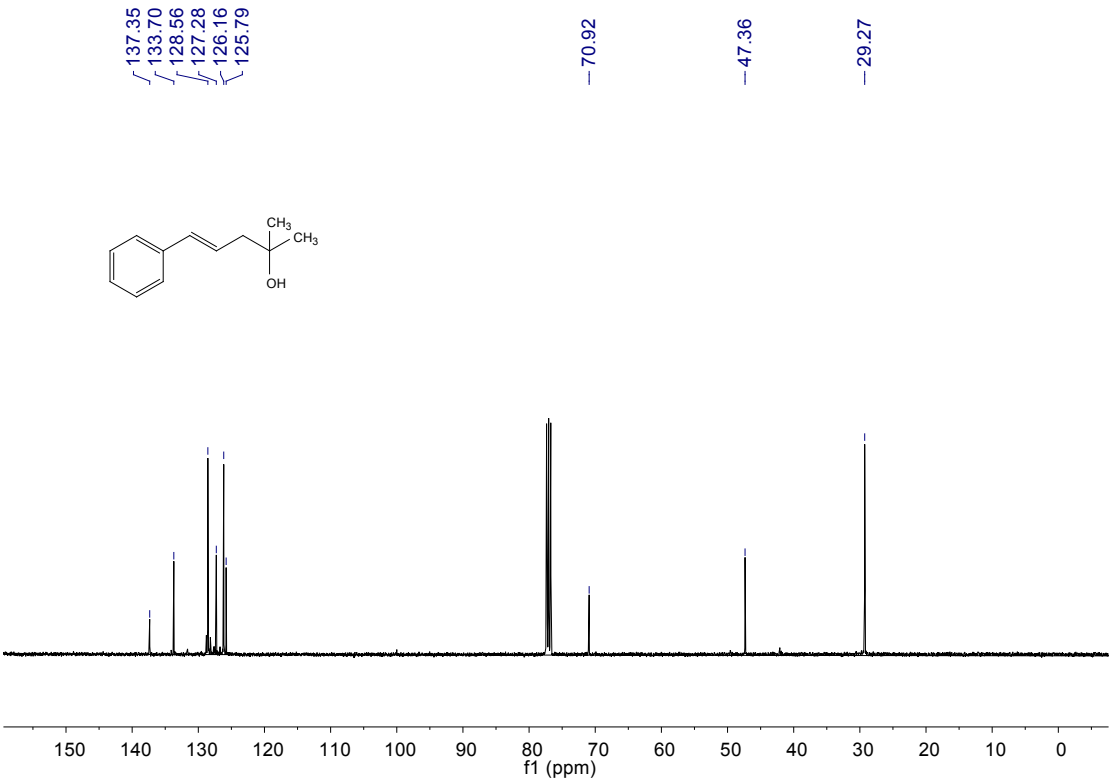
7.37
7.33
7.31
7.29
7.25
7.24
6.45
6.33
6.31
6.29
6.27
6.25
2.39
2.38
1.27
CH3
CH3
OH
1.93
1.98
1.14
0.97
1.00
1.84
6.05
f1 (ppm)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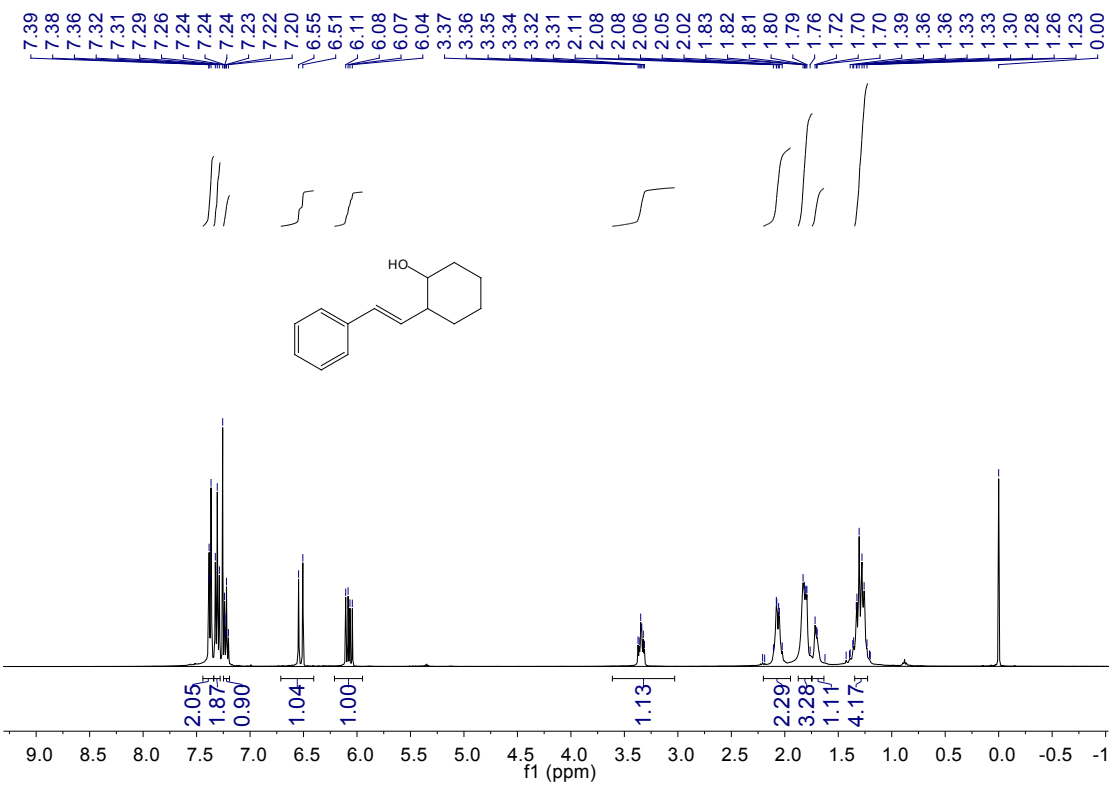
125.79
70.92
47.36
29.27
CH3
CH3
OH
f1 (ppm)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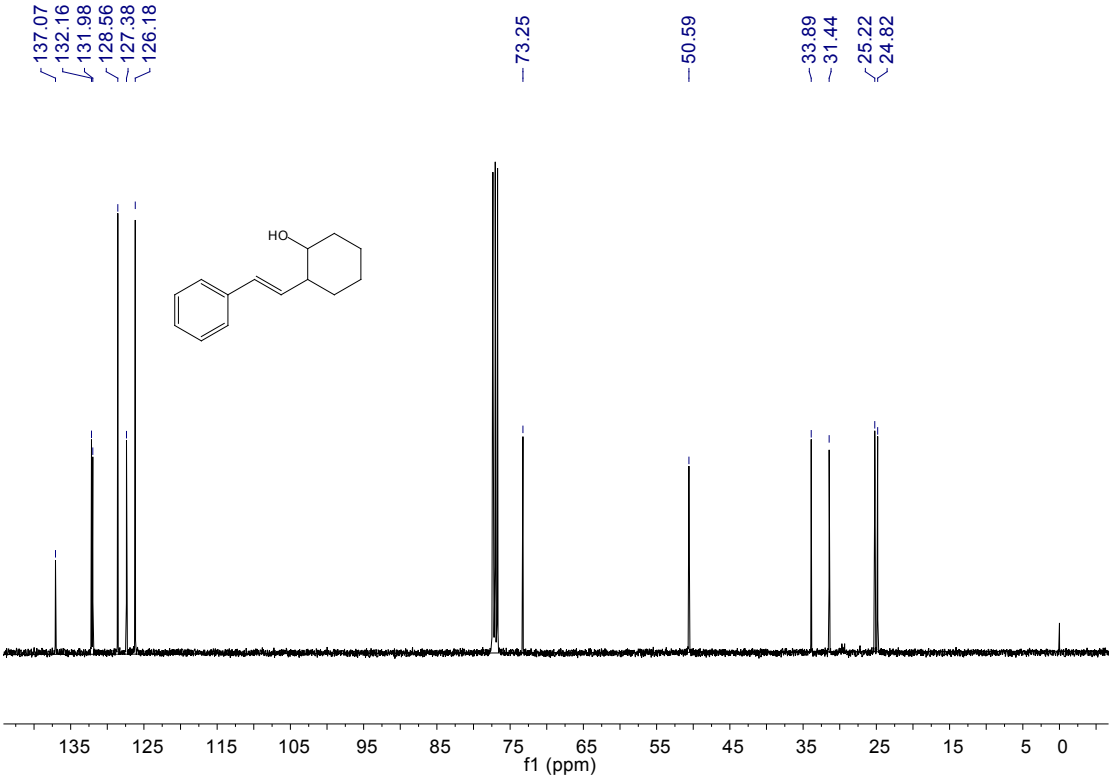
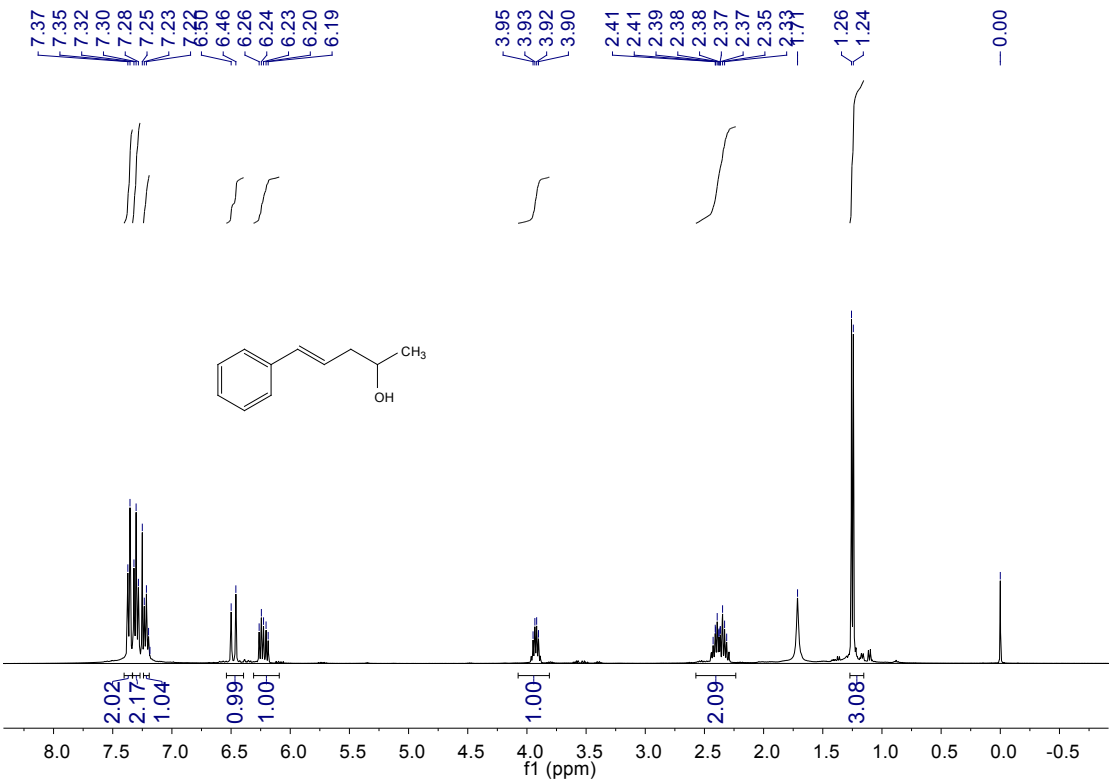
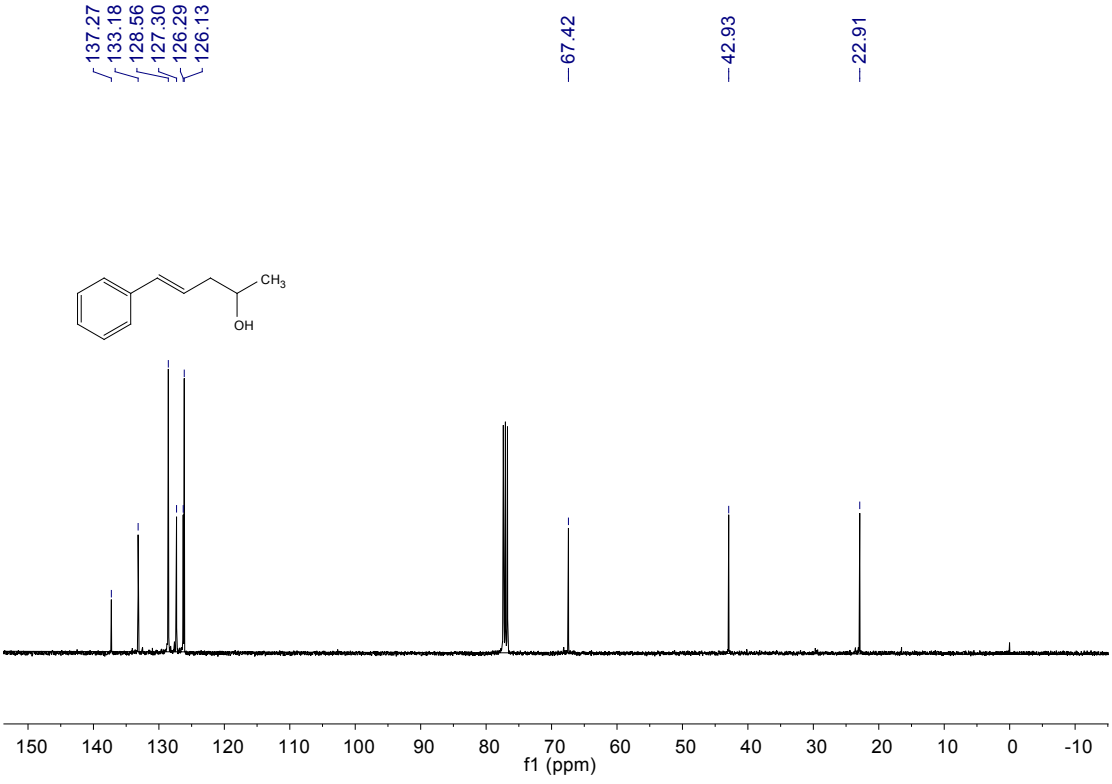
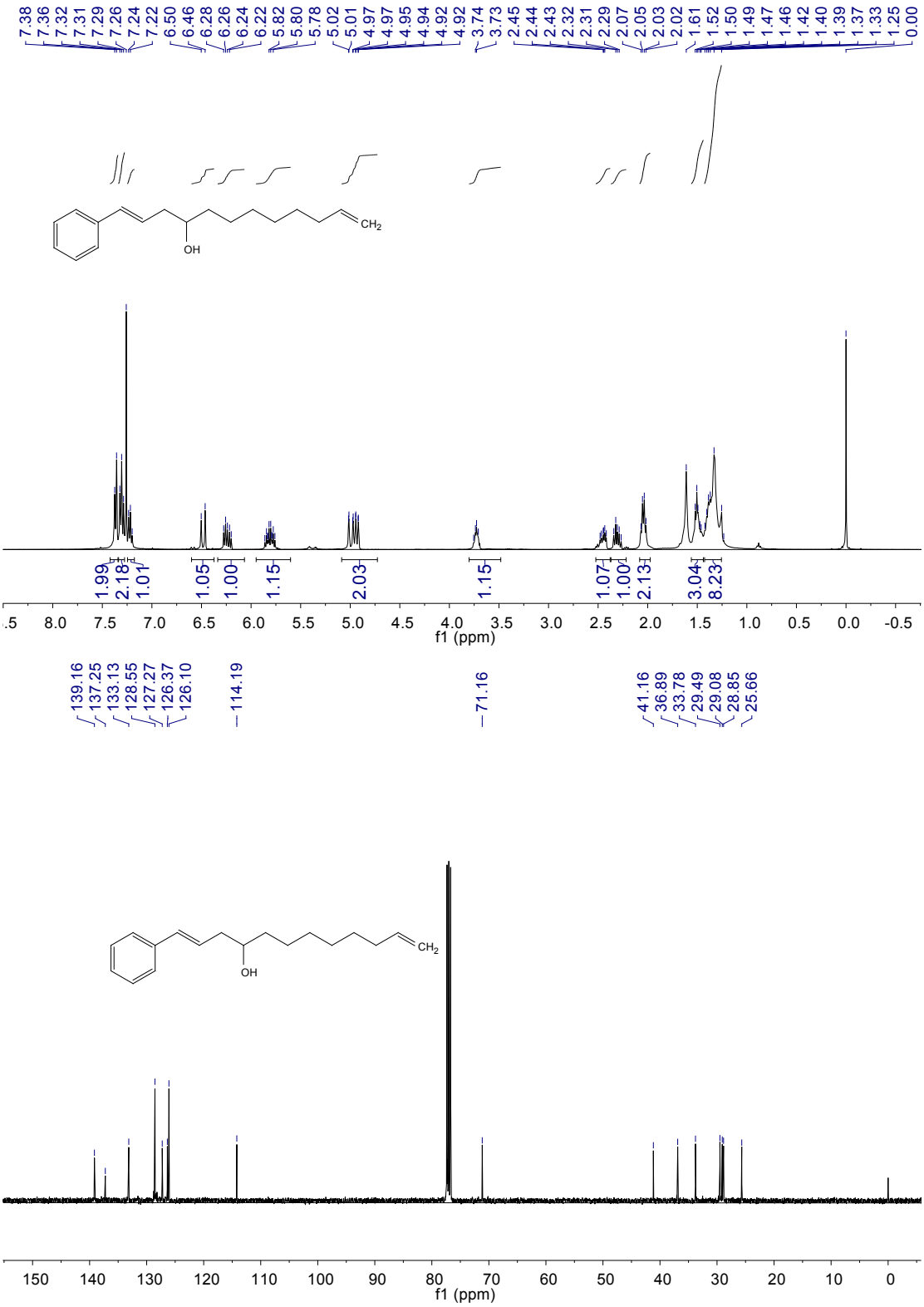
7.38
7.36
7.32
7.31
7.29
7.26
7.24
7.24
7.24
7.23
7.22
7.20
6.55
6.51
6.11
6.08
6.07
6.04
3.37
3.36
3.35
3.34
3.32
3.31
2.11
2.08
2.08
2.06
2.05
2.02
1.83
1.82
1.81
1.80
1.79
1.76
1.72
1.70
1.70
1.39
1.36
1.36
1.33
1.33
1.30
1.28
1.26
1.23
0.00
HO
2.05
1.87
0.90
1.04
1.00
1.13
2.29
3.28
1.11
4.17
f1 (ppm)


