Supplementary Material (ESI) for Chemical Communications

Electronic Supplementary Information for

Rhodium-Catalyzed Oxidative Coupling of Aromatic Imines with Internal Alkynes via Regioselective C–H Bond Cleavage

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List of Contents for Experimental Section

General. ^{1}H and ^{13}C NMR spectra were recorded at 400 and 100 MHz, respectively, for $CDCl_3$ solutions. MS data were obtained by EI, unless noted. GC analysis was carried out using a silicon OV-17 column (i. d. 2.6 mm x 1.5 m) or a CBP-1 capillary column (i. d. 0.5 mm x 25 m). GC-MS analysis was carried out using a CBP-1 capillary column (i. d. 0.25 mm x 25 m) on a Shimadzu QP-5050. The structures of all products listed below were unambiguously determined by ^{1}H and ^{13}C NMR with the aid of NOE, COSY, HMQC, and HMBC experiments.

Imines **1b**-**g**[14] and **6**[15] and diarylacetylenes **2b**-**d**[16] were prepared according to published procedures. Other starting materials were commercially available.

Experimental Procedures. The following experimental procedures may be regarded as typical in methodology and scale.

Procedure for the reaction of *N*-benzylideneaniline (1a) with diphenylacetylene (2a) (entry 6 in Table 1): To a 20 mL two-necked flask were added *N*-benzylideneaniline (**1a**) (1 mmol, 181 mg), diphenylacetylene (**2a**) (0.5 mmol, 89 mg), $[(Cp^*RhCl_2)_2]$ (0.01 mmol, 6 mg), $Cu(OAc)_2•H_2O$ (1 mmol, 199 mg), 1-methylnaphthalene (ca. 50 mg) as internal standard, and DMF (3 mL) were added. The resulting mixture was stirred under N_2 at 80 ºC for 6 h. GC and GC-MS analyses of the mixtures confirmed formation of **3a**. Then, the reaction mixture was cooled to room temperature and extracted with EtOAc (100 mL) and ethylenediamine (2 mL). The organic layer was washed by water (100 mL, three times), and dried over Na_2SO_4. Product **3a** (136 mg, 76%) was isolated by column chromatography on silica gel using hexane-ethyl acetate (99:1, v/v) as eluant.

Procedure for the reaction of benzophenone imine (4) with diphenylacetylene (2a) (entry 1 in Table 3): To a 20 mL two-necked flask were added benzophenone imine (**4**) (0.5 mmol, 91 mg), diphenylacetylene (**2a**) (0.5 mmol, 89 mg), $[(Cp^*RhCl_2)_2]$ (0.005 mmol, 3 mg), $Cu(OAc)_2•H_2O$ (1 mmol, 199 mg), 1-methylnaphthalene (ca. 50 mg) as internal standard, and DMF (3 mL) were added. The resulting mixture was stirred under N_2 at 80 ºC for 2 h. GC and GC-MS analyses of the mixtures confirmed formation of **5**. Then, the reaction mixture was cooled to room temperature and extracted with Et_2O (100 mL) and ethylenediamine (2 mL). The organic layer was washed by water (100 mL, three times), and dried over Na_2SO_4. Product **5** (160 mg, 90%) was isolated by column chromatography on silica gel using hexane-ethyl acetate (99:1, v/v) as eluant.

Characterization Data of Products.

***N*-(2,3-Diphenyl-1*H*-inden-1-ylidene)benzenamine** (**3a**): Mp 173-174 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 6.47 (d, *J* = 7.3 Hz, 1H), 6.89 (dt, *J* = 7.7, 1.8 Hz, 1H), 6.96 (d, *J* = 8.4 Hz, 2H), 7.15-7.28 (m, 6H), 7.32-7.40 (m, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) 117.87, 120.77, 123.83, 125.91, 127.10, 127.27, 127.70, 128.25, 128.27, 128.52,129.08 (overlapped), 130.75, 131.12, 132.70, 133.67, 136.64, 145.43, 148.61, 152.15, 166.11; HRMS m/z (M+) calcd for $C_{27}H_{19}N$: 357.1517, found: 357.1514. Anal. calcd for $C_{27}H_{19}N$: C, 90.72; H, 5.36; N, 3.89, found: C, 90.43; H, 5.41; N, 3.89.

***N*-(5-Chloro-2,3-diphenyl-1*H*-inden-1-ylidene)benzenamine** (**3b**): Mp 212-213 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 6.37 (d, *J* = 8.1 Hz, 1H), 6.86 (d, *J* =7.4 Hz, 1H), 6.94 (d, *J* = 8.5 Hz, 2H), 7.14-7.41 (m, 14H); ^{13}C NMR (100 MHz, $CDCl_3$) 117.83, 121.22, 124.12, 126.34, 126.69, 126.71, 127.56, 127.77, 128.56, 128.72, 128.97, 129.13, 131.09, 132.26, 133.11, 136.96, 137.95, 147.45, 147.53, 151.82, 164.96; HRMS m/z (M+) calcd for $C_{27}H_{18}ClN$: 391.1128, found: 391.1124. Anal. calcd for $C_{27}H_{18}ClN$: C, 82.75; H, 4.63; N, 3.57, found: C, 82.46; H, 4.67; N, 3.56.

***N*-(5-Methyl-2,3-diphenyl-1*H*-inden-1-ylidene)benzenamine** (**3c**): Mp 170-171 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 2.26 (s, 3H), 6.34 (d, *J* = 7.7 Hz, 1H), 6.69 (d, *J* = 7.7 Hz, 1H), 6.94-6.98 (m, 3H), 7.14-7.27 (m, 3H), 7.31-7.40 (m, 10H); ^{13}C NMR (100 MHz, $CDCl_3$) 21.73, 117.98, 121.79, 123.72, 125.76, 125.82, 127.20, 127.37, 127.67, 128.18, 128.52, 129.03, 129.10, 131.11, 132.77, 133.81, 136.95, 141.31, 145.76, 148.45, 152.32, 166.03; HRMS m/z (M+) calcd for $C_{28}H_{21}N$: 371.1674, found: 371.1672.

4-Chloro-*N*-(2,3-diphenyl-1*H*-inden-1-ylidene)benzenamine (**3d**): Mp 215-216 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 6.56 (d, *J* = 7.7 Hz, 1H), 7.18-7.28 (m, 3H), 7.18-7.28 (m, 5H), 7.30-7.39 (m, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) 119.43, 120.97, 125.86, 127.20, 127.38, 127.74 128.12, 128.39, 128.54, 129.03, 129.17, 129.20, 131.04 (overlapped), 132.52, 133.47, 136.54, 145.46, 148.99, 150.52, 166.71; HRMS m/z (M+) calcd for $C_{27}H_{18}ClN$: 391.1128, found: 391.1124. Anal. calcd for $C_{27}H_{18}ClN$: C, 82.75; H, 4.63; N, 3.57, found: C, 82.73; H, 4.70; N, 3.58.

4-Methoxy-*N*-(2,3-diphenyl-1*H*-inden-1-ylidene)benzenamine (**3e**): Mp 169-170 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 3.86 (s, 3), 6.64 (d, *J* = 7.7 Hz, 1H), 6.90-6.95 (m, 5H),

7.18-7.27 (m, 5H), 7.32- 7.39 (m, 7H); ^{13}C NMR (100 MHz, $CDCl_3$) 55.54, 114.37, 119.40, 120.69, 125.74, 127.10, 127.20, 127.68, 128.15, 128.21, 128.49, 129.10, 130.64, 131.15, 132.82, 133.75, 136.87, 145.42 (overlapped), 148.36, 156.64, 166.54; HRMS m/z (M+) calcd for $C_{28}H_{21}NO$: 387.1623, found: 387.1619.

4-Chloro-*N*-(5-chloro-2,3-diphenyl-1*H*-inden-1-ylidene)benzenamine (**3f**): Mp 215-217 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 6.47 (d, *J* = 8.1 Hz, 1H), 6.87-6.93 (m, 3H), 7.15 (s, 1H), 7.23-7.40 (m. 12H); ^{13}C NMR (100 MHz, $CDCl_3$) 119.39, 121.44, 126.19, 126.60, 126.80, 127.67, 127.80, 128.67, 128.74, 128.92, 129.27, 129.48, 131.01, 132.06, 132.89, 137.28, 137.84, 147.45, 147.89, 150.13, 165.52; HRMS m/z (M+) calcd for $C_{27}H_{17}Cl_2N$: 425.0738, found: 425.0735.

***N*-(2,3-Diphenyl-1*H*-benz[*f*]inden-1-ylidene)benzenamine** (**3g**) : Mp 225-226 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 6.86 (s, 1H), 7.01 (d, *J* = 8.0 Hz, 2H), 7.21-7.32 (m, 5H), 7.38-7.45 (m, 11H), 7.47 (s, 1H), 7.65 (d, *J* = 7.7 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) 118.08, 119.44, 123.71, 126.08, 127.12, 127.32, 127.46, 127.73, 127.81, 128.34, 128.38, 128.60, 129.19, 129.24, 130.04, 131.06, 132.67, 132.70, 133.78, 134.44, 139.80, 141.55, 149.37, 152.66, 165.20; HRMS m/z (M+) calcd for $C_{31}H_{21}N$: 407.1674, found: 407.1662.

***N*-[2,3-Bis(4-chlorophenyl)-1*H*-inden-1-ylidene]benzenamine** (**3h**): Mp 202-203 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 6.49 (d, *J* = 7.7 Hz, 1H), 6.90-6.95 (m, 3H), 7.13-7.29 (m, 9H), 7.36-7.41 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) 117.78, 120.65, 124.12, 126.08, 127.51, 128.02, 128.18, 129.06, 129.17, 130.40, 130.84, 130.95, 131.80, 132.35, 133.58, 134.48, 135.79, 144.77, 147.68, 151.80, 165.65; HRMS m/z (M+) calcd for $C_{27}H_{17}Cl_2N$: 425.0738, found: 425.0735

***N*-[2,3-Bis(4-methylphenyl)-1*H*-inden-1-ylidene]benzenamine** (**3i**): Mp 192-193 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 2.30 (s, 3H), 2.38 (s, 3H), 6.44 (d, *J* = 7.7 Hz, 1H), 6.85-6.89 (m, 1H), 6.94 (d, *J* = 8.5 Hz, 2H), 7.07 (d, *J* = 8.1 Hz, 2H), 7.14-7.19 (m, 5H), 7.25 (m, 4H), 7.36 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) 21.31, 21.41, 117.92, 120.66, 123.70, 125.81, 126.86, 128.37, 128.51, 129.00 (overlapped), 129.22, 129.85, 130.64, 130.78, 130.95, 136.28, 136.90, 138.07, 145.67, 148.06, 152.29, 166.31; HRMS m/z (M+) calcd for $C_{29}H_{23}N$: 385.1830, found: 385.1833.