137.07
132.16
131.98
128.56
127.38
126.18
73.25
50.59
33.89
31.44
25.22
24.82
HO
f1 (ppm)


7.37
7.35
7.32
7.30
7.28
7.25
7.23
6.50
6.46
6.26
6.24
6.23
6.20
6.19
3.95
3.93
3.92
3.90
2.41
2.41
2.39
2.38
2.38
2.37
2.37
2.35
1.71
1.26
1.24
0.00
CH3
OH
2.02
2.17
1.04
0.99
1.00
1.00
2.09
3.08
f1 (ppm)


137.27
133.18
128.56
127.30
126.29
126.13
67.42
42.93
22.91
CH3
OH
f1 (ppm)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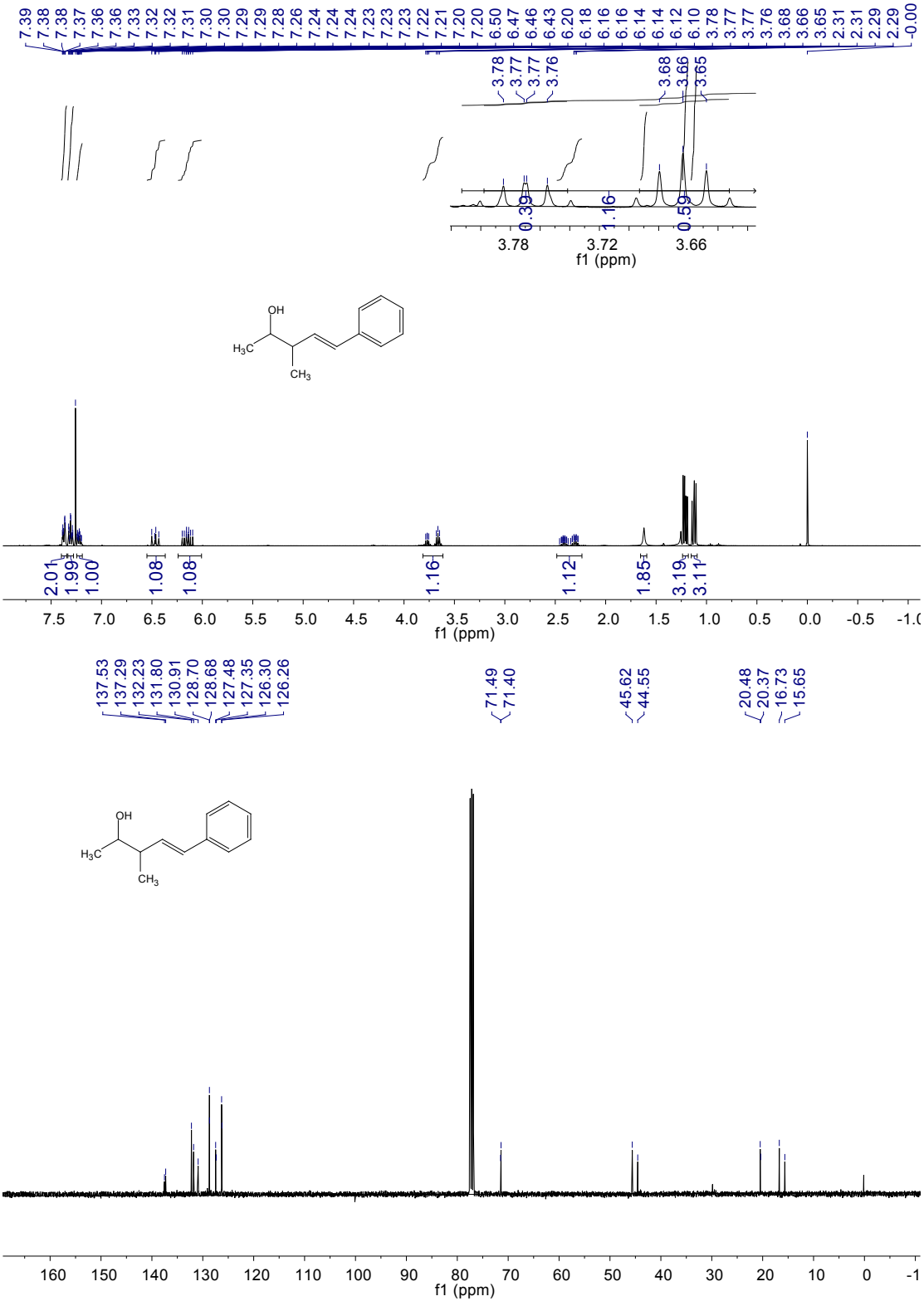
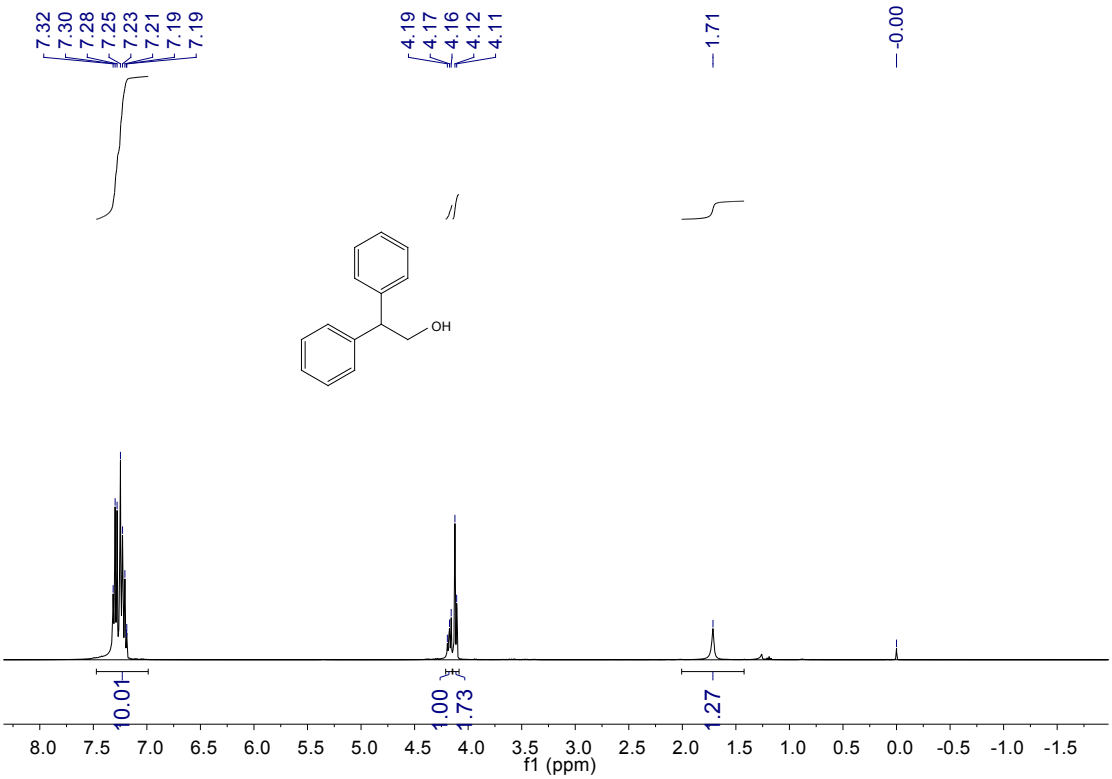
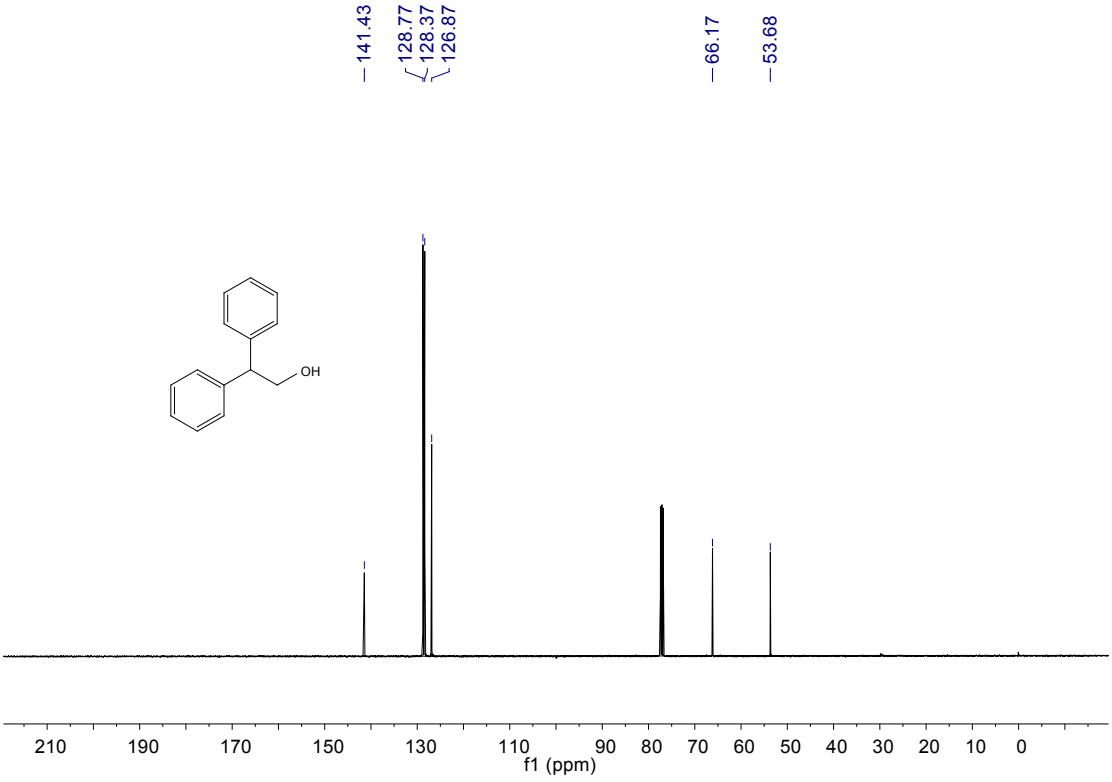
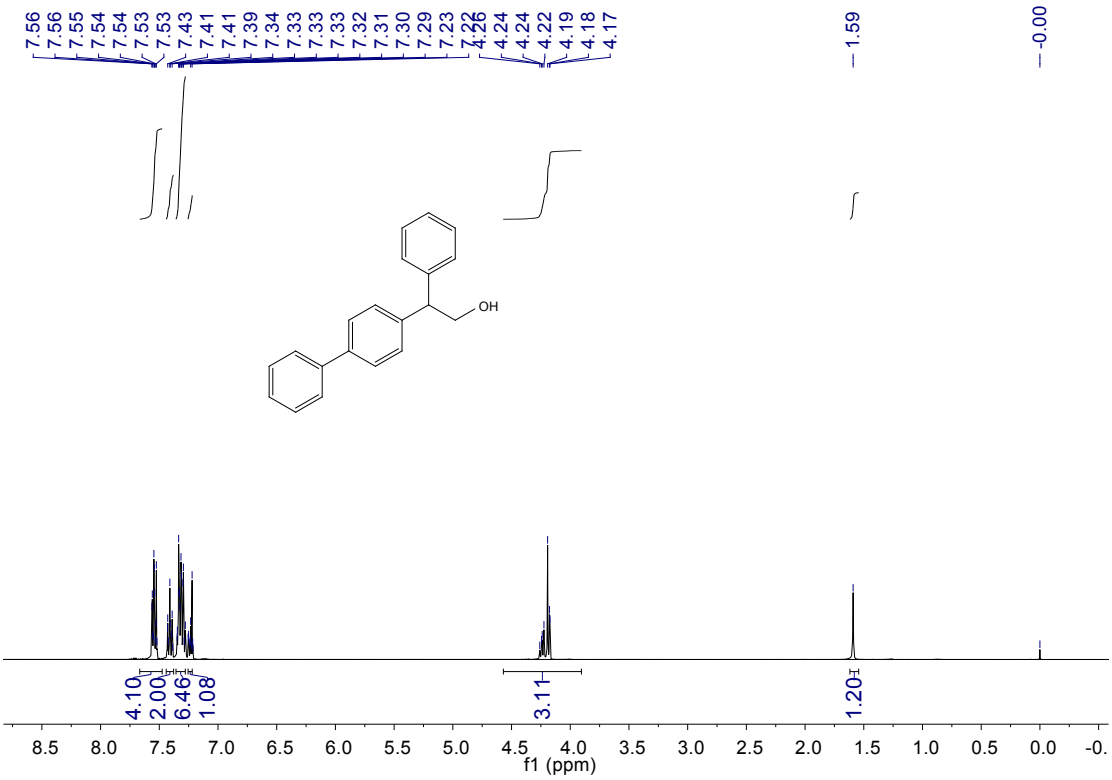
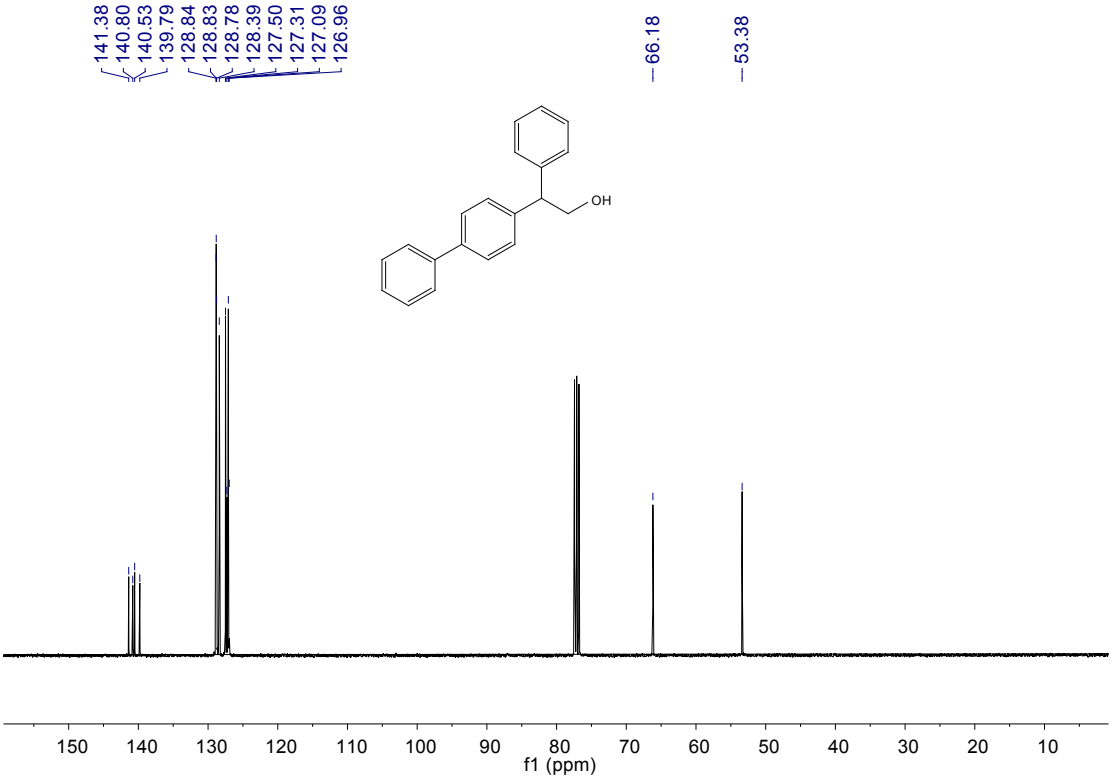
7.36
7.32
7.31
7.29
7.26
7.24
7.22
6.50
6.46
6.28
6.26
6.24
6.22
5.82
5.80
5.78
5.02
5.01
4.97
4.97
4.95
4.94
4.92
4.92
3.74
3.73
2.45
2.44
2.43
2.32
2.31
2.29
2.07
2.05
2.03
2.02
1.61
1.52
1.50
1.49
1.47
1.46
1.42
1.40
1.39
1.37
1.33
1.25
0.00
CH2
OH
1.99
2.18
1.01
1.05
1.00
1.15
2.03
1.15
1.07
1.00
2.13
3.04
8.23
f1 (ppm)
139.16
137.25
133.13
128.55
127.27
126.37
126.10
114.19
71.16
41.16
36.89
33.78
29.49
29.08
28.85
25.66
CH2
OH
f1 (ppm)

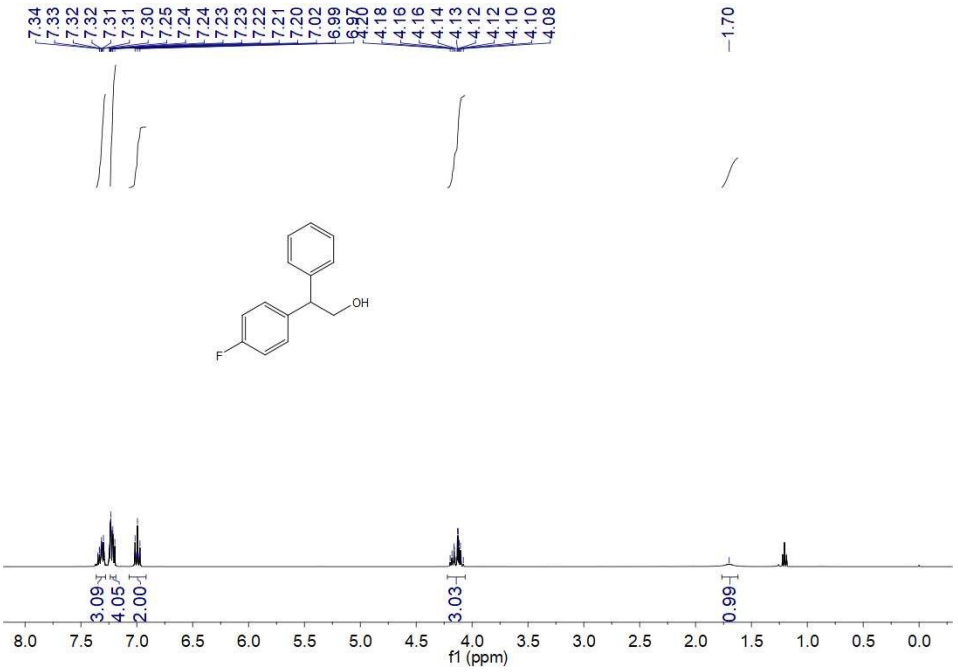

7.39 7.38 7.38 7.37 7.36 7.36 7.33 7.32 7.32 7.31 7.30 7.30 7.29 7.29 7.28 7.26 7.24 7.24 7.24 7.23 7.23 7.22 7.21 7.20 7.20 6.50 6.47 6.46 6.43 6.20 6.18 6.16 6.16 6.14 6.14 6.12 6.10 3.78 3.77 3.77 3.76 3.68 3.66 3.65 3.78 3.77 3.76 3.68 3.66 3.65 0.39 1.16 0.59
3.78 3.72 3.66
f1 (ppm)
OH
H3C
CH3
2.01 1.99 1.00 1.08 1.08 1.16 1.12 1.85 3.19 3.11
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)
137.53 137.29 132.23 131.80 130.91 128.70 128.68 127.48 127.35 126.30 126.26 71.49 71.40 45.62 44.55 20.48 20.37 16.73 15.65
OH
H3C
CH3
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

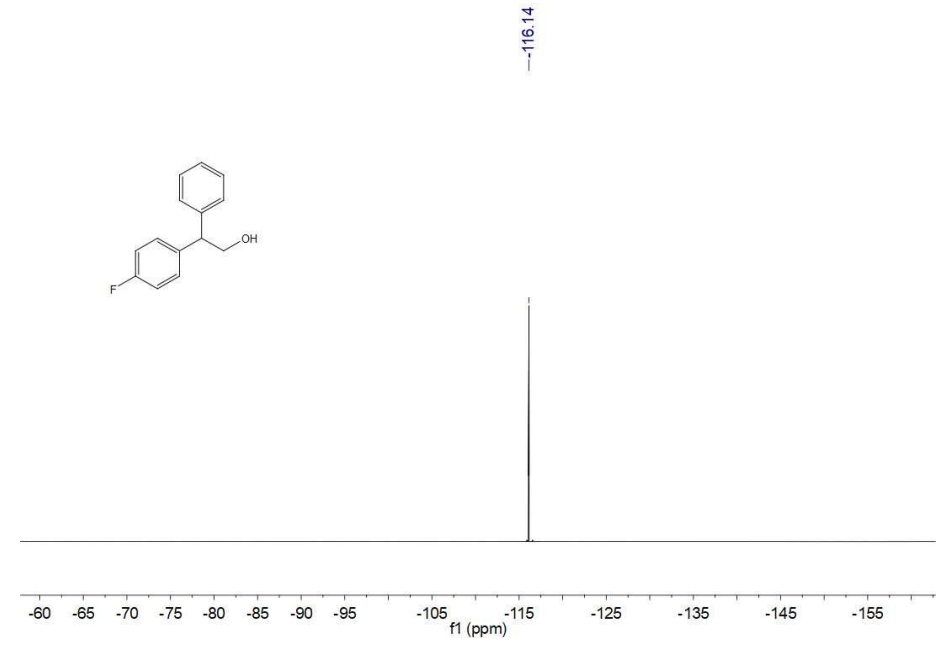

7.32
7.30
7.28
7.25
7.23
7.21
7.19
7.19
4.19
4.17
4.16
4.12
4.11
1.71
0.00
OH
10.01
1.00
1.73
1.27
f1 (ppm)

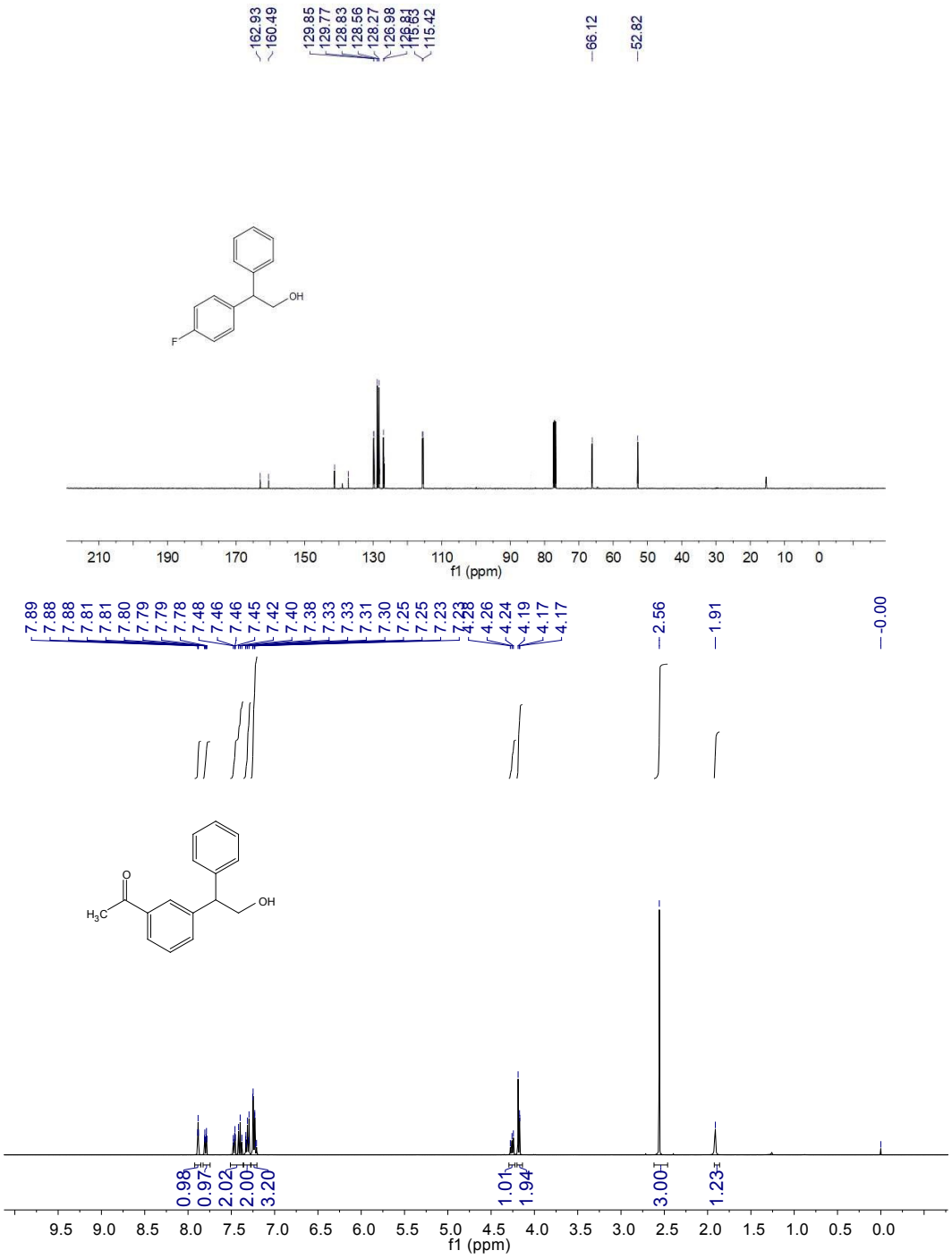

141.43
128.77
128.37
126.87
66.17
53.68
OH
f1 (ppm)

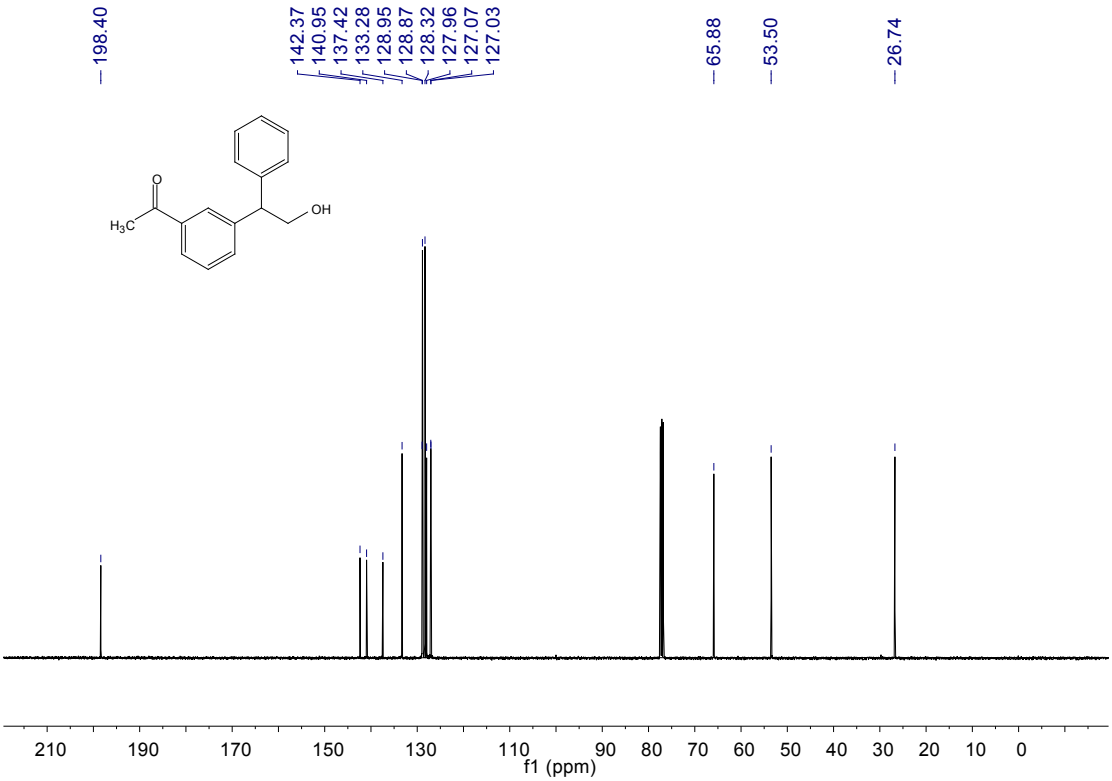

7.56
7.56
7.55
7.54
7.54
7.53
7.53
7.43
7.41
7.41
7.39
7.34
7.33
7.33
7.33
7.32
7.31
7.30
7.29
7.23
4.24
4.24
4.22
4.19
4.18
4.17
1.59
-0.00
OH
4.10
2.00
6.46
1.08
3.11
1.20
f1 (ppm)


141.38
140.80
140.53
139.79
128.84
128.83
128.78
128.39
127.50
127.31
127.09
126.96
66.18
53.38
OH
f1 (ppm)


7.34
7.33
7.32
7.32
7.31
7.31
7.30
7.25
7.24
7.24
7.23
7.23
7.22
7.21
7.20
7.02
6.99
4.18
4.16
4.16
4.14
4.13
4.12
4.12
4.10
4.10
4.08
1.70
OH
F
3.09
4.05
2.00
3.03
0.99
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


-116.14
OH
F
-60 -65 -70 -75 -80 -85 -90 -95 -105 -115 -125 -135 -145 -155
f1 (ppm)