***N*-[2,3-Bis(4-methoxyphenyl)-1*H*-inden-1-ylidene]benzenamine** (**3j**): Mp 183-184 °C; ^{1}H NMR (400 MHz, $CDCl_3$) 3.78 (s, 3H), 3.83 (s, 3H), 6.43 (d, *J* = 7.4 Hz, 1H), 6.81-6.96 (m, 7H), 7.14-7.20 (m, 3H), 7.28-7.39 (m, 6H); ^{13}C NMR (100 MHz,

$CDCl_3$) δ 55.14, 55.25, 113.36, 114.01, 117.93, 120.50, 123.70, 125.26, 125.77, 126.06, 126.78, 128.41, 129.02, 130.49, 130.63, 132.31, 135.52, 145.72, 147.27, 152.28, 158.76, 159.48, 166.37; HRMS m/z (M+) calcd for $C_{29}H_{23}NO_2$: 417.1729, found: 417.1733.

***N*-(2,3-Dipropyl-1*H*-inden-1-ylidene)benzenamine** (**3k**): Oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.98-1.07 (m, 6H), 1.60-1.68 (m, 4H), 2.47-2.56 (m, 4H), 6.28 (d, *J* = 7.3 Hz, 1H), 6.75 (t, *J* = 7.4 Hz, 1H), 6.90 (d, *J* = 7.4 Hz, 2H), 7.05 (d, *J* = 7.4 Hz, 1H), 7.12-7.17 (m, 2H), 7.35 (m, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 14.34, 14.48, 21.66, 23.43, 26.04, 27.96, 118.18, 118.63, 123.58, 125.06, 125.83, 128.73, 128.98, 130.51, 137.75, 146.32, 148.55, 152.17, 166.78; HRMS m/z (M+) calcd for $C_{21}H_{23}N$: 289.1830, found: 289.1832.

1,3,4-Triphenylisoquinoline (**5a**):[17] Mp 130-132 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.15-7.20 (m, 3H), 7.28-7.31 (m, 2H), 7.35-7.44 (m, 5H), 7.49-7.60 (m, 5H), 7.72 (d, *J* = 8.4 Hz, 1H), 7.82 (d, *J* = 6.6 Hz, 2H), 8.18 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 125.44, 126.02, 126.54, 126.97, 127.27, 127.49, 127.52, 128.28, 128.30, 128.50, 129.75, 129.91, 130.23, 130.45, 131.36, 137.00, 137.58, 139.85, 140.92, 149.67, 159.79; HRMS m/z (M+) calcd for $C_{27}H_{19}N$: 357.1517, found: 357.1503. Anal. calcd for $C_{27}H_{19}N$: C, 90.72; H, 5.36; N, 3.92, found: C, 90.48; H, 5.40; N, 3.94.

3,4-Bis(4-chlorophenyl)-1-phenylisoquinoline (**5b**): Mp 193-194 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (d, *J* = 8.5 Hz, 2H), 7.22 (d, *J* = 8.5 Hz, 2H) 7.35 (d, *J* = 8.5 Hz, 2H), 7.39 (d, *J* = 8.0 Hz, 2H), 7.49-7.57 (m, 4H), 7.61 (d, *J* = 8.5 Hz, 1H), 7.66 (t, *J* = 9.1 Hz, 1H), 7.79 (d, *J* = 8.1 Hz, 2H), 8.18 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 125.54, 125.64, 126.94, 127.69, 127.96, 128.37, 128.56, 128.72, 128.85, 130.14, 130.31, 131.74, 132.60, 133.34, 133.65, 135.79, 136.77, 139.10, 139.51, 148.47, 160.32; HRMS m/z (M+) calcd for $C_{27}H_{17}Cl_2N$: 425.0738, found: 425.0729. Anal. calcd for $C_{27}H_{17}ClN$: C, 76.06; H, 4.02; N, 3.29, found: C, 75.93; H, 4.00; N, 3.31.

3,4-Bis(4-methylphenyl)-1-phenylisoquinoline (**5c**): Mp 173-174 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.27 (s, 3H), 2.41 (s, 3H), 6.99 (d, *J* = 7.6 Hz, 2H), 7.17-7.22 (m, 4H), 7.34 (d, *J* = 7.9 Hz, 2H), 7.46-7.58 (m, 5H), 7.71 (d, *J* = 7.9 Hz, 1H), 7.80-7.83 (m, 2H), 8.16 (d, *J* = 7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.16, 21.32, 125.31, 126.07, 126.31, 127.42, 128.23, 128.29, 128.42, 129.08, 129.44, 129.71, 130.26,

130.35, 131.16, 134.67, 136.55, 136.81, 137.25, 138.16, 139.98, 149.59, 159.48; HRMS m/z (M+) calcd for $C_{29}H_{23}N$: 385.1830, found: 385.1825.

3,4-Bis(4-methoxyphenyl)-1-phenylisoquinoline (**5d**): Mp 162-163 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.75 (s, 3H), 3.86 (s, 3H), 6.74 (d, *J* = 8.8 Hz, 2H), 6.95 (d, *J* = 8.5 Hz, 2H), 7.21 (d, *J* = 8.5 Hz, 2H), 7.39 (d, *J* = 8.8 Hz, 2H) 7.46-7.59 (m, 5H), 7.73 (d, *J* = 8.5 Hz, 1H), 7.81 (d, *J* = 8.5 Hz, 2H), 8.15 (d, *J* = 8.5 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 55.18, 55.28, 113.09, 113.95, 125.25, 125.94, 126.23, 127.45, 128.23, 128.42, 128.83, 129.73, 129.94, 130.23, 131.71, 132.38, 133.63, 137.41, 139.98, 149.37, 158.63, 158.78, 159.44; HRMS m/z (M+) calcd for $C_{29}H_{23}NO_2$: 417.1729, found: 417.1716.

1-Phenyl-3,4-dipropylisoquinoline (**5e**):[18] Oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.05 (t, *J* = 7.4 Hz, 3H), 1.13 (t, *J* = 7.4 Hz, 3H), 1.71-1.88 (m, 4H), 2.99-3.08 (m, 4H), 7.38-7.52 (m, 4H), 7.62 (m, 3H), 8.00-8.03 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.36, 14.68, 23.63, 24.14, 29.98, 37.41, 123.30, 125.25, 125.28, 127.11, 128.06, 128.13, 128.23, 129.41, 130.04, 136.13, 140.20, 152.26, 158.07; HRMS m/z (M+) calcd for $C_{21}H_{23}N$: 289.1830, found: 289.1833.

4-Methyl-1,3-diphenylisoquinoline (**5f**): Mp 77-78 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.68 (s, 3H), 7.37 (t, *J* = 7.3 Hz, 1H), 7.42-7.53 (m, 6H), 7.64 (d, *J* = 8.1 Hz, 2H), 7.71 (m, 3H), 8.11 (t, *J* = 9.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 15.65, 123.03, 123.87, 125.38, 126.26, 127.42, 127.98, 128.02, 128.17, 128.24, 129.83, 130.08, 130.18, 137.06, 139.92, 141.54, 151.08, 158.20; HRMS m/z (M+) calcd for $C_{22}H_{17}N$: 295.1361, found: 295.1346.

N-{[2-(1,2-Diphenylethenyl)phenyl]phenylmethylene}benzenamine (**7**): Mp 97-98 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.95-7.04 (m, 6H), 7.25-7.36 (m, 7H), 7.46-7.49 (m, 4H), 7.71-7.86 (m, 7H), 7.97 (t, J = 7.3 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 126.99, 127.28, 128.11, 128.13, 128.14, 128.26, 128.28, 128.53, 128.82, 129.22, 130.08, 130.45, 130.60 (overlapped), 130.91, 131.15, 131.68, 132.33, 133.97, 136.39, 138.75, 139.17, 140.72, 145.59, 160.13; HRMS m/z (M+) calcd for $C_{33}H_{25}N$: 435.1987, found: 435.1993.

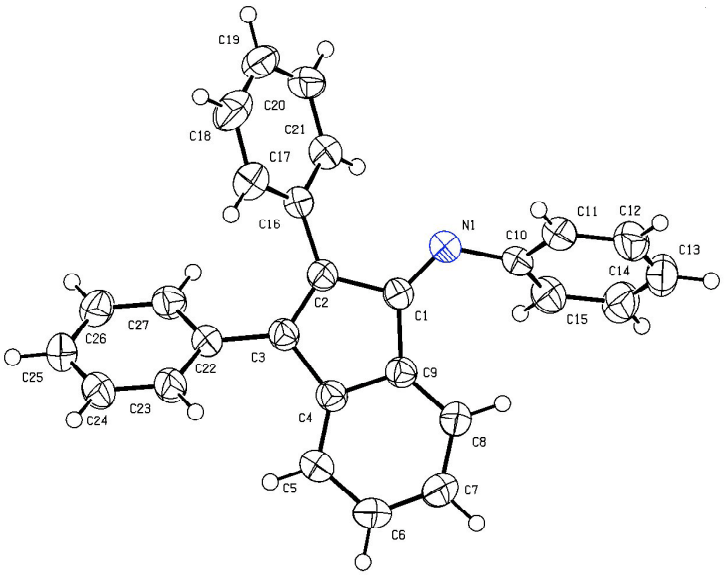

Figure S1. ORTEP drawing of compound **3a**. Crystal data: C27H19N, Mw = 357.45, monoclinic, space group P 1 21 1, T = 296 K, a = 9.8978(8), b = 9.7275(10), c = 10.0052(9), □ = 95.038(7), V = 959.59(15), Z = 2, 2951 reflections measured, R = 0.0423, Rw = 0.1001.

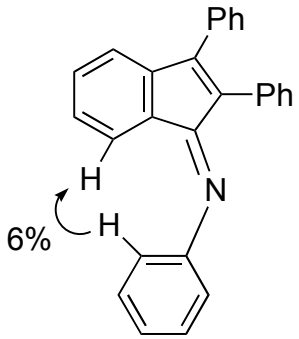

Figure S2. NOE enhancement in ^{1}H NMR of **3a**.

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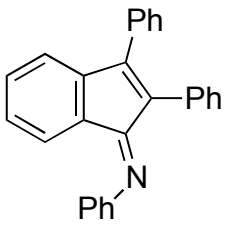
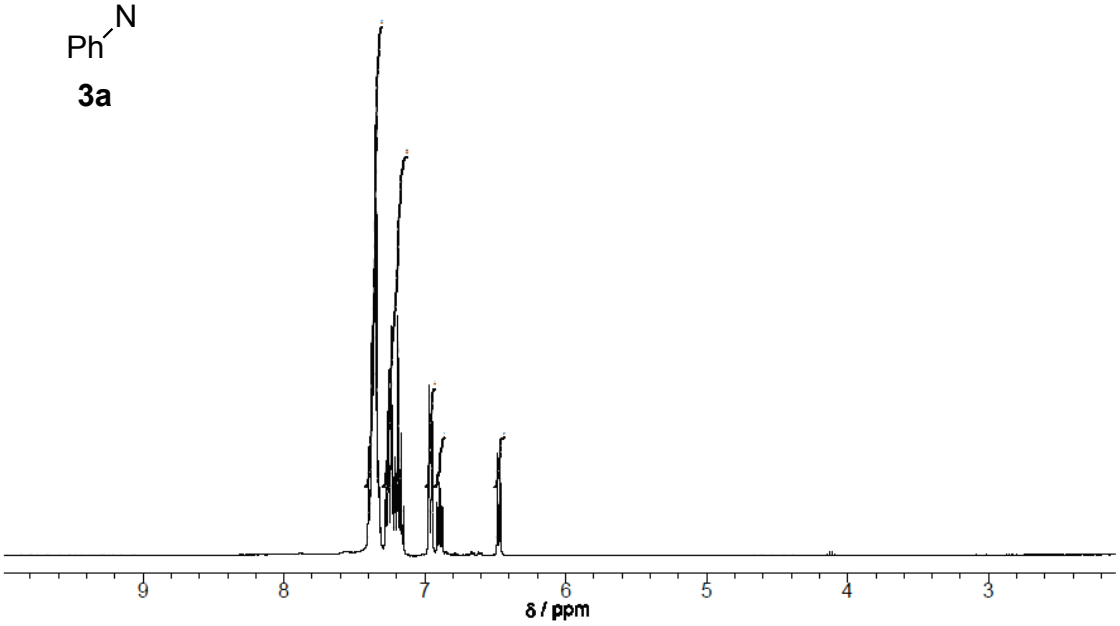
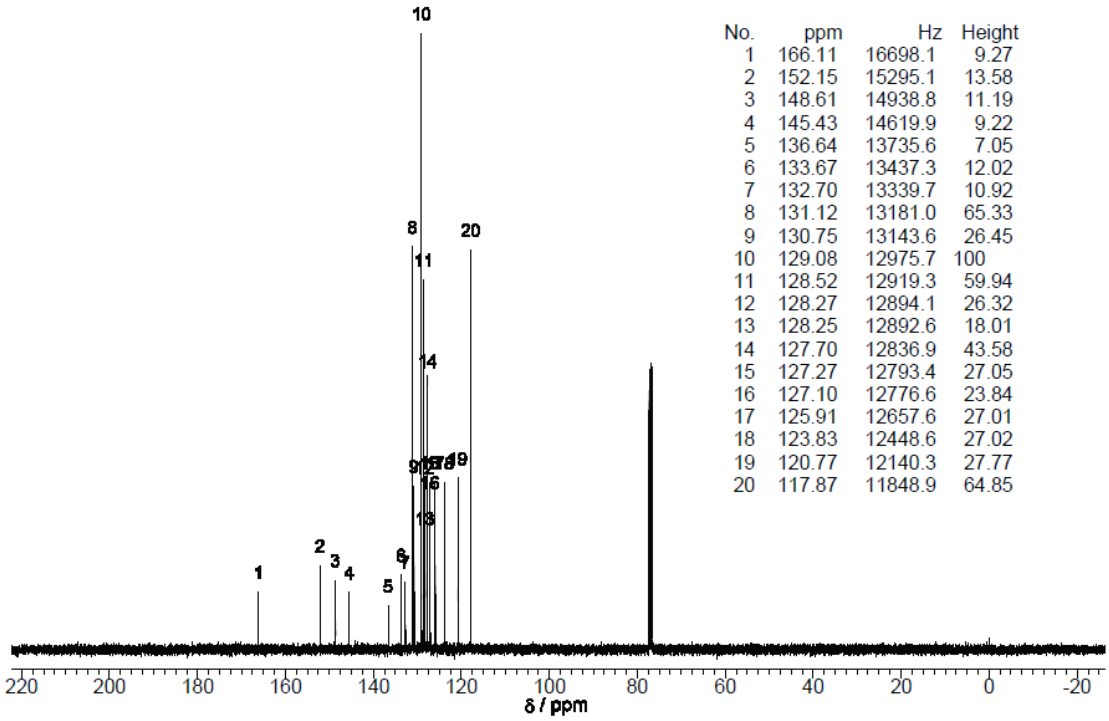


3a





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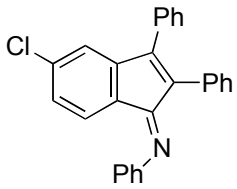
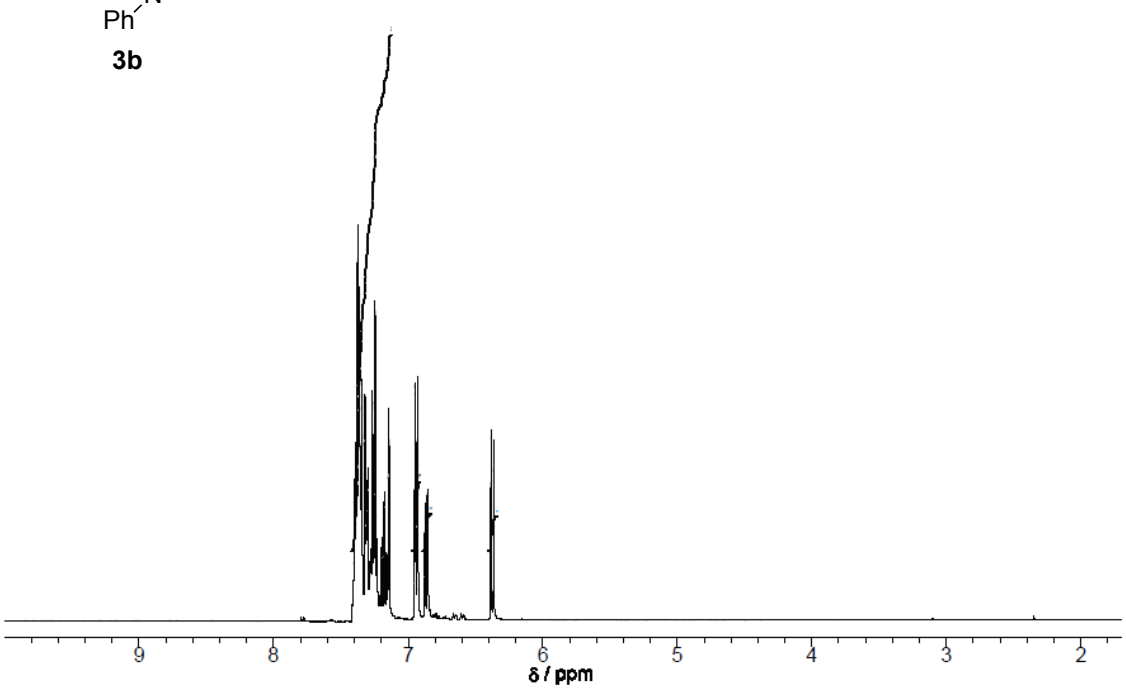
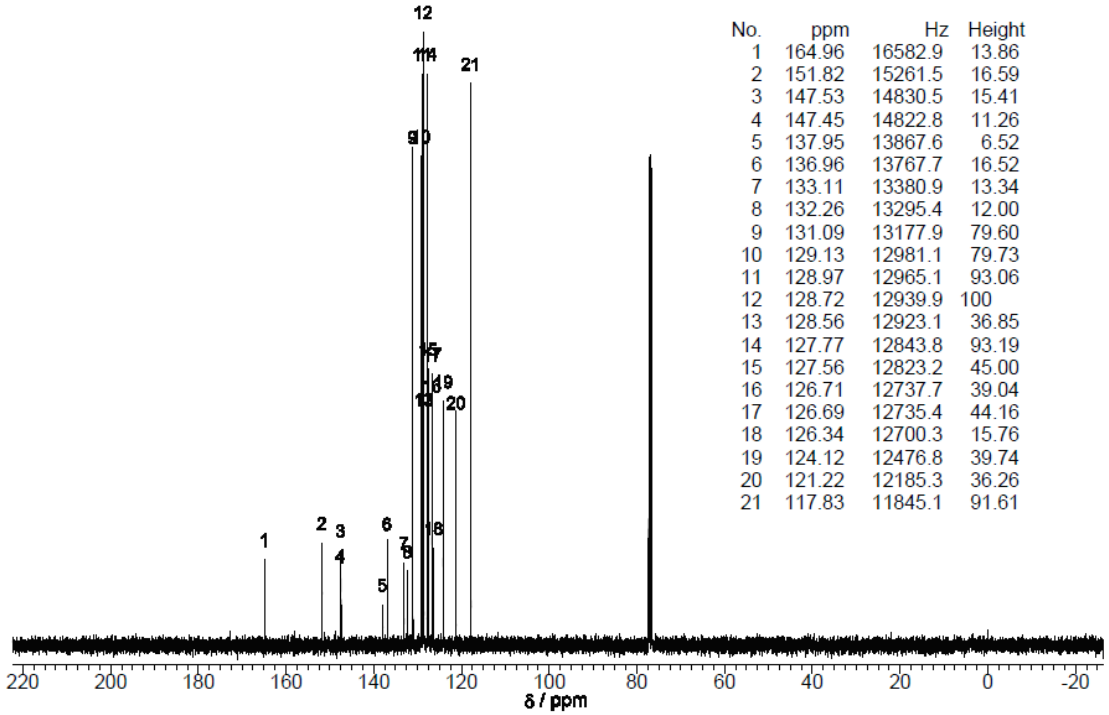
1	166.11	16698.1	9.27
2	152.15	15295.1	13.58
3	148.61	14938.8	11.19
4	145.43	14619.9	9.22
5	136.64	13735.6	7.05
6	133.67	13437.3	12.02
7	132.70	13339.7	10.92
8	131.12	13181.0	65.33
9	130.75	13143.6	26.45
10	129.08	12975.7	100
11	128.52	12919.3	59.94
12	128.27	12894.1	26.32
13	128.25	12892.6	18.01
14	127.70	12836.9	43.58
15	127.27	12793.4	27.05
16	127.10	12776.6	23.84
17	125.91	12657.6	27.01
18	123.83	12448.6	27.02
19	120.77	12140.3	27.77
20	117.87	11848.9	64.85