162.93
160.49
129.85
129.77
128.83
128.56
128.27
126.98
115.42
66.12
52.82
OH
F
f1 (ppm)
7.89
7.88
7.88
7.81
7.81
7.80
7.79
7.79
7.78
7.48
7.46
7.46
7.45
7.42
7.40
7.38
7.33
7.33
7.31
7.30
7.25
7.25
7.23
4.26
4.24
4.19
4.17
4.17
2.56
1.91
0.00
O
H3C
OH
0.98
0.97
2.02
2.00
3.20
1.01
1.94
3.00
1.23
f1 (ppm)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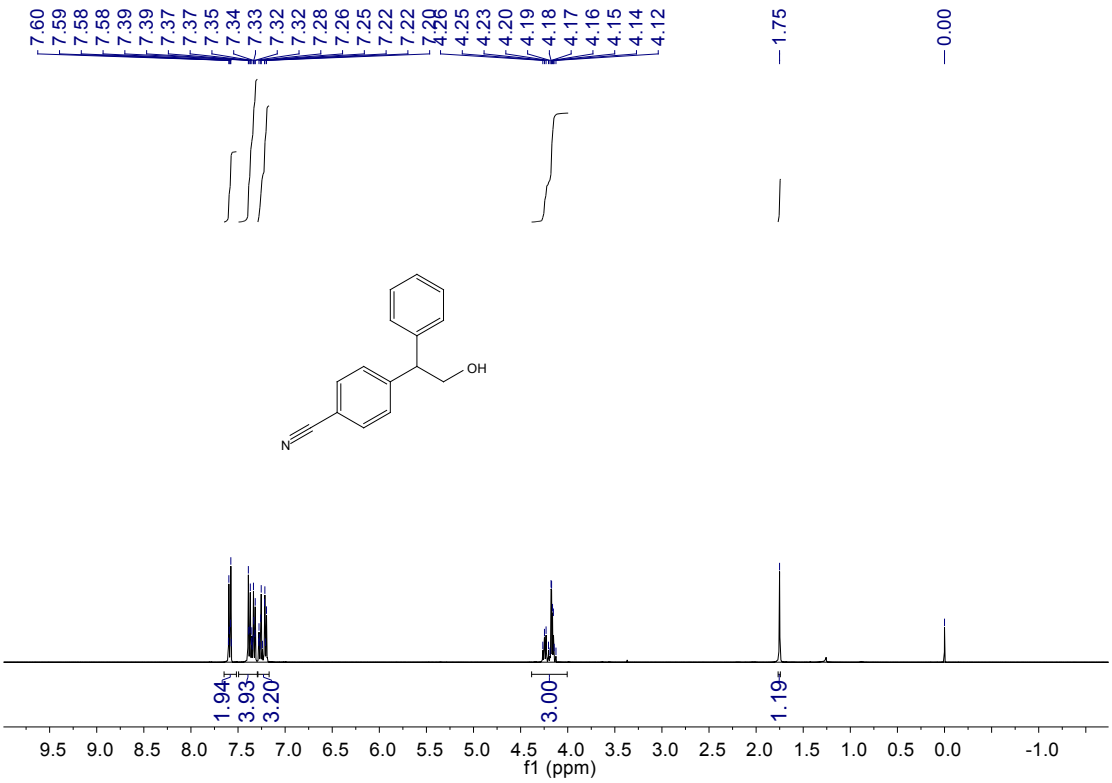
133.28
128.95
128.87
128.32
127.96
127.07
127.03
65.88
53.50
26.74
O
H3C
OH
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.59
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7.58
7.39
7.39
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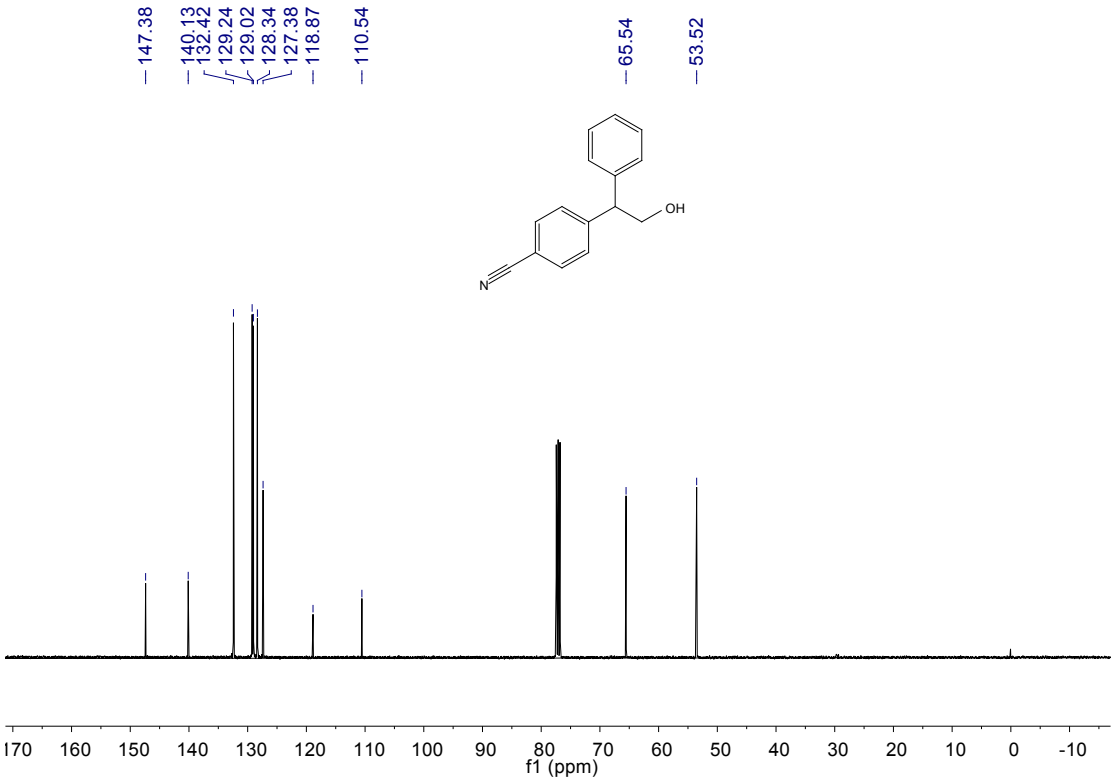
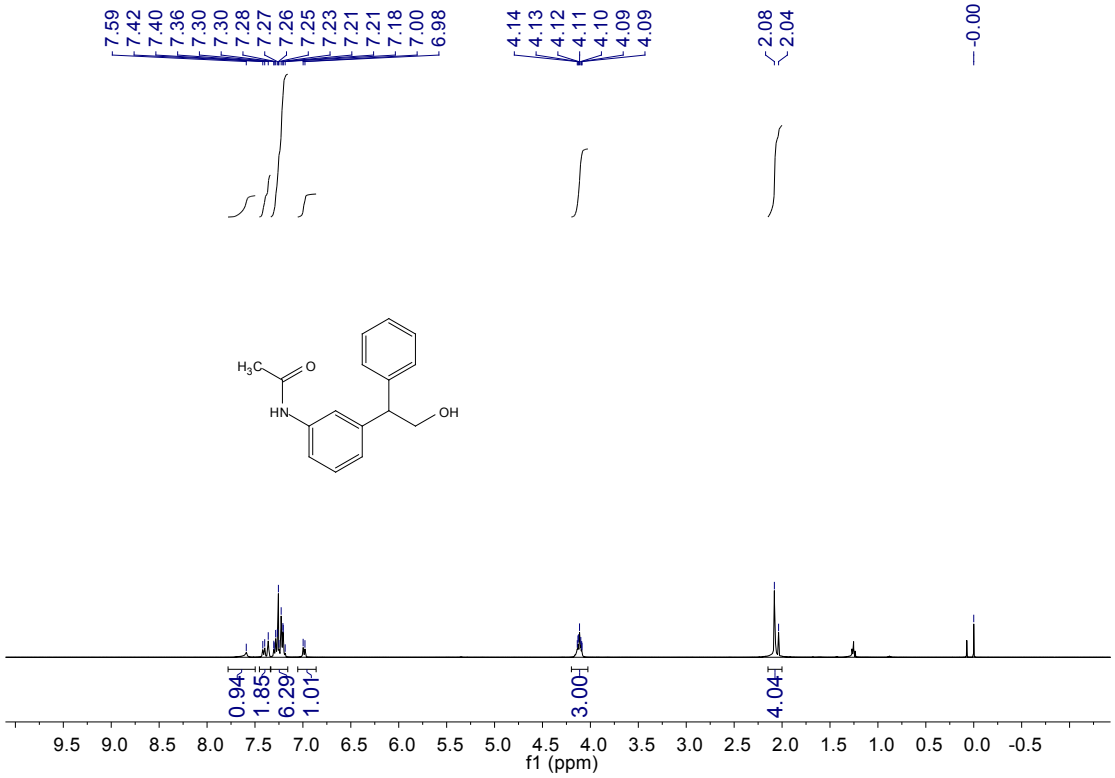
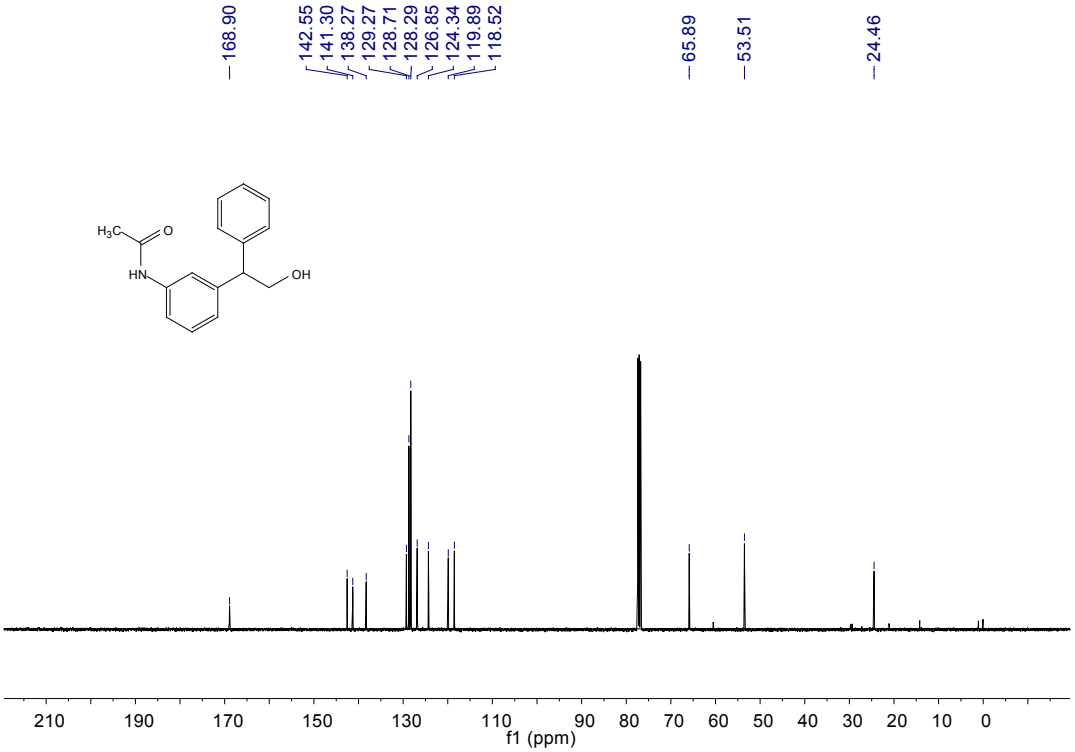
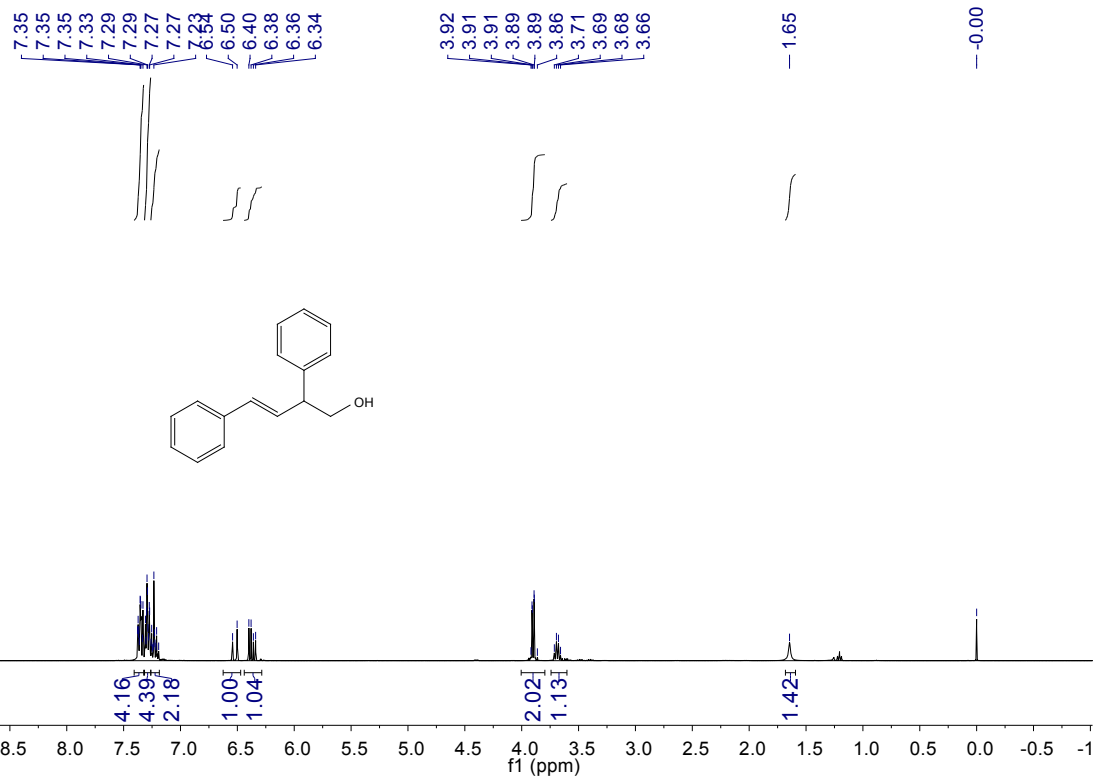
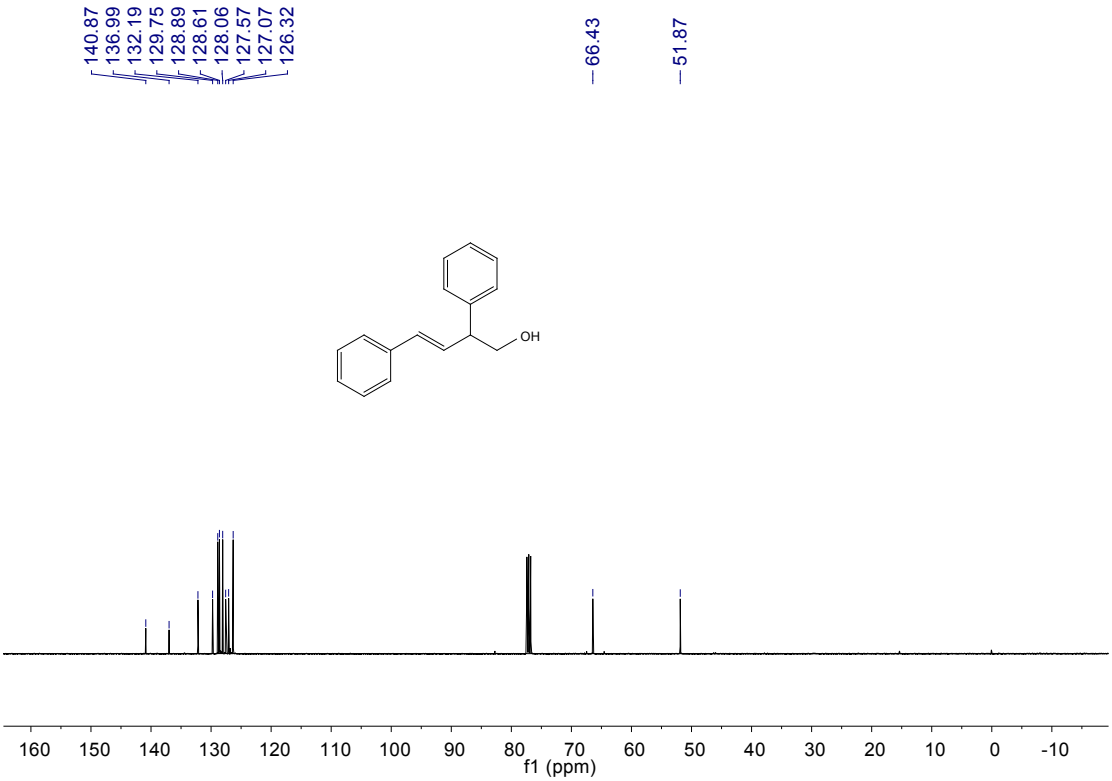
7.37
7.35
7.34
7.33
7.32
7.32
7.28
7.26
7.25
7.22
7.22
4.25
4.23
4.20
4.19
4.18
4.17
4.16
4.15
4.14
4.12
1.75
0.00
OH
N
1.94
3.93
3.20
3.00
1.19
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-1.0
f1 (ppm)

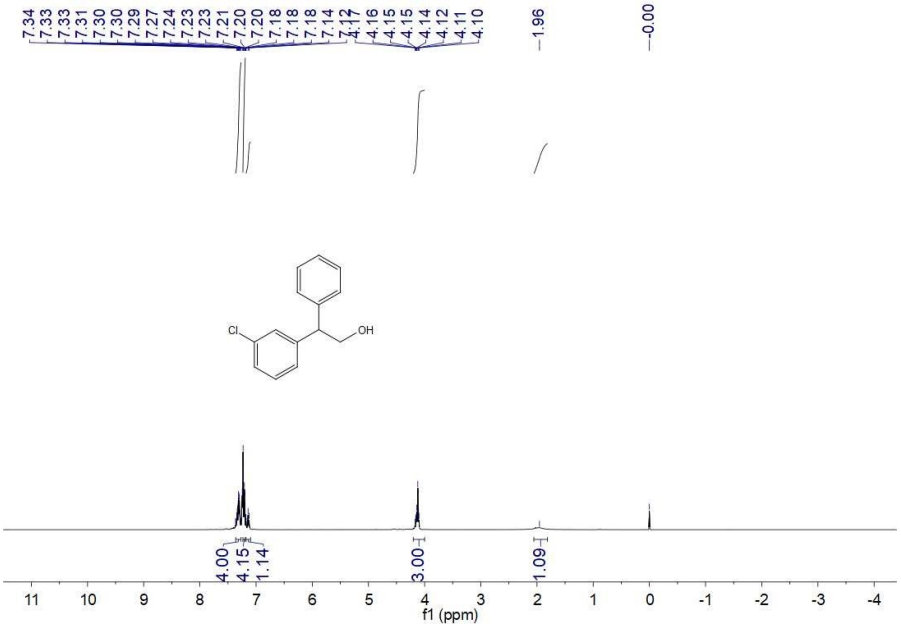

147.38
140.13
132.42
129.24
129.02
128.34
127.38
118.87
110.54
65.54
53.52
OH
N
f1 (ppm)

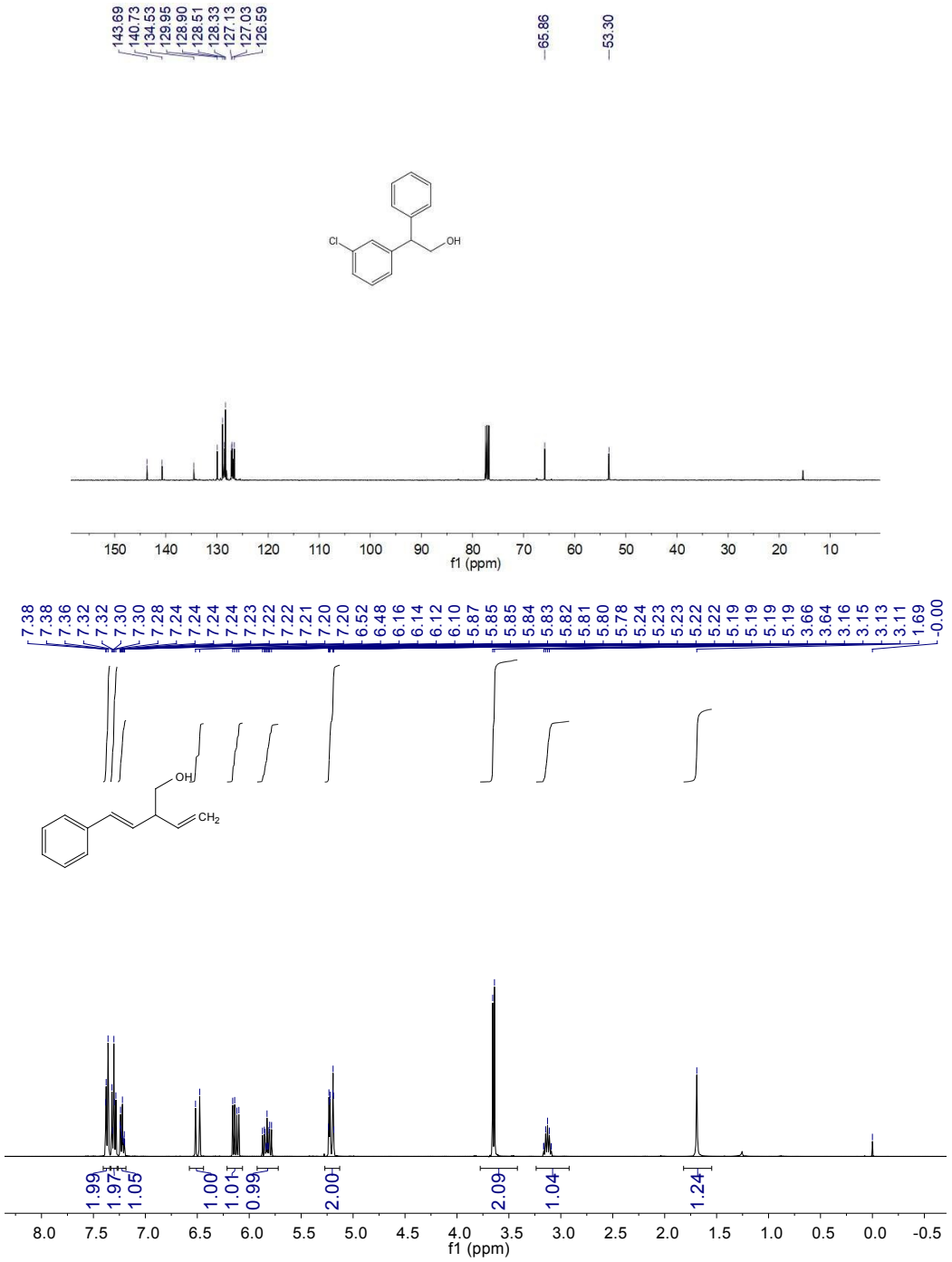

7.59
7.42
7.40
7.36
7.30
7.30
7.28
7.27
7.26
7.25
7.23
7.21
7.21
7.18
7.00
6.98
4.14
4.13
4.12
4.11
4.10
4.09
4.09
2.08
2.04
-0.00
H3C
O
HN
OH
0.94
1.85
6.29
1.01
3.00
4.04
f1 (ppm)


168.90
142.55
141.30
138.27
129.27
128.71
128.29
126.85
124.34
119.89
118.52
65.89
53.51
24.46
H3C
O
HN
OH
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.35
7.35
7.35
7.33
7.29
7.29
7.27
7.27
7.23
6.54
6.50
6.40
6.38
6.36
6.34
3.92
3.91
3.91
3.89
3.89
3.86
3.71
3.69
3.68
3.66
1.65
-0.00
OH
4.16
4.39
2.18
1.00
1.04
2.02
1.13
1.42
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)


140.87
136.99
132.19
129.75
128.89
128.61
128.06
127.57
127.07
126.32
66.43
51.87
OH
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.34
7.33
7.33
7.31
7.30
7.30
7.29
7.27
7.24
7.23
7.23
7.21
7.20
7.20
7.18
7.18
7.14
4.16
4.15
4.15
4.14
4.12
4.11
4.10
1.96
0.00
Cl
OH
4.00
4.15
1.14
3.00
1.09
11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4
f1 (ppm)


143.69
140.73
134.53
129.95
128.90
128.51
128.33
127.13
127.03
126.59
65.86
53.30
Cl
OH
f1 (ppm)
7.38
7.38
7.36
7.32
7.32
7.30
7.30
7.28
7.24
7.24
7.24
7.24
7.23
7.22
7.22
7.21
7.20
7.20
6.52
6.48
6.16
6.14
6.12
6.10
5.87
5.85
5.85
5.84
5.83
5.82
5.81
5.80
5.78
5.24
5.23
5.23
5.22
5.22
5.19
5.19
5.19
5.19
3.66
3.64
3.16
3.15
3.13
3.11
1.69
-0.00
OH
CH2
1.99
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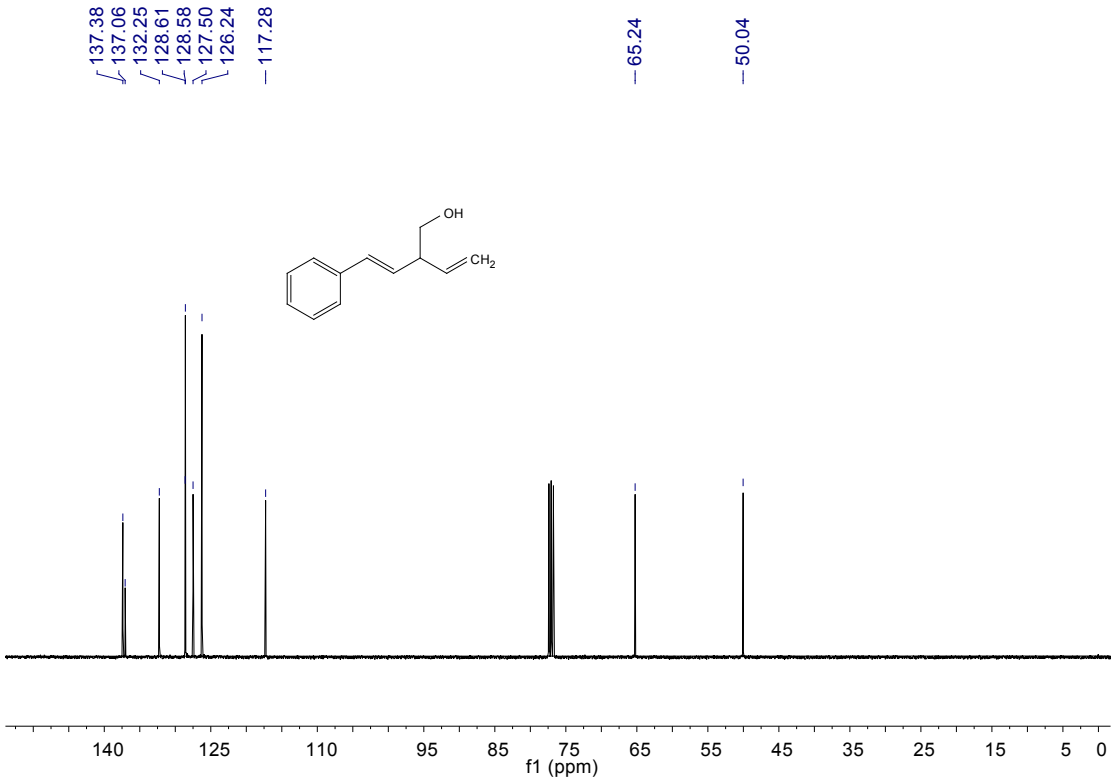
1.05
1.00
1.01
0.99
2.00
2.09
1.04
1.24
f1 (ppm)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132.25
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127.50
126.24
117.28
65.24
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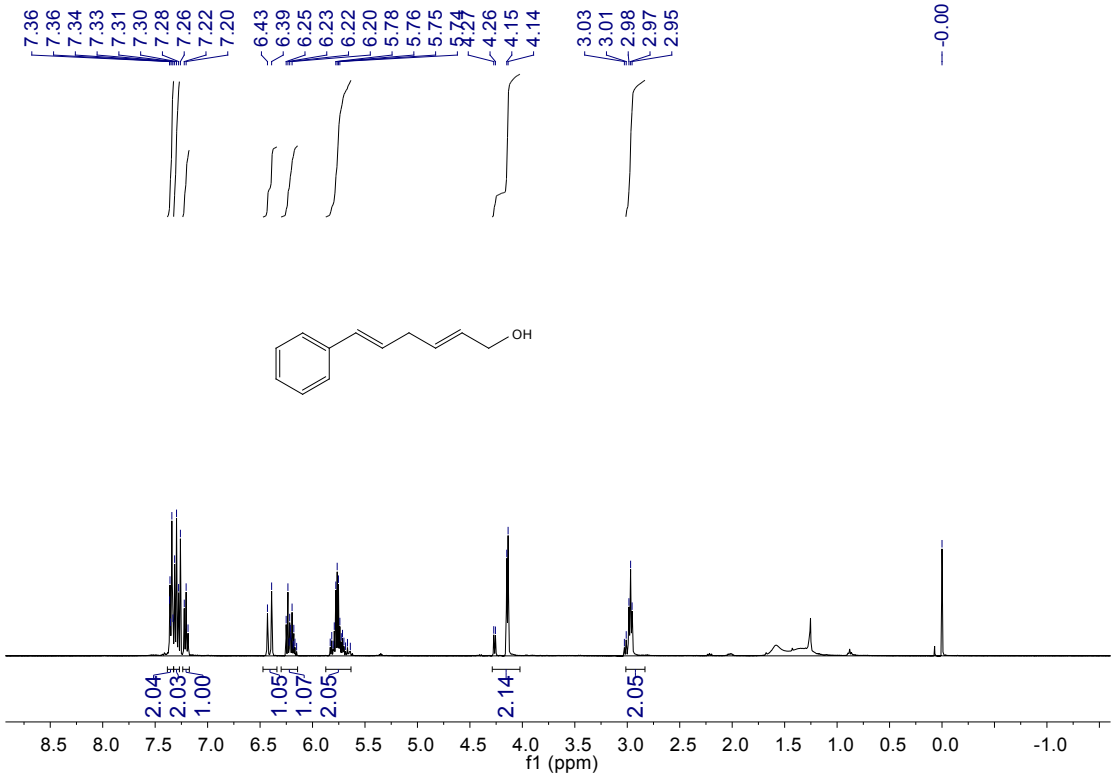
OH
CH2
140
125
110
95
85
75
65
55
45
35
25
15
5
0
f1 (ppm)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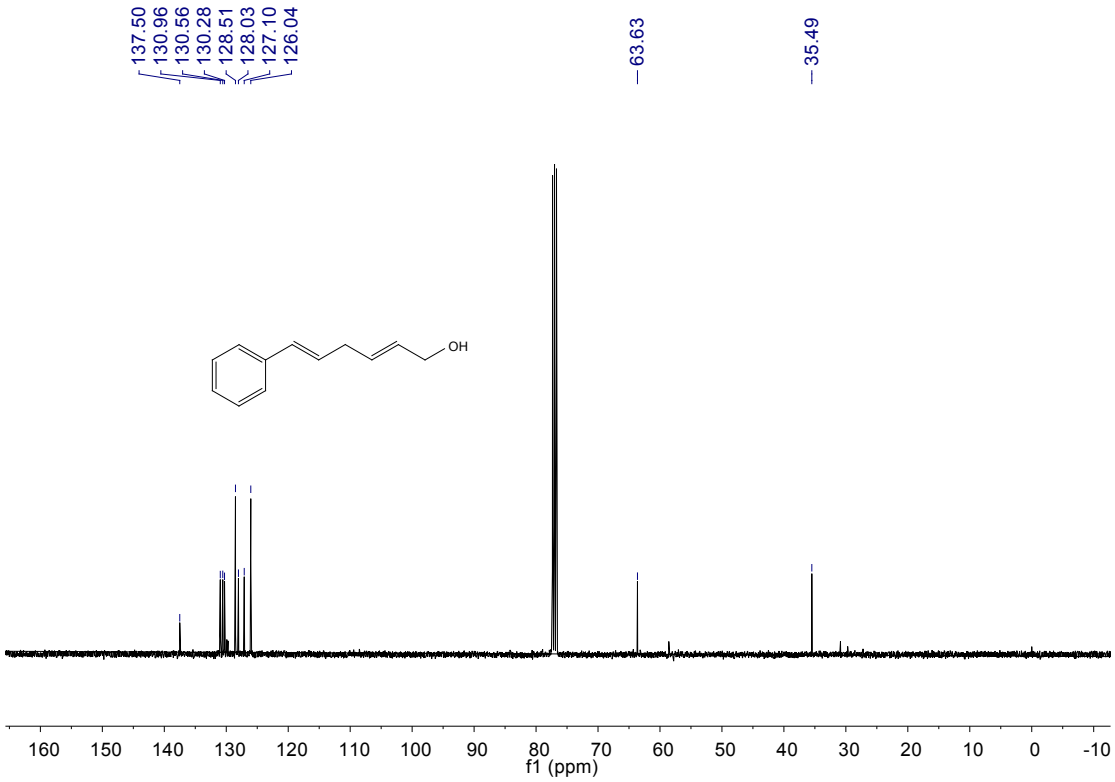
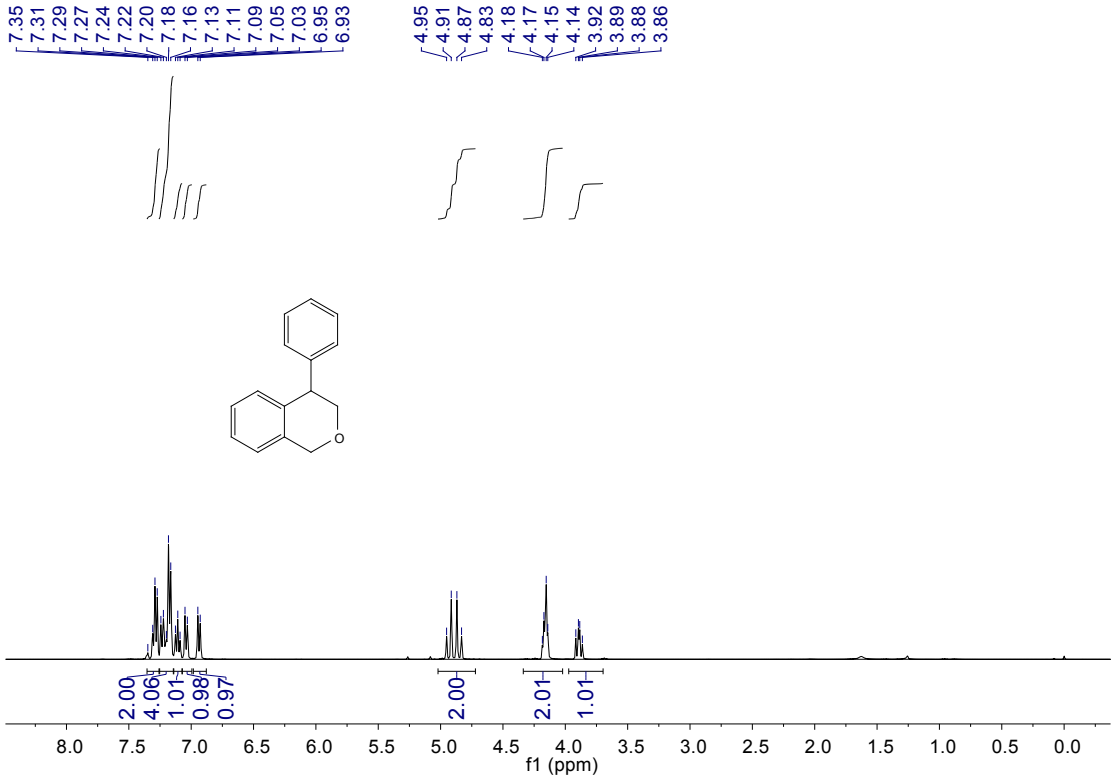
6.43
6.39
6.25
6.23
6.22
6.20
5.78
5.76
5.75
4.26
4.15
4.14
3.03
3.01
2.98
2.97
2.95
-0.00
OH
2.04
2.03
1.00
1.05
1.07
2.05
2.14
2.05
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-1.0
f1 (ppm)