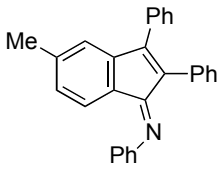


3b

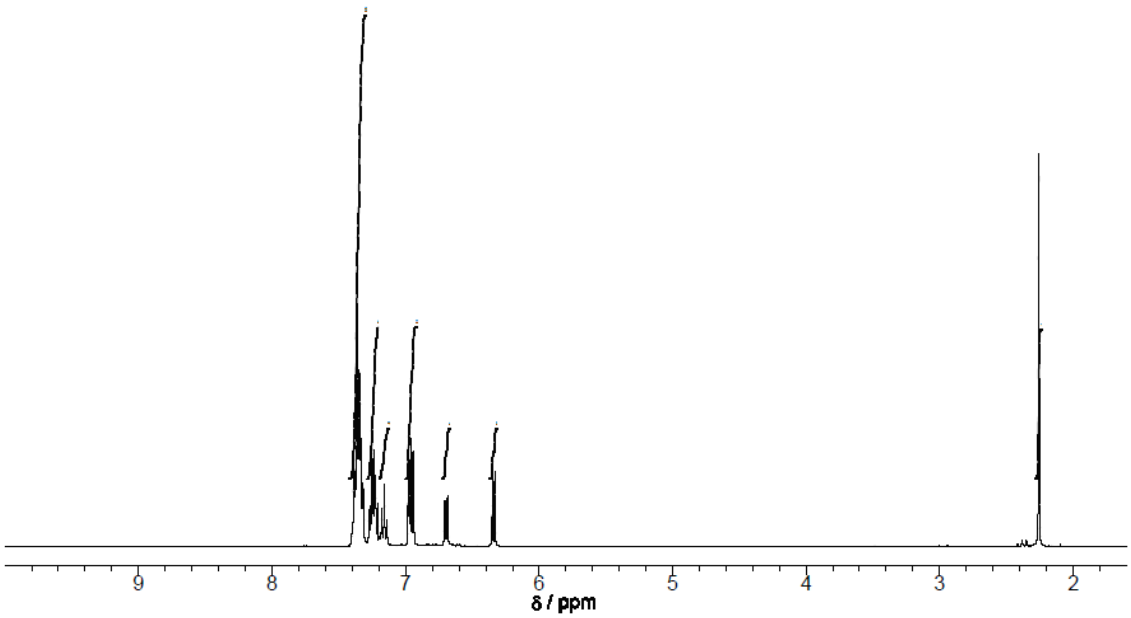




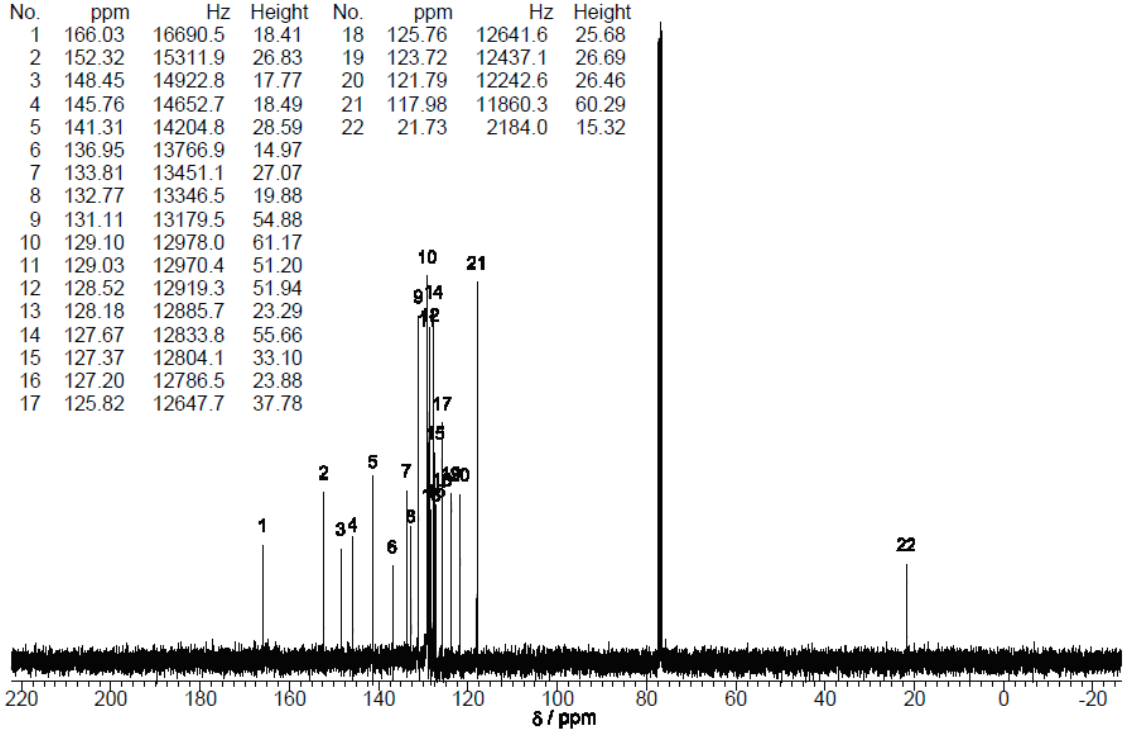
No.	ppm	Hz	Height
1	164.96	16582.9	13.86
2	151.82	15261.5	16.59
3	147.53	14830.5	15.41
4	147.45	14822.8	11.26
5	137.95	13867.6	6.52
6	136.96	13767.7	16.52
7	133.11	13380.9	13.34
8	132.26	13295.4	12.00
9	131.09	13177.9	79.60
10	129.13	12981.1	79.73
11	128.97	12965.1	93.06
12	128.72	12939.9	100
13	128.56	12923.1	36.85
14	127.77	12843.8	93.19
15	127.56	12823.2	45.00
16	126.71	12737.7	39.04
17	126.69	12735.4	44.16
18	126.34	12700.3	15.76
19	124.12	12476.8	39.74
20	121.22	12185.3	36.26
21	117.83	11845.1	91.61

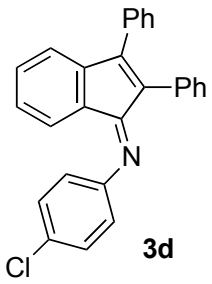


3c

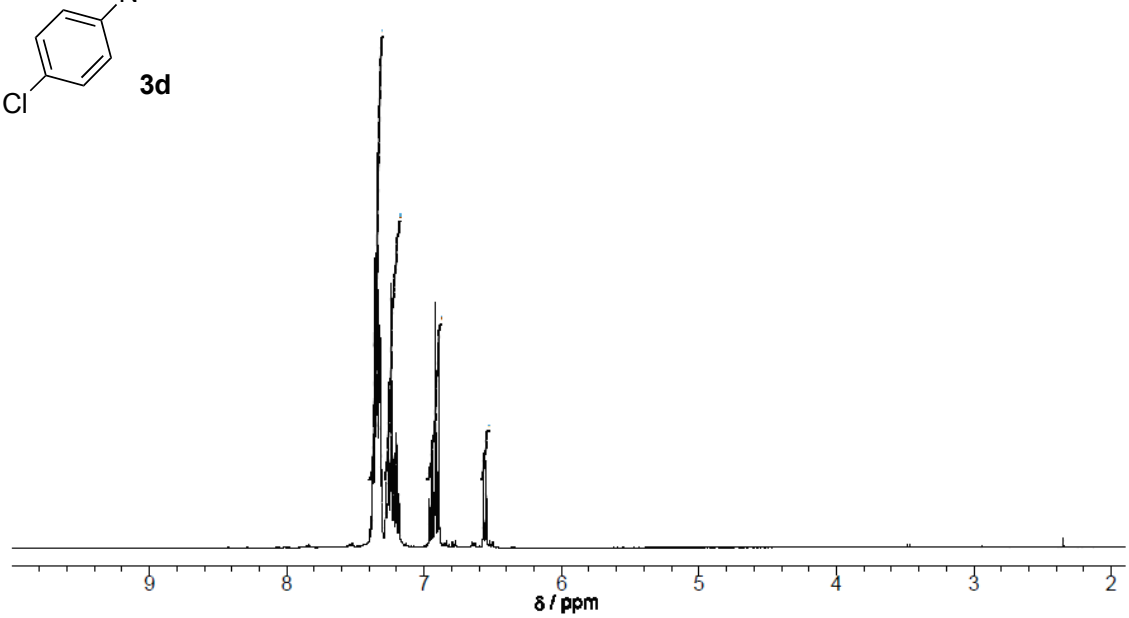


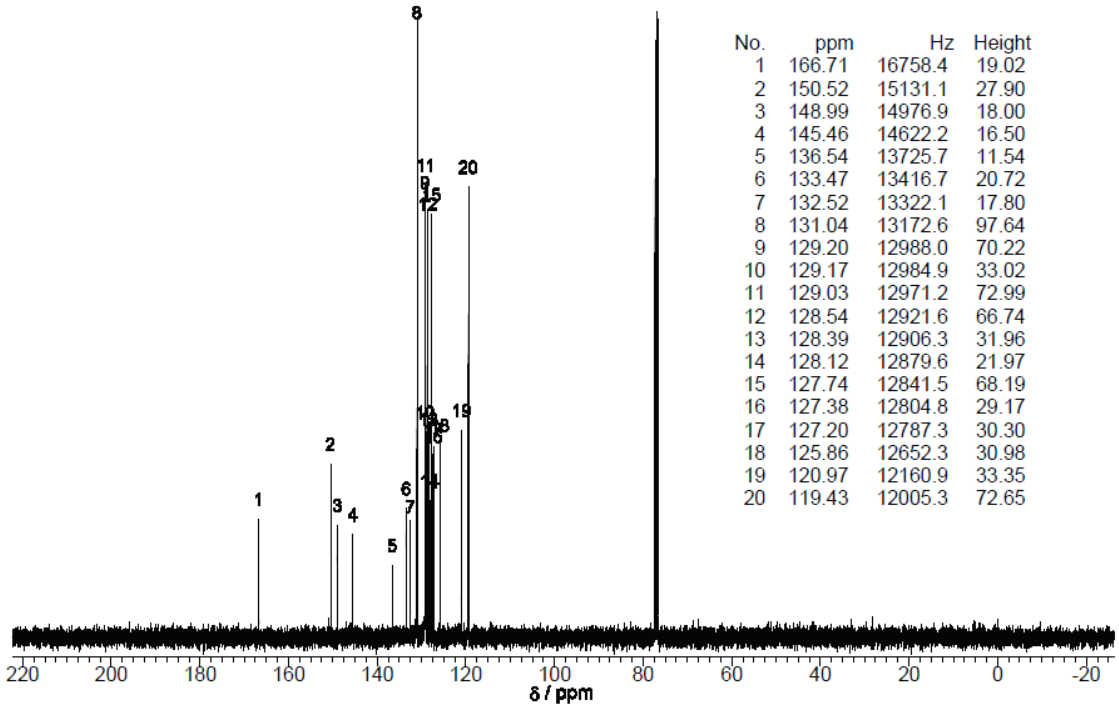
No.	ppm	Hz	Height	No.	ppm	Hz	Height
1	166.03	16690.5	18.41	18	125.76	12641.6	25.68
2	152.32	15311.9	26.83	19	123.72	12437.1	26.69
3	148.45	14922.8	17.77	20	121.79	12242.6	26.46
4	145.76	14652.7	18.49	21	117.98	11860.3	60.29
5	141.31	14204.8	28.59	22	21.73	2184.0	15.32
6	136.95	13766.9	14.97				
7	133.81	13451.1	27.07				
8	132.77	13346.5	19.88				
9	131.11	13179.5	54.88				
10	129.10	12978.0	61.17				
11	129.03	12970.4	51.20				
12	128.52	12919.3	51.94				
13	128.18	12885.7	23.29				
14	127.67	12833.8	55.66				
15	127.37	12804.1	33.10				
16	127.20	12786.5	23.88				
17	125.82	12647.7	37.78				