137.50
130.96
130.56
130.28
128.51
128.03
127.10
126.04
63.63
35.49
OH
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.31
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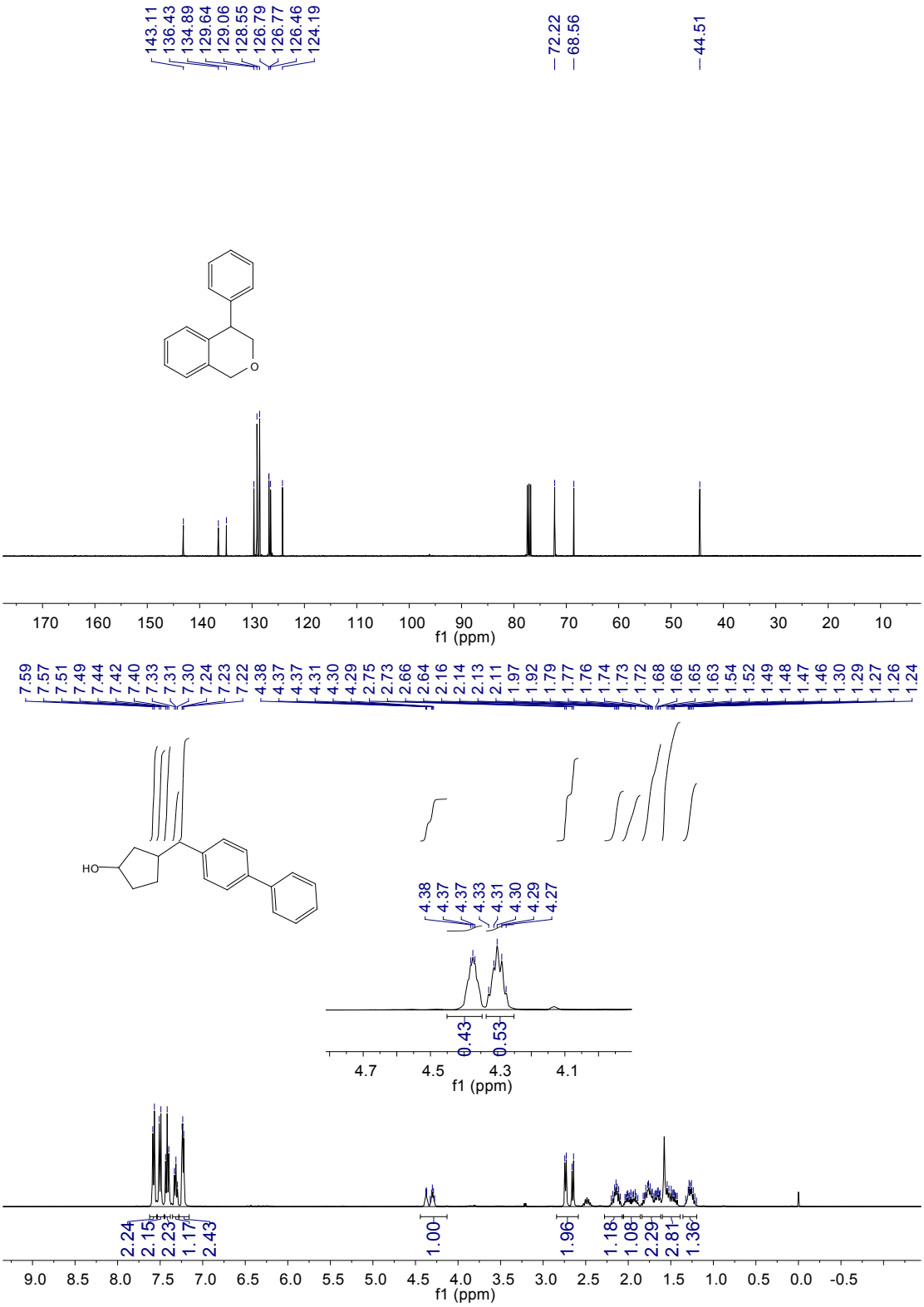
7.22
7.20
7.18
7.16
7.13
7.11
7.09
7.05
7.03
6.95
6.93
4.95
4.91
4.87
4.83
4.18
4.17
4.15
4.14
3.92
3.89
3.88
3.86
O
2.00
4.06
1.01
0.98
0.97
2.00
2.01
1.01
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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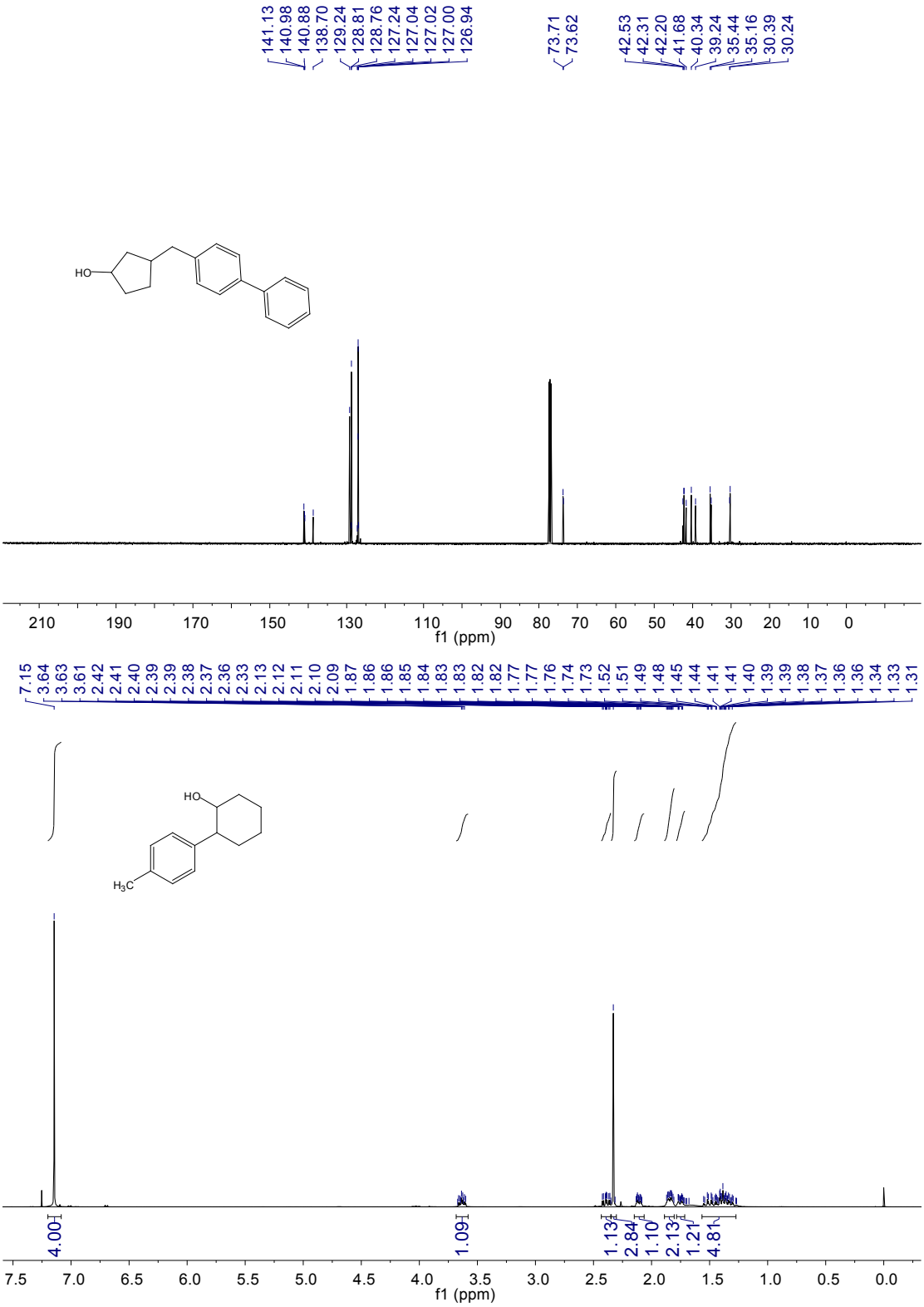
136.43
134.89
129.64
129.06
128.55
126.79
126.77
126.46
124.19
72.22
68.56
44.51
O
f1 (ppm)
HO
0.43
0.53
2.24
2.15
2.23
1.17
2.43
1.00
1.96
1.18
1.08
2.29
2.81
1.36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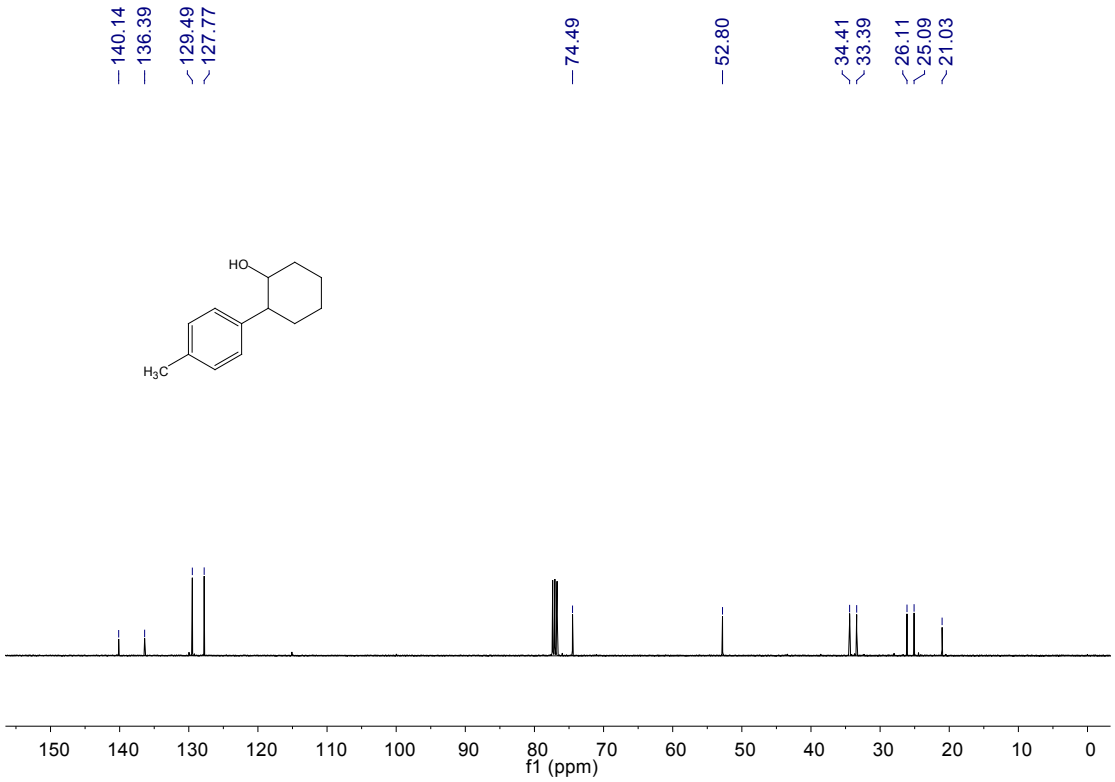
140.98
140.88
138.70
129.24
128.81
128.76
127.24
127.04
127.02
127.00
126.94
73.71
73.62
42.53
42.31
42.20
41.68
40.34
39.24
35.44
35.16
30.39
30.24
HO
f1 (ppm)
7.15
3.64
3.63
3.61
2.42
2.41
2.40
2.39
2.39
2.38
2.37
2.36
2.33
2.13
2.12
2.11
2.10
2.09
1.87
1.86
1.86
1.85
1.84
1.83
1.83
1.82
1.82
1.77
1.77
1.76
1.74
1.73
1.52
1.51
1.49
1.48
1.45
1.44
1.41
1.41
1.40
1.39
1.39
1.38
1.37
1.36
1.36
1.34
1.33
1.31
HO
H3C
4.00
1.09
1.13
2.84
1.10
2.13
1.21
4.81
f1 (ppm)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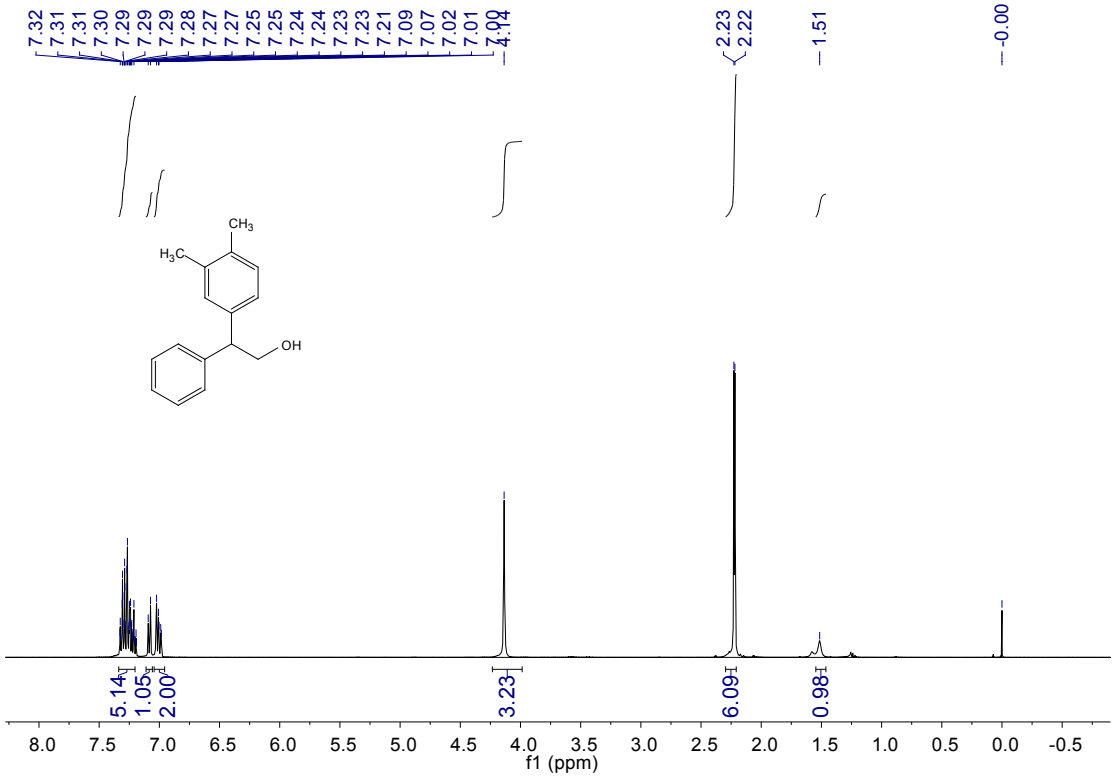
136.39
129.49
127.77
74.49
52.80
34.41
33.39
26.11
25.09
21.03
HO
H3C
f1 (ppm)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7.31
7.31
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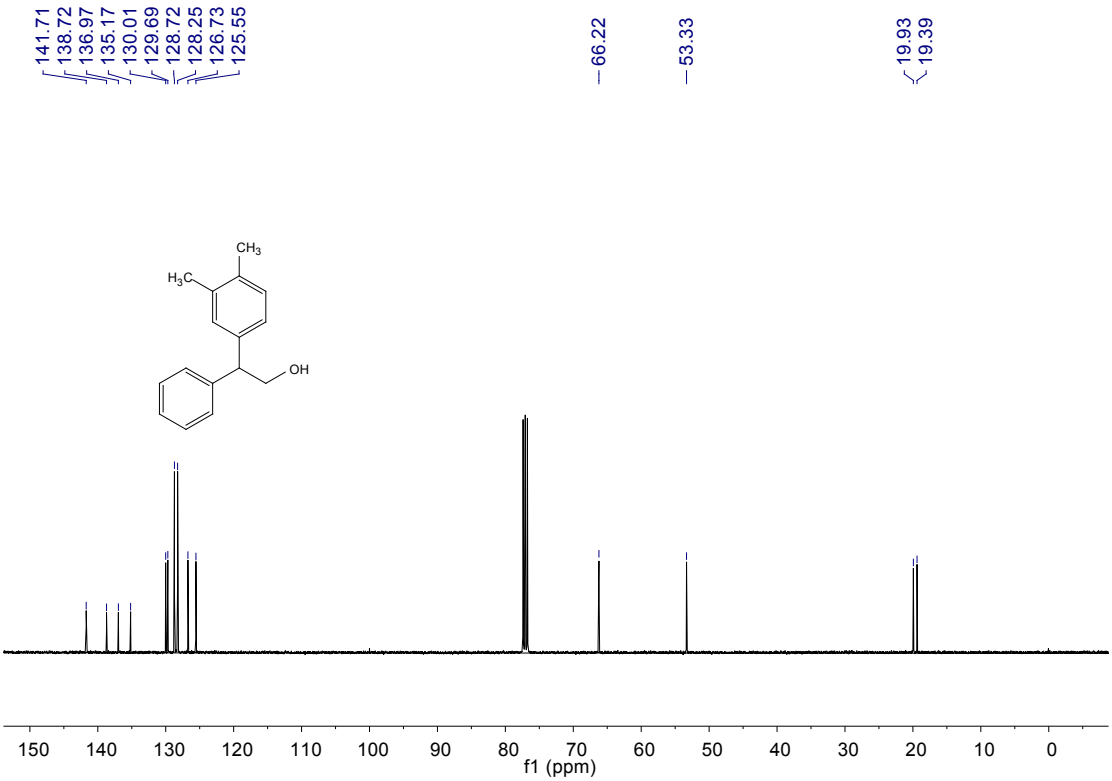
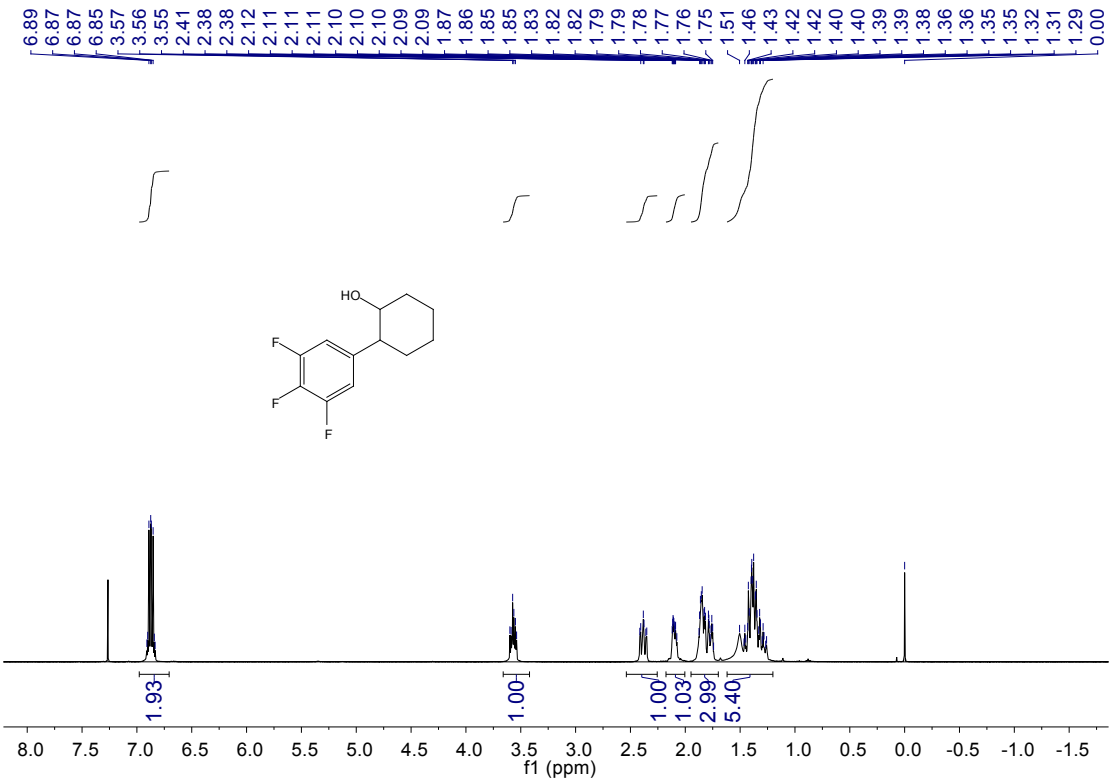
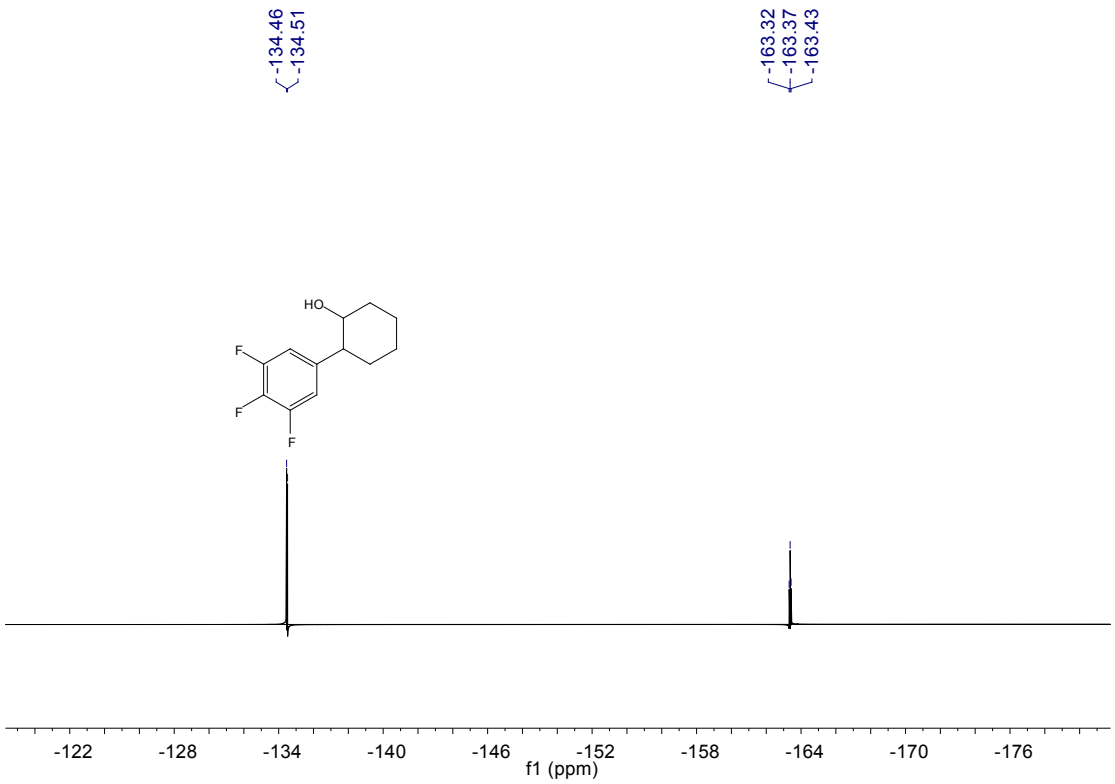
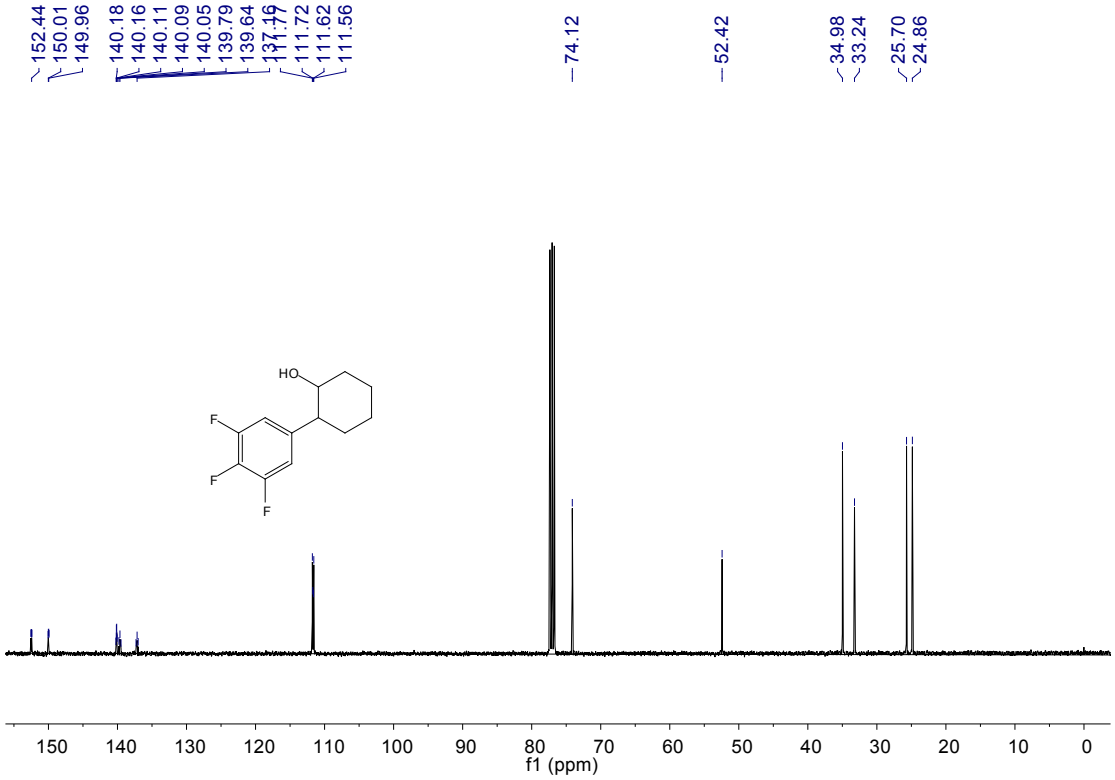
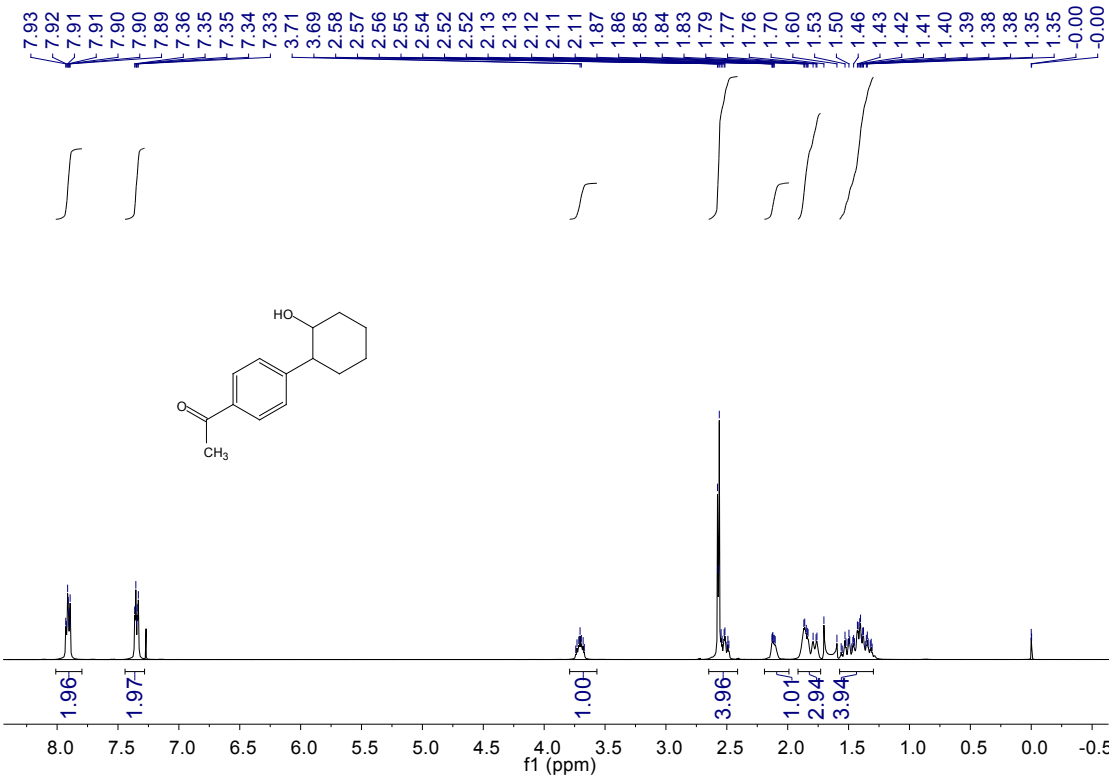
7.29
7.29
7.28
7.27
7.27
7.25
7.25
7.24
7.24
7.23
7.23
7.21
7.09
7.07
7.02
7.01
7.00
4.14
2.23
2.22
1.51
-0.00
CH3
H3C
OH
5.14
1.05
2.00
3.23
6.09
0.98
f1 (ppm)

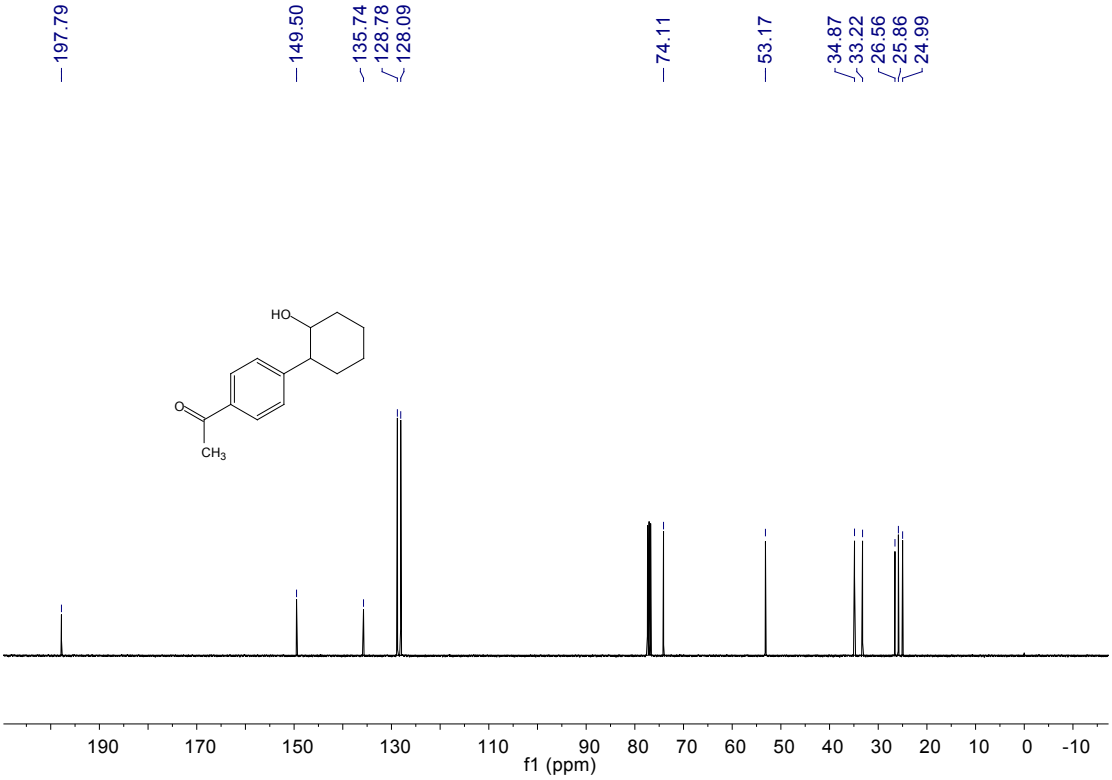

141.71
138.72
136.97
135.17
130.01
129.69
128.72
128.25
126.73
125.55
66.22
53.33
19.93
19.39
CH3
H3C
OH
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


6.89 6.87 6.87 6.85 3.57 3.56 3.55 2.41 2.38 2.38 2.12 2.11 2.11 2.11 2.10 2.10 2.10 2.09 2.09 1.87 1.86 1.85 1.85 1.83 1.82 1.82 1.79 1.79 1.78 1.77 1.76 1.75 1.51 1.46 1.43 1.42 1.42 1.40 1.40 1.39 1.39 1.38 1.36 1.36 1.35 1.35 1.32 1.31 1.29 0.00
HO
F
F
F
1.93
1.00
1.00
1.03
2.99
5.40
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)


-134.46
-134.51
-163.32
-163.37
-163.43
HO
F
F
F
-122
-128
-134
-140
-146
-152
-158
-164
-170
-176
f1 (ppm)