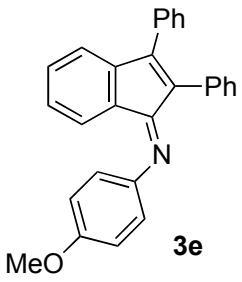


3d

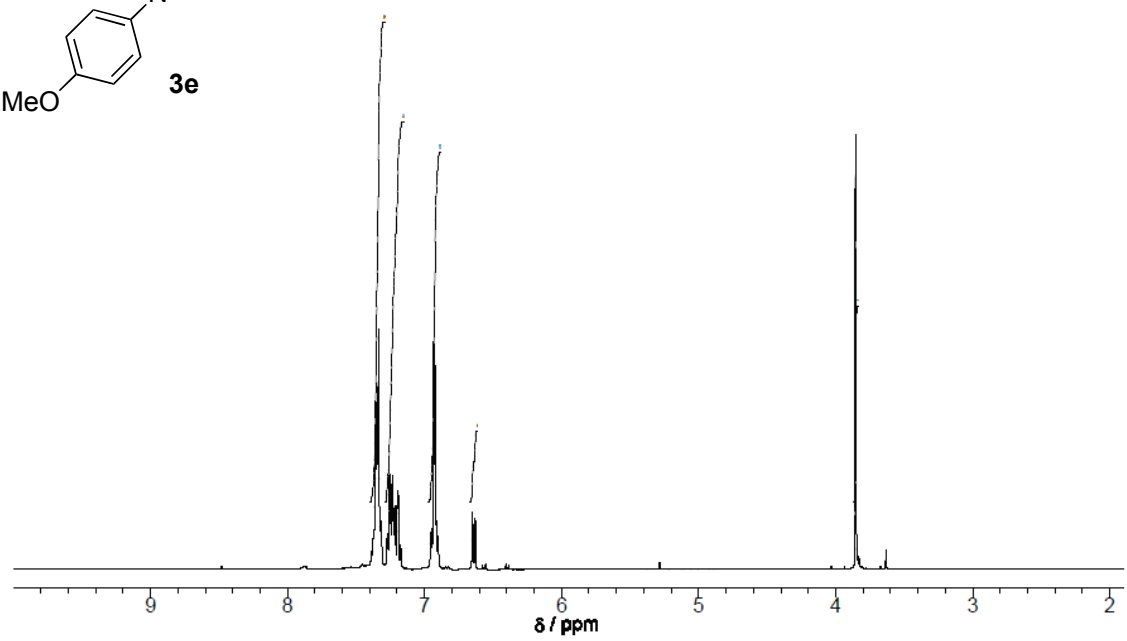


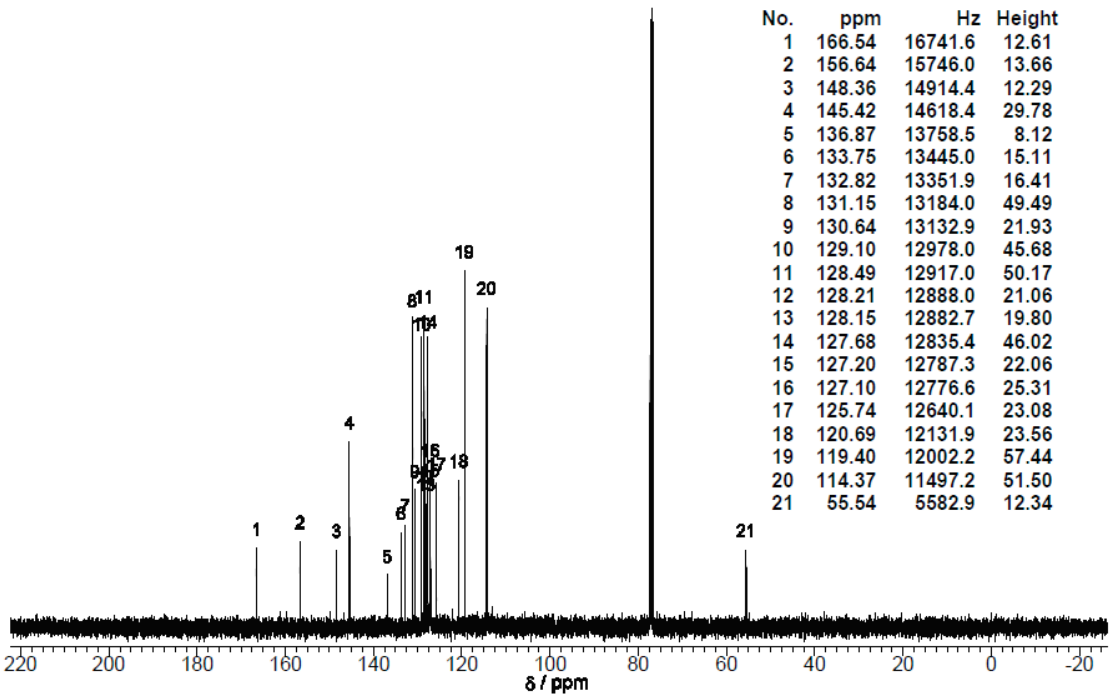


No.	ppm	Hz	Height
1	166.71	16758.4	19.02
2	150.52	15131.1	27.90
3	148.99	14976.9	18.00
4	145.46	14622.2	16.50
5	136.54	13725.7	11.54
6	133.47	13416.7	20.72
7	132.52	13322.1	17.80
8	131.04	13172.6	97.64
9	129.20	12988.0	70.22
10	129.17	12984.9	33.02
11	129.03	12971.2	72.99
12	128.54	12921.6	66.74
13	128.39	12906.3	31.96
14	128.12	12879.6	21.97
15	127.74	12841.5	68.19
16	127.38	12804.8	29.17
17	127.20	12787.3	30.30
18	125.86	12652.3	30.98
19	120.97	12160.9	33.35
20	119.43	12005.3	72.65

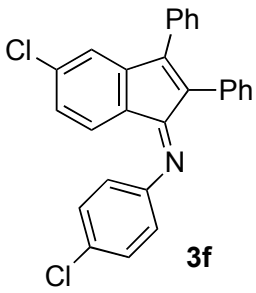


3e

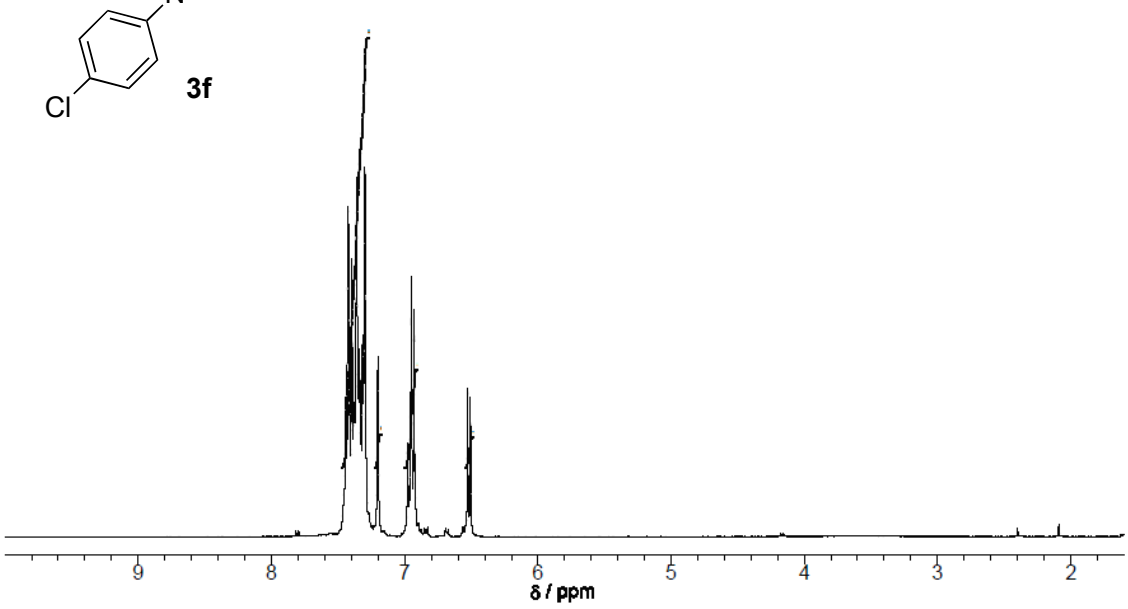


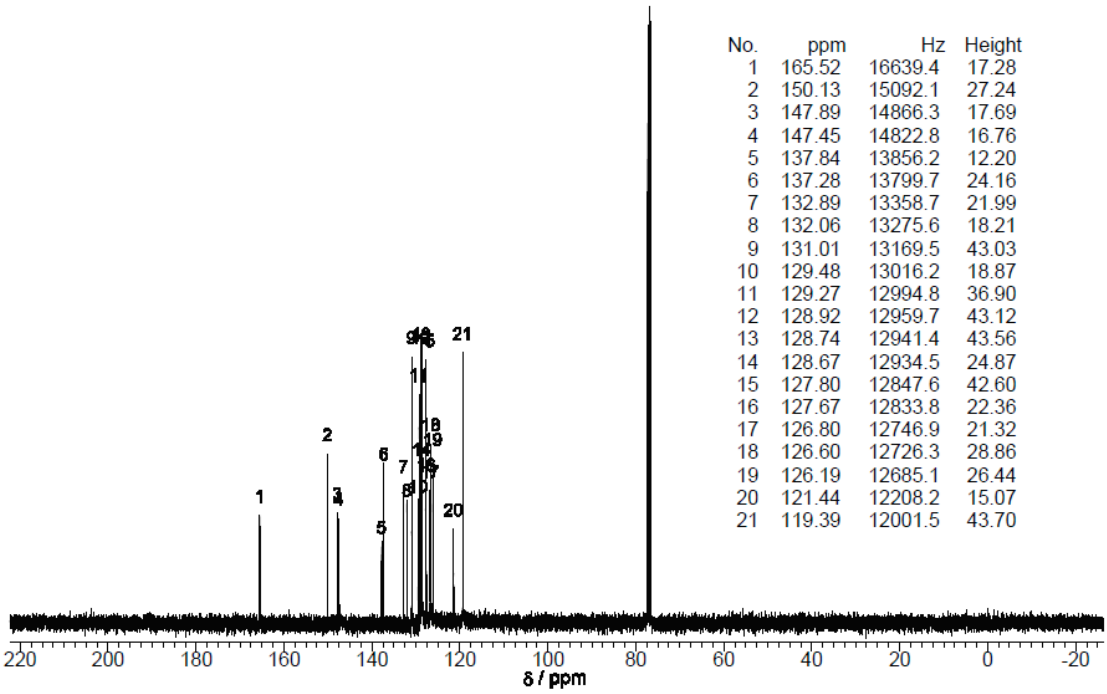


No.	ppm	Hz	Height
1	166.54	16741.6	12.61
2	156.64	15746.0	13.66
3	148.36	14914.4	12.29
4	145.42	14618.4	29.78
5	136.87	13758.5	8.12
6	133.75	13445.0	15.11
7	132.82	13351.9	16.41
8	131.15	13184.0	49.49
9	130.64	13132.9	21.93
10	129.10	12978.0	45.68
11	128.49	12917.0	50.17
12	128.21	12888.0	21.06
13	128.15	12882.7	19.80
14	127.68	12835.4	46.02
15	127.20	12787.3	22.06
16	127.10	12776.6	25.31
17	125.74	12640.1	23.08
18	120.69	12131.9	23.56
19	119.40	12002.2	57.44
20	114.37	11497.2	51.50
21	55.54	5582.9	12.34

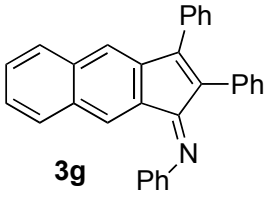


3f

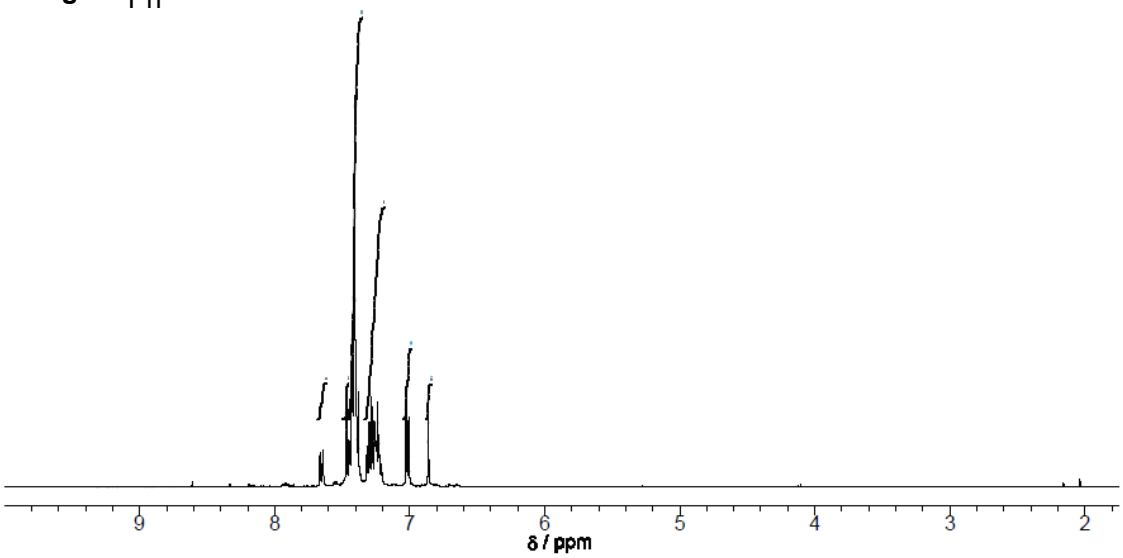


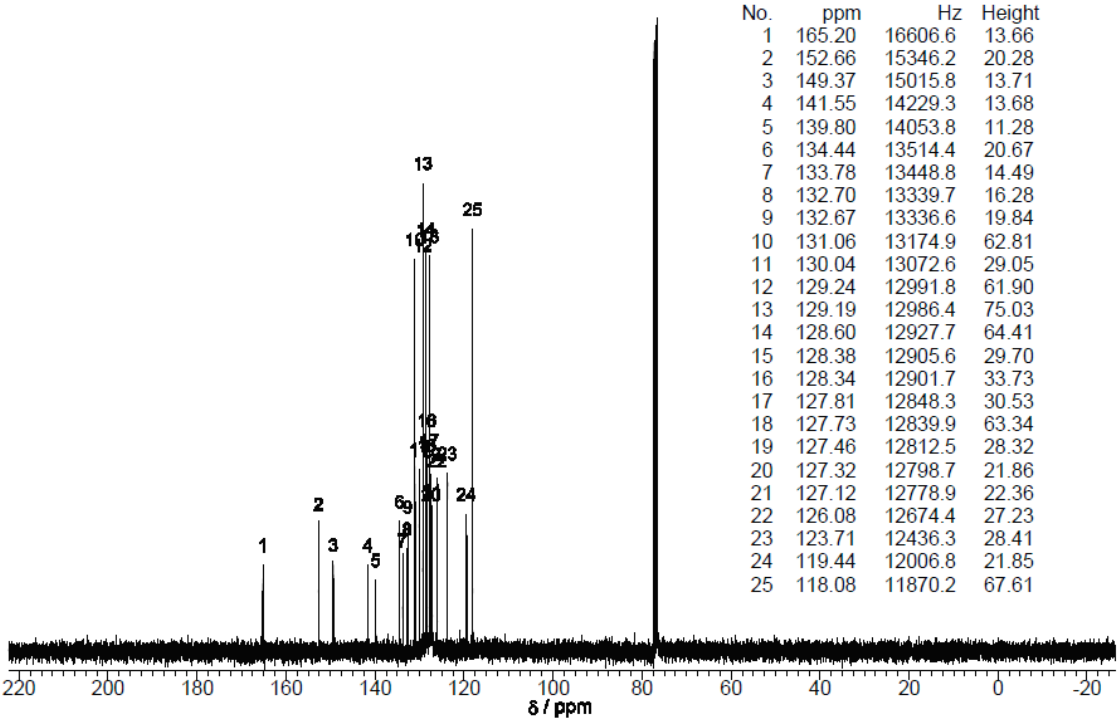


No.	ppm	Hz	Height
1	165.52	16639.4	17.28
2	150.13	15092.1	27.24
3	147.89	14866.3	17.69
4	147.45	14822.8	16.76
5	137.84	13856.2	12.20
6	137.28	13799.7	24.16
7	132.89	13358.7	21.99
8	132.06	13275.6	18.21
9	131.01	13169.5	43.03
10	129.48	13016.2	18.87
11	129.27	12994.8	36.90
12	128.92	12959.7	43.12
13	128.74	12941.4	43.56
14	128.67	12934.5	24.87
15	127.80	12847.6	42.60
16	127.67	12833.8	22.36
17	126.80	12746.9	21.32
18	126.60	12726.3	28.86
19	126.19	12685.1	26.44
20	121.44	12208.2	15.07
21	119.39	12001.5	43.70

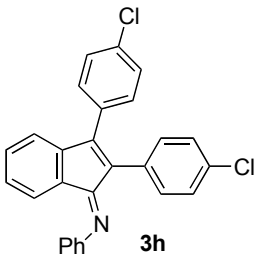


3g

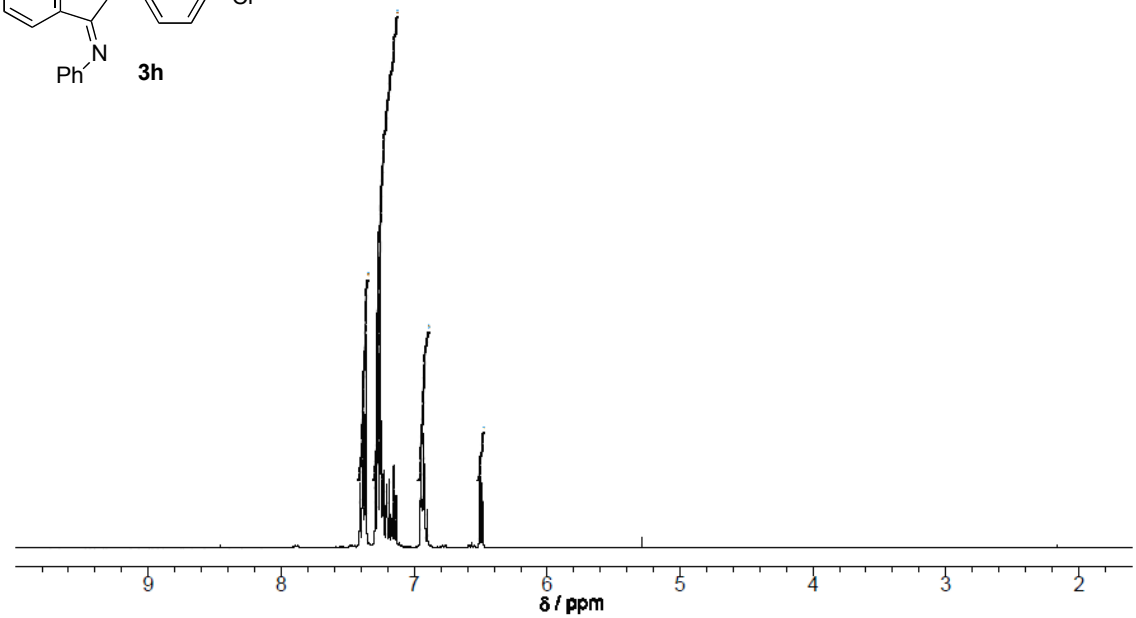




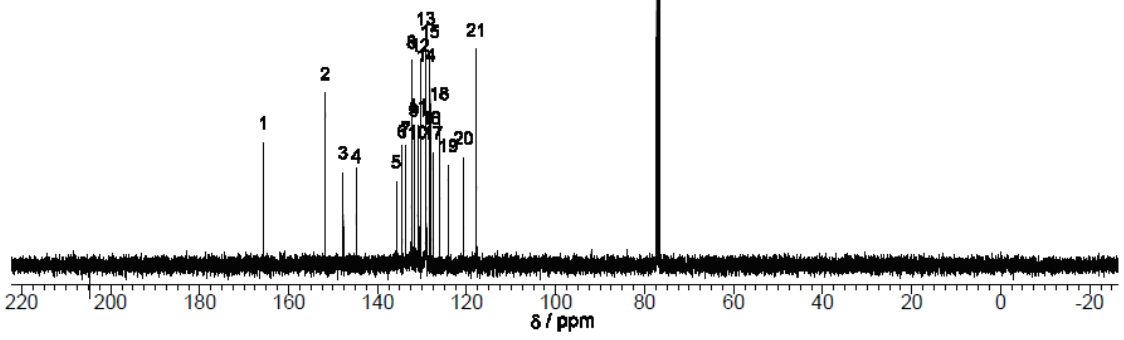
No.	ppm	Hz	Height
1	165.20	16606.6	13.66
2	152.66	15346.2	20.28
3	149.37	15015.8	13.71
4	141.55	14229.3	13.68
5	139.80	14053.8	11.28
6	134.44	13514.4	20.67
7	133.78	13448.8	14.49
8	132.70	13339.7	16.28
9	132.67	13336.6	19.84
10	131.06	13174.9	62.81
11	130.04	13072.6	29.05
12	129.24	12991.8	61.90
13	129.19	12986.4	75.03
14	128.60	12927.7	64.41
15	128.38	12905.6	29.70
16	128.34	12901.7	33.73
17	127.81	12848.3	30.53
18	127.73	12839.9	63.34
19	127.46	12812.5	28.32
20	127.32	12798.7	21.86
21	127.12	12778.9	22.36
22	126.08	12674.4	27.23
23	123.71	12436.3	28.41
24	119.44	12006.8	21.85
25	118.08	11870.2	67.61

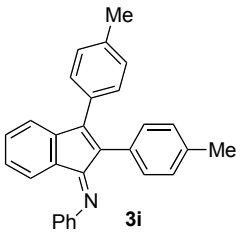


3h

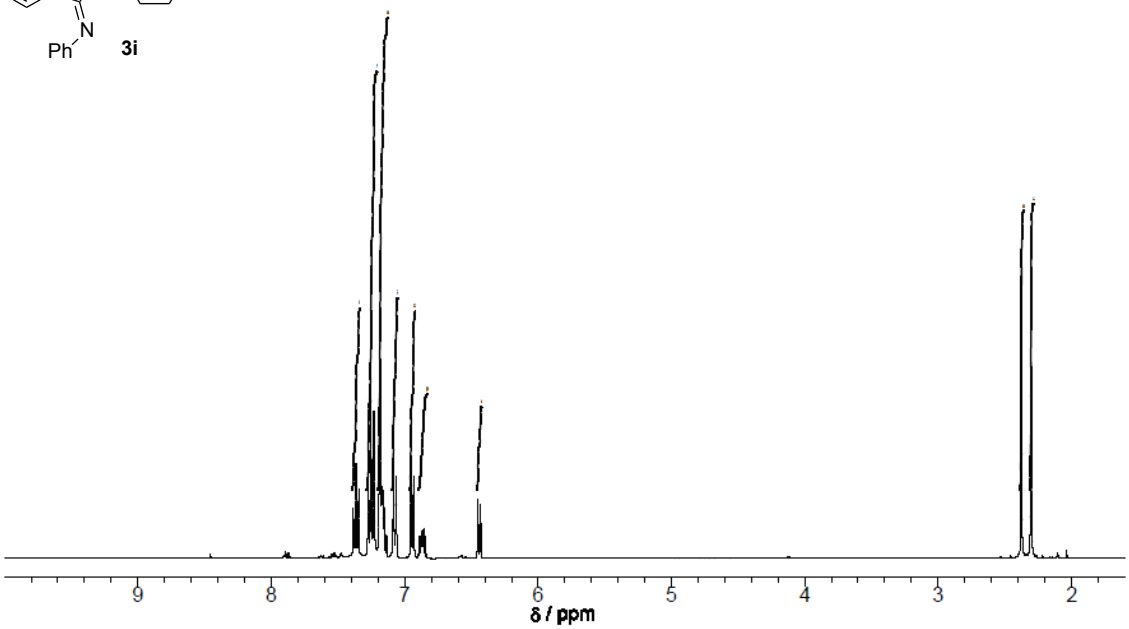


No.	ppm	Hz	Height	No.	ppm	Hz	Height
1	165.65	16651.6	19.64	16	128.02	12868.9	20.42
2	151.80	15260.0	27.58	17	127.51	12817.8	17.99
3	147.68	14845.7	14.81	18	126.08	12674.4	24.34
4	144.77	14553.5	14.27	19	124.12	12476.8	15.94
5	135.79	13650.2	13.35	20	120.65	12128.9	17.18
6	134.48	13519.0	18.25	21	117.78	11839.7	34.60
7	133.58	13428.2	18.74				
8	132.35	13304.6	32.64				
9	131.80	13248.9	21.69				
10	130.95	13164.2	18.13				
11	130.84	13152.7	22.33				
12	130.40	13108.5	32.07				
13	129.17	12984.9	36.44				
14	129.06	12974.2	30.55				
15	128.18	12885.7	34.32				

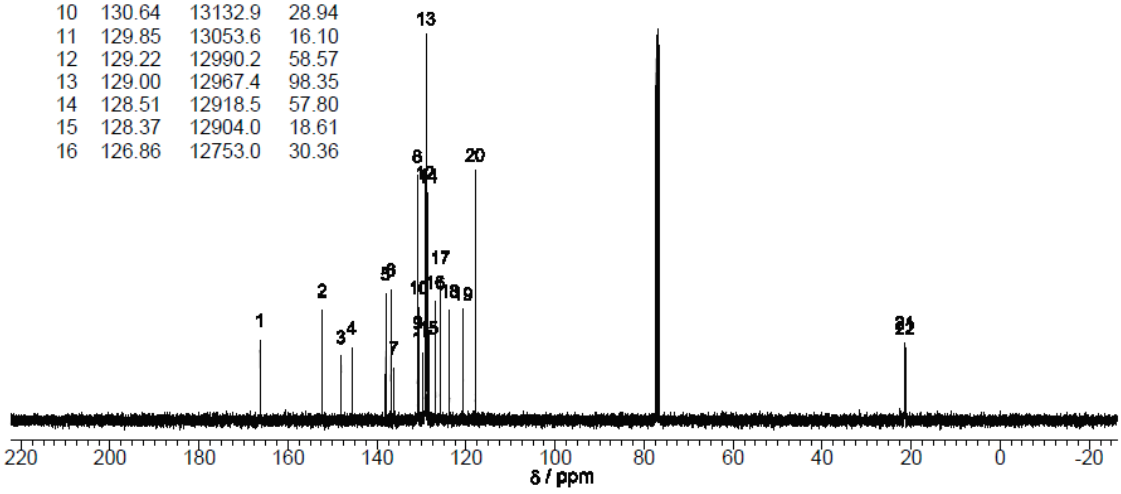


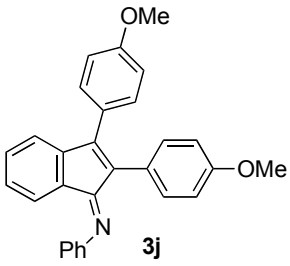


3i

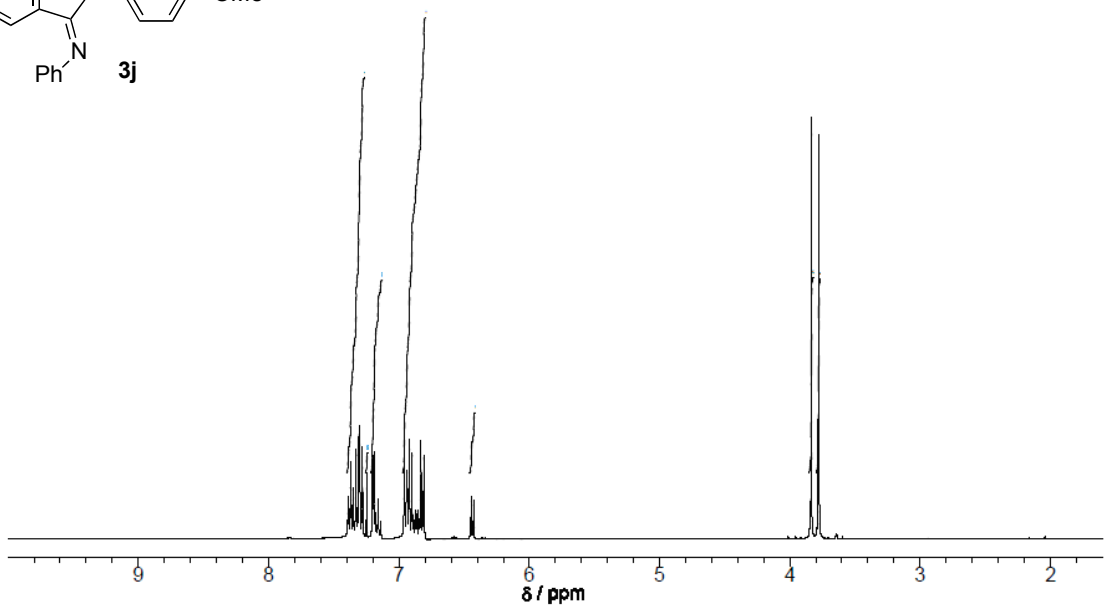


No.	ppm	Hz	Height	No.	ppm	Hz	Height
1	166.31	16718.0	20.54	17	125.81	12646.9	36.74
2	152.29	15308.8	28.15	18	123.70	12434.8	28.14
3	148.06	14883.9	16.21	19	120.66	12129.6	27.28
4	145.67	14643.5	18.53	20	117.92	11853.5	63.19
5	138.07	13879.1	32.47	21	21.41	2151.9	19.85
6	136.90	13761.6	33.44	22	21.31	2142.0	18.52
7	136.28	13699.8	13.38				
8	130.95	13163.4	62.90				
9	130.78	13146.6	19.95				
10	130.64	13132.9	28.94				
11	129.85	13053.6	16.10				
12	129.22	12990.2	58.57				
13	129.00	12967.4	98.35				
14	128.51	12918.5	57.80				
15	128.37	12904.0	18.61				
16	126.86	12753.0	30.36				

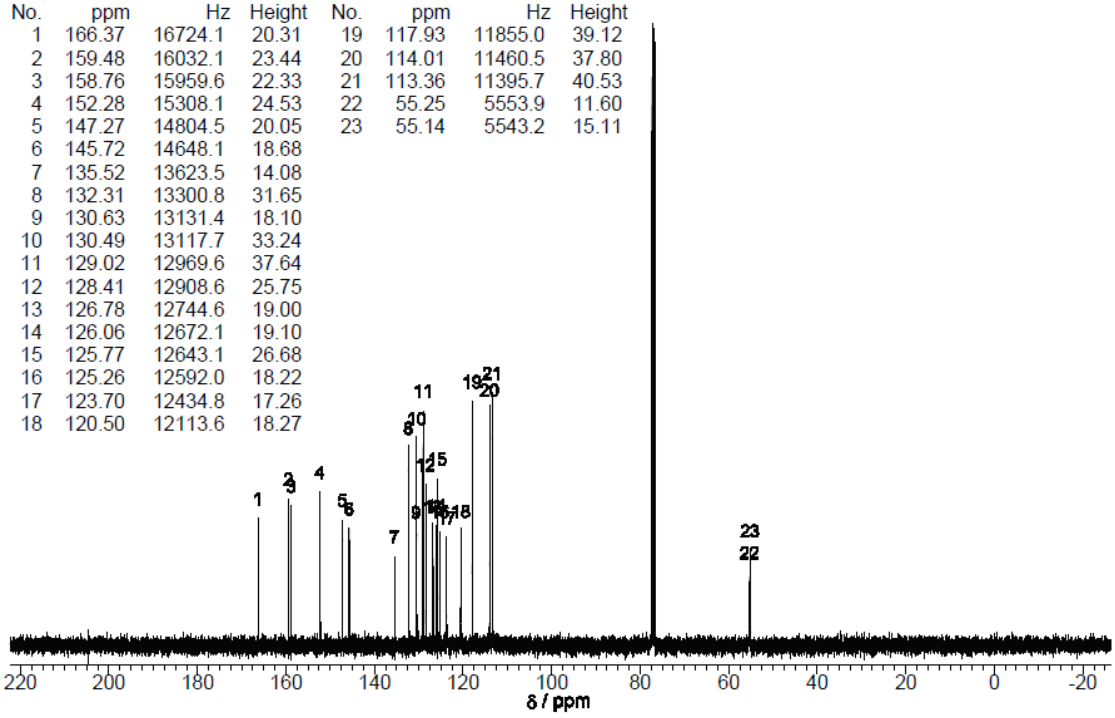


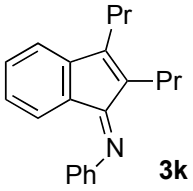


3j

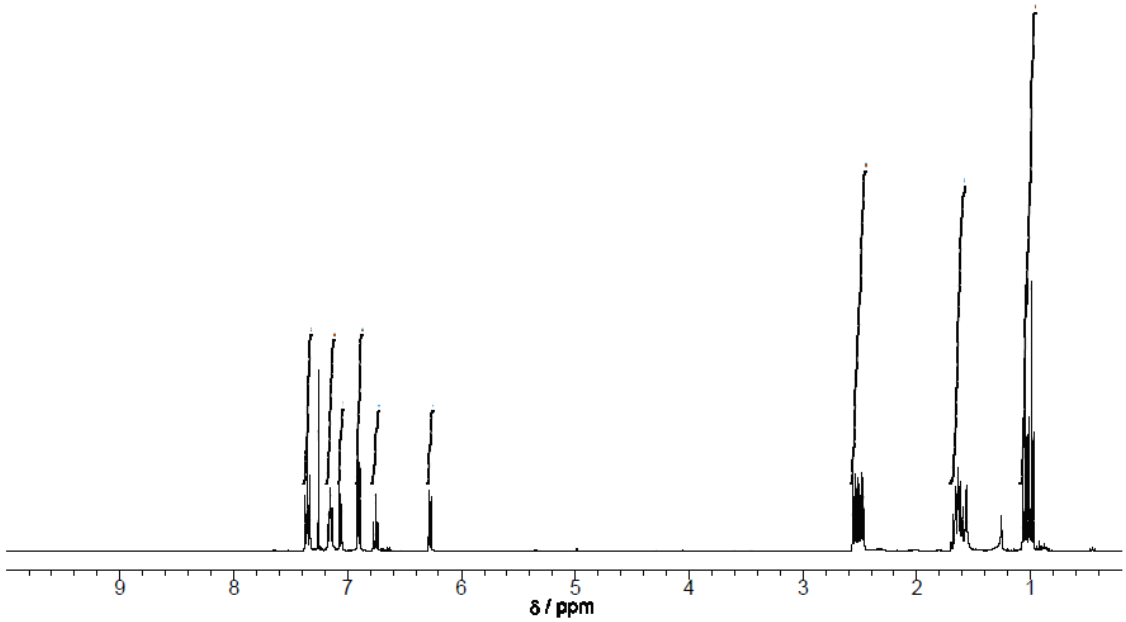


No.	ppm	Hz	Height	No.	ppm	Hz	Height
1	166.37	16724.1	20.31	19	117.93	11855.0	39.12
2	159.48	16032.1	23.44	20	114.01	11460.5	37.80
3	158.76	15959.6	22.33	21	113.36	11395.7	40.53
4	152.28	15308.1	24.53	22	55.25	5553.9	11.60
5	147.27	14804.5	20.05	23	55.14	5543.2	15.11
6	145.72	14648.1	18.68				
7	135.52	13623.5	14.08				
8	132.31	13300.8	31.65				
9	130.63	13131.4	18.10				
10	130.49	13117.7	33.24				
11	129.02	12969.6	37.64				
12	128.41	12908.6	25.75				
13	126.78	12744.6	19.00				
14	126.06	12672.1	19.10				
15	125.77	12643.1	26.68				
16	125.26	12592.0	18.22				
17	123.70	12434.8	17.26				
18	120.50	12113.6	18.27				

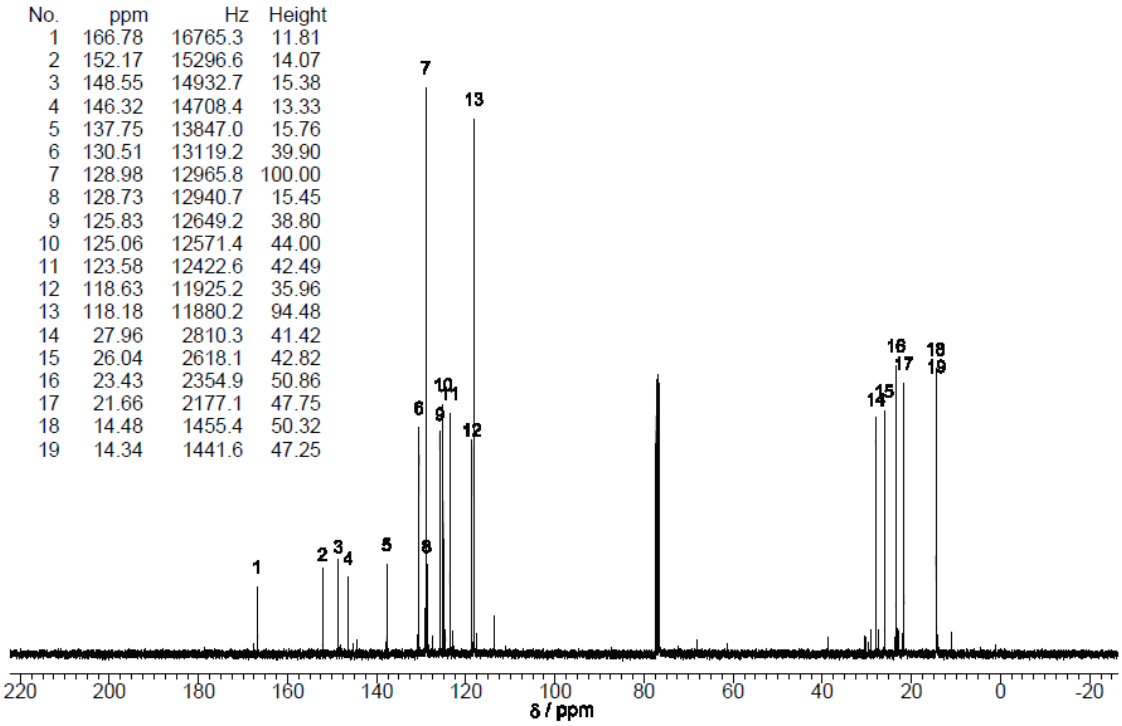


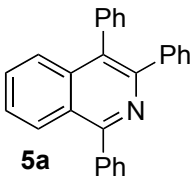


3k

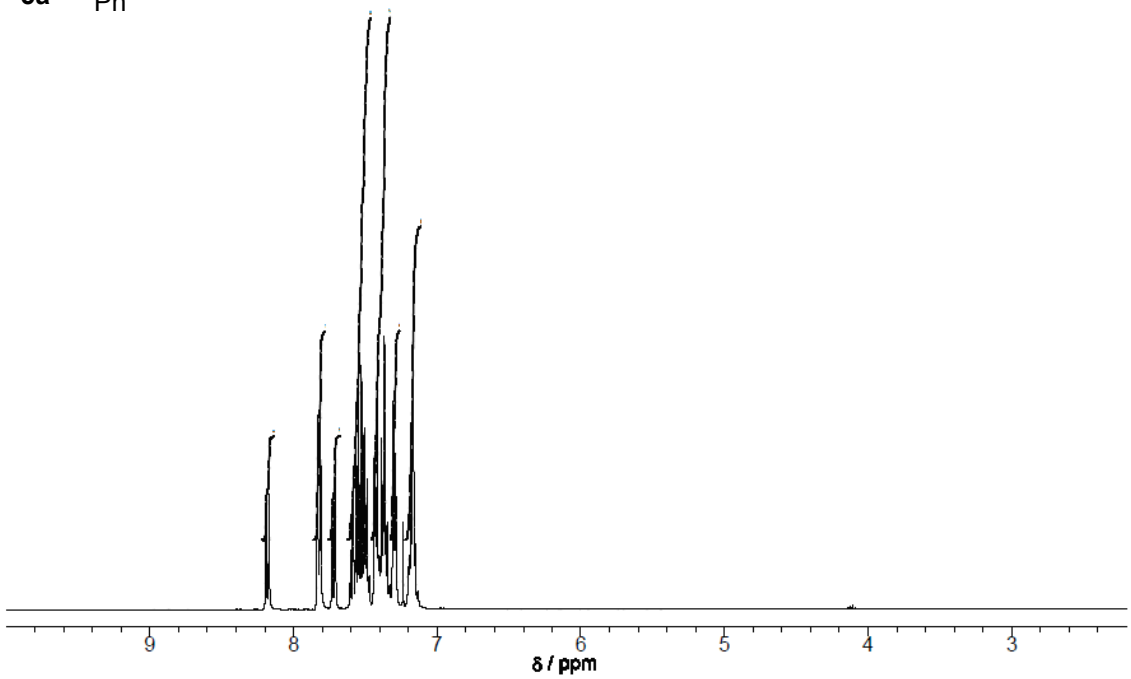