152.44
150.01
149.96
140.18
140.16
140.11
140.09
140.05
139.79
139.64
111.72
111.62
111.56
74.12
52.42
34.98
33.24
25.70
24.86
HO
F
F
F
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.93 7.92 7.91 7.91 7.90 7.90 7.89 7.36 7.35 7.35 7.34 7.33 3.71 3.69 2.58 2.57 2.56 2.55 2.54 2.52 2.52 2.13 2.13 2.12 2.11 2.11 1.87 1.86 1.85 1.84 1.83 1.79 1.77 1.76 1.70 1.60 1.53 1.50 1.46 1.43 1.42 1.41 1.40 1.39 1.38 1.38 1.35 1.35 -0.00 -0.00
HO
O
CH3
1.96 1.97 1.00 3.96 1.01 2.94 3.94
f1 (ppm)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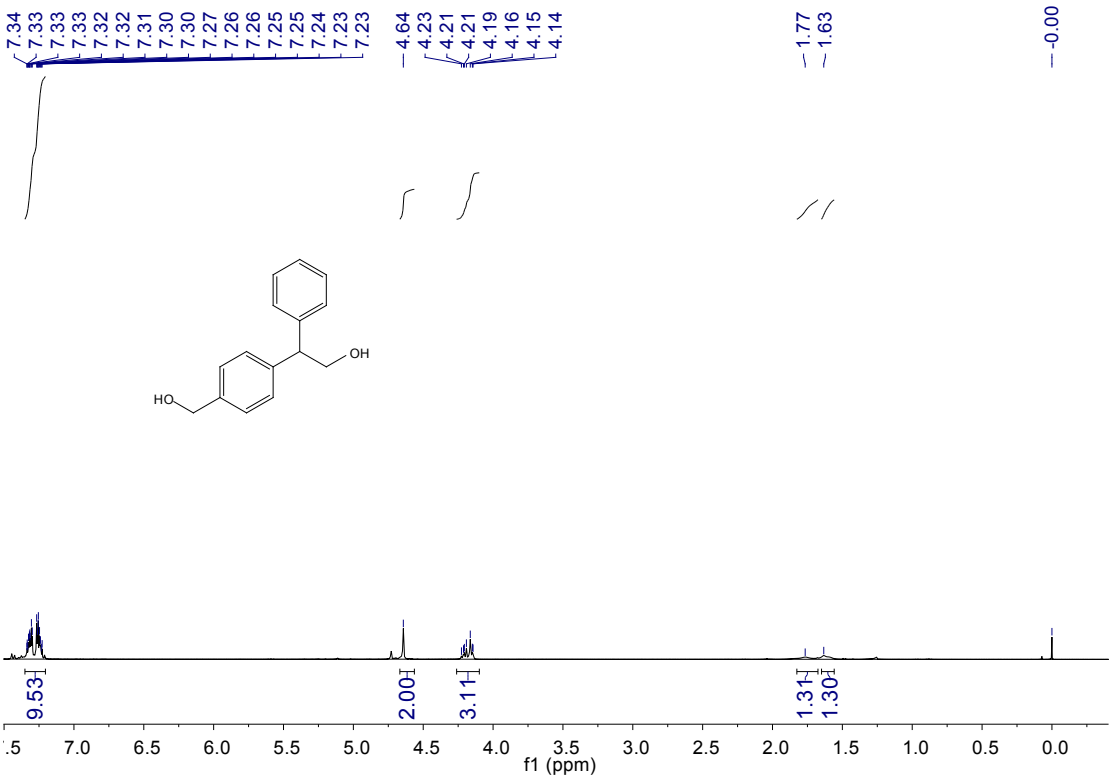
HO
O
CH3
f1 (ppm)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7.33
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7.32
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7.27
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7.25
7.24
7.23
7.23
4.64
4.23
4.21
4.21
4.19
4.16
4.15
4.14
1.77
1.63
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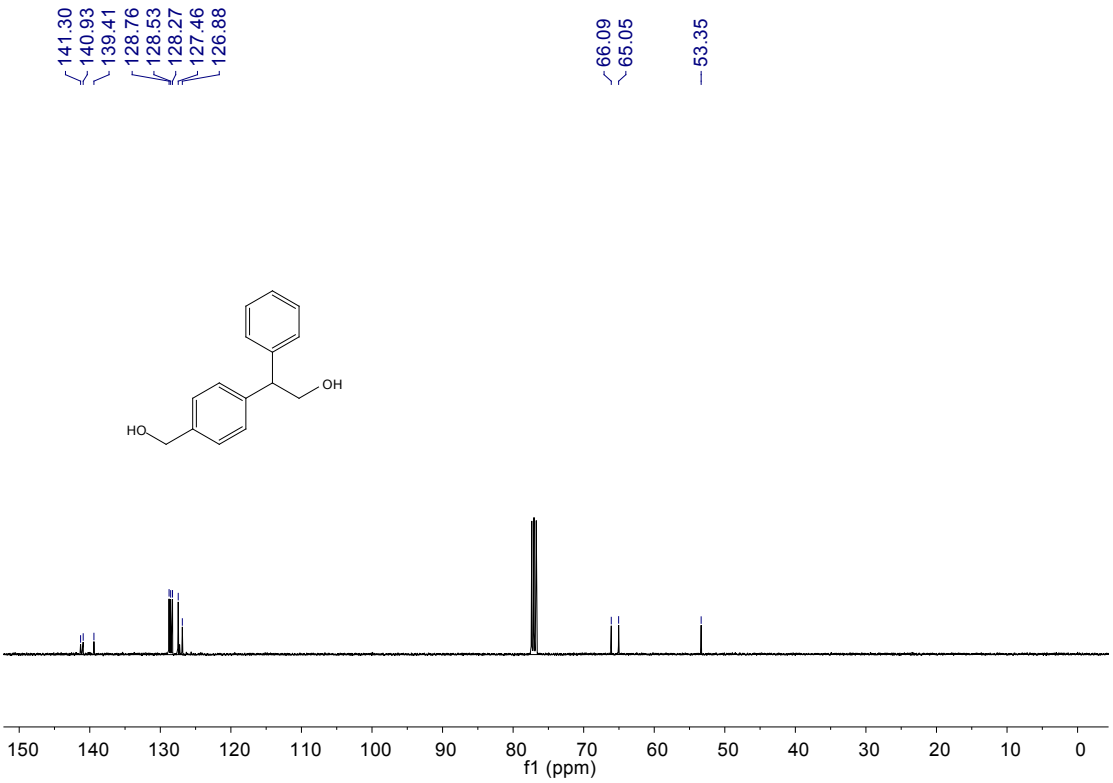
OH
HO
9.53
2.00
3.11
1.31
1.30
f1 (ppm)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140.93
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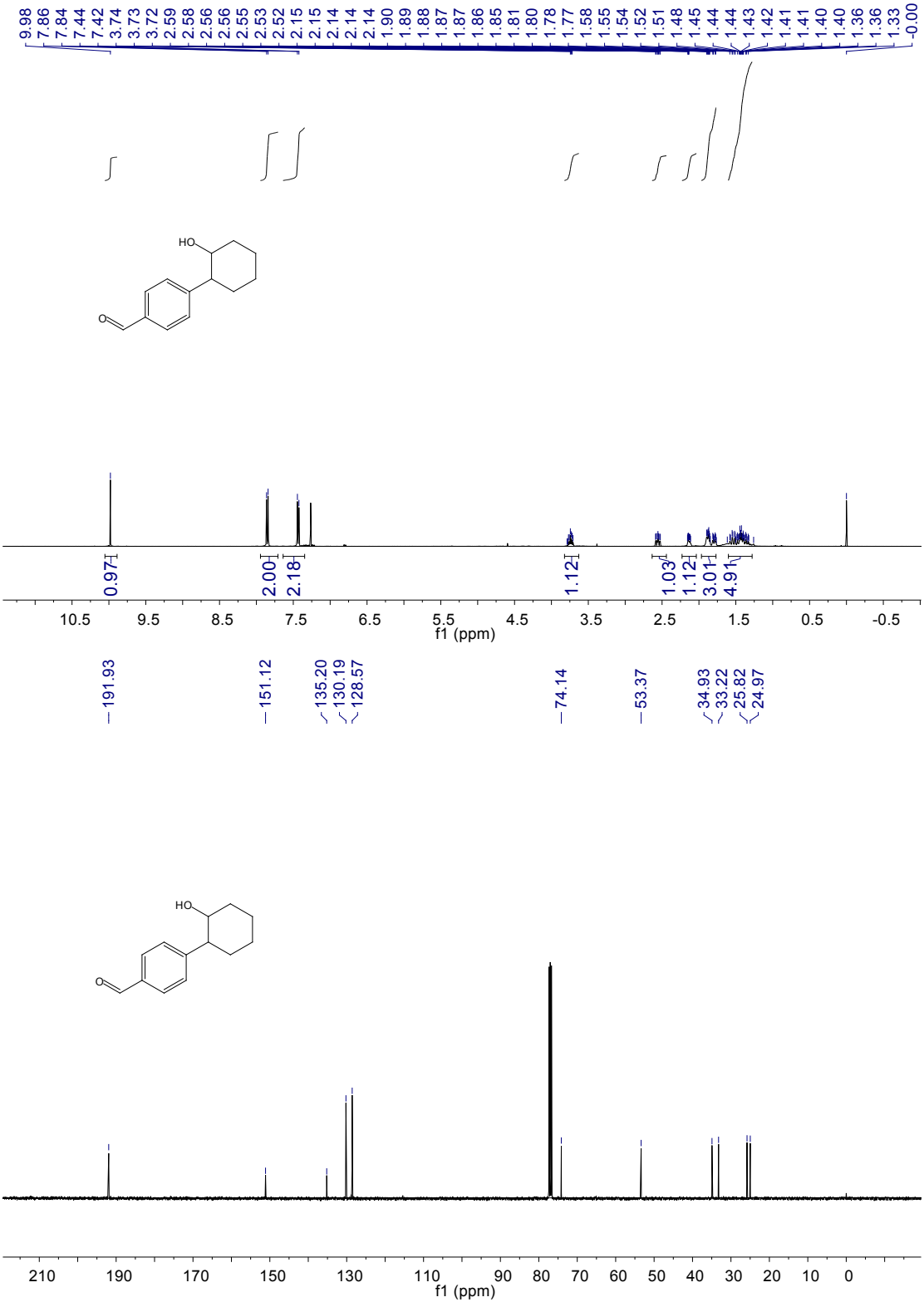
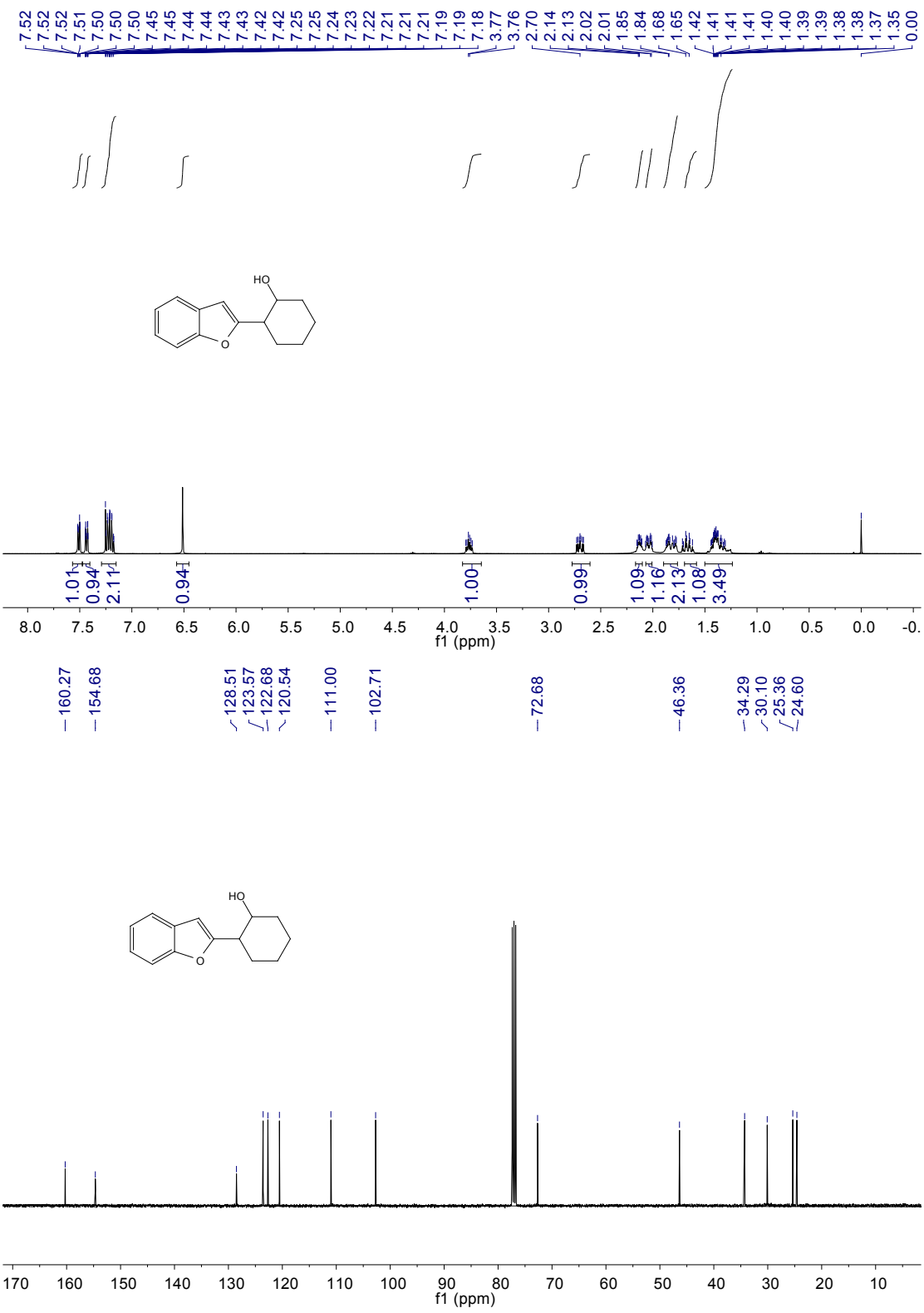
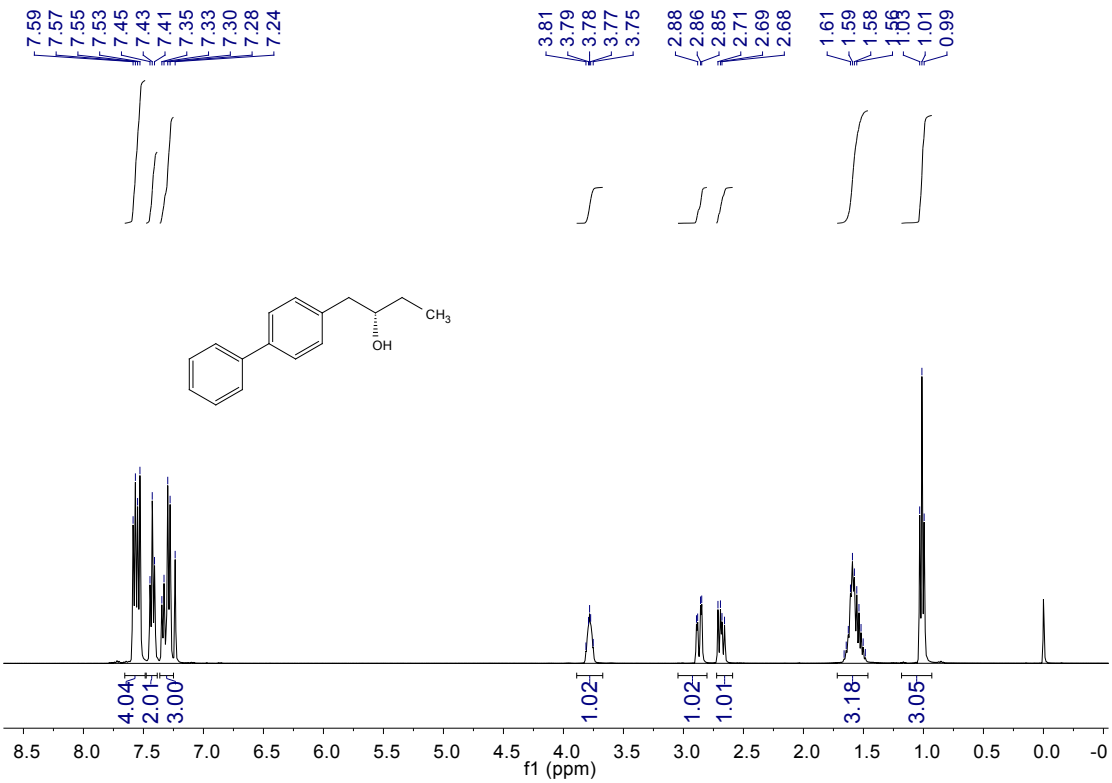
128.76
128.53
128.27
127.46
126.88
66.09
65.05
53.35
OH
HO
f1 (ppm)


9.98 7.86 7.84 7.44 7.42 3.74 3.73 3.72 2.59 2.58 2.56 2.56 2.55 2.53 2.52 2.15 2.15 2.14 2.14 2.14 1.90 1.89 1.88 1.87 1.87 1.86 1.85 1.81 1.80 1.78 1.77 1.58 1.55 1.54 1.52 1.51 1.48 1.45 1.44 1.44 1.43 1.42 1.41 1.41 1.40 1.40 1.36 1.33 -0.00
HO
O
0.97 2.00 2.18 1.12 1.03 1.12 3.01 4.91
10.5 9.5 8.5 7.5 6.5 5.5 4.5 3.5 2.5 1.5 0.5 -0.5
f1 (ppm)
191.93 151.12 135.20 130.19 128.57 74.14 53.37 34.93 33.22 25.82 24.97
HO
O
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.52 7.52 7.52 7.51 7.50 7.50 7.50 7.45 7.45 7.44 7.44 7.43 7.43 7.42 7.42 7.25 7.25 7.24 7.23 7.22 7.21 7.21 7.21 7.19 7.19 7.18 3.77 3.76 2.70 2.14 2.13 2.02 2.01 1.85 1.84 1.68 1.65 1.42 1.41 1.41 1.41 1.40 1.40 1.39 1.39 1.38 1.38 1.37 1.35 0.00
HO
O
1.01 0.94 2.11 0.94 1.00 0.99 1.09 1.16 2.13 1.08 3.49
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.
f1 (ppm)
160.27 154.68 128.51 123.57 122.68 120.54 111.00 102.71 72.68 46.36 34.29 30.10 25.36 24.60
HO
O
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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7.41
7.35
7.33
7.30
7.28
7.24
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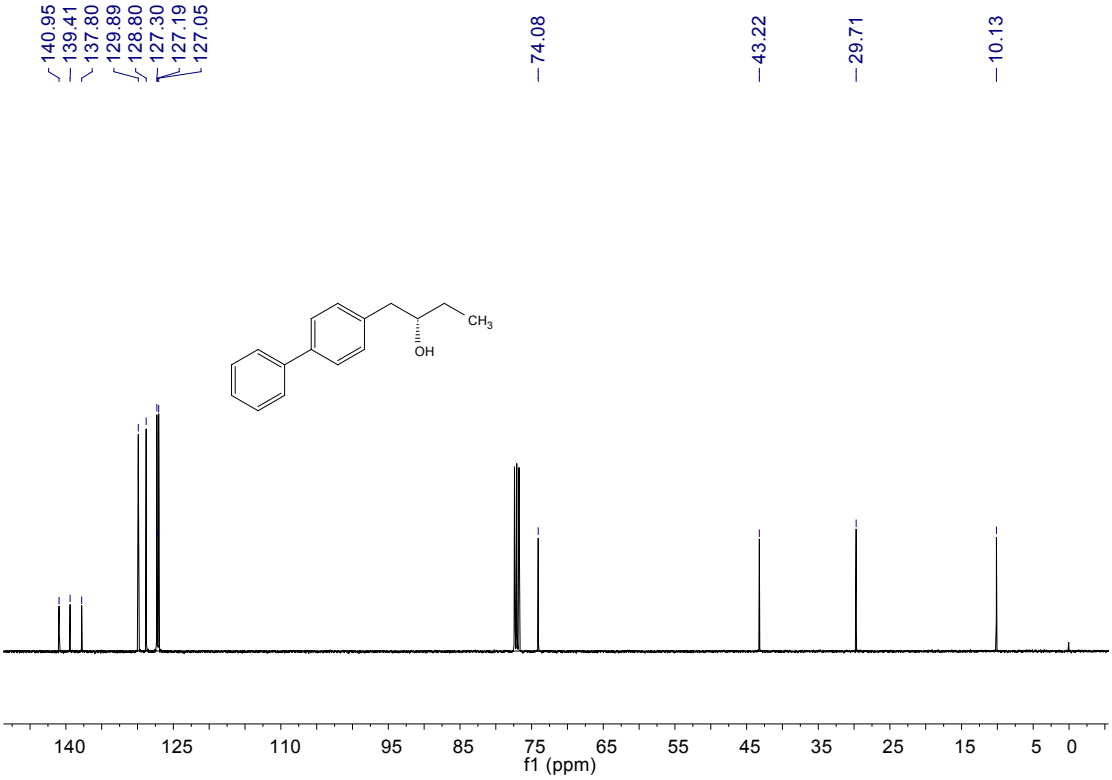
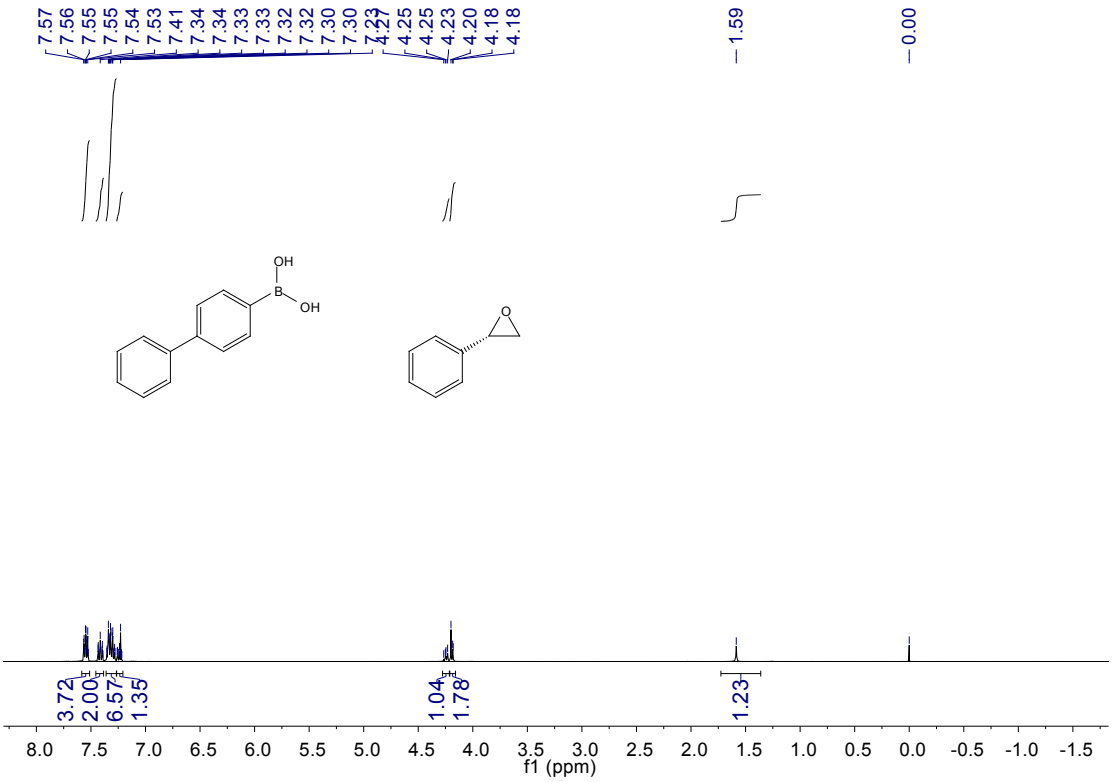
3.79
3.78
3.77
3.75
2.88
2.86
2.85
2.71
2.69
2.68
1.61
1.59
1.58
1.01
0.99
CH3
OH
4.04
2.01
3.00
1.02
1.02
1.01
3.18
3.05
f1 (ppm)


140.95
139.41
137.80
129.89
128.80
127.30
127.19
127.05
74.08
43.22
29.71
10.13
CH3
OH
f1 (ppm)


7.57
7.56
7.55
7.55
7.54
7.53
7.41
7.34
7.34
7.33
7.33
7.32
7.32
7.30
7.30
7.23
4.27
4.25
4.25
4.23
4.20
4.18
4.18
1.59
0.00
OH
B
OH
O
3.72
2.00
6.57
1.35
1.04
1.78
1.23
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)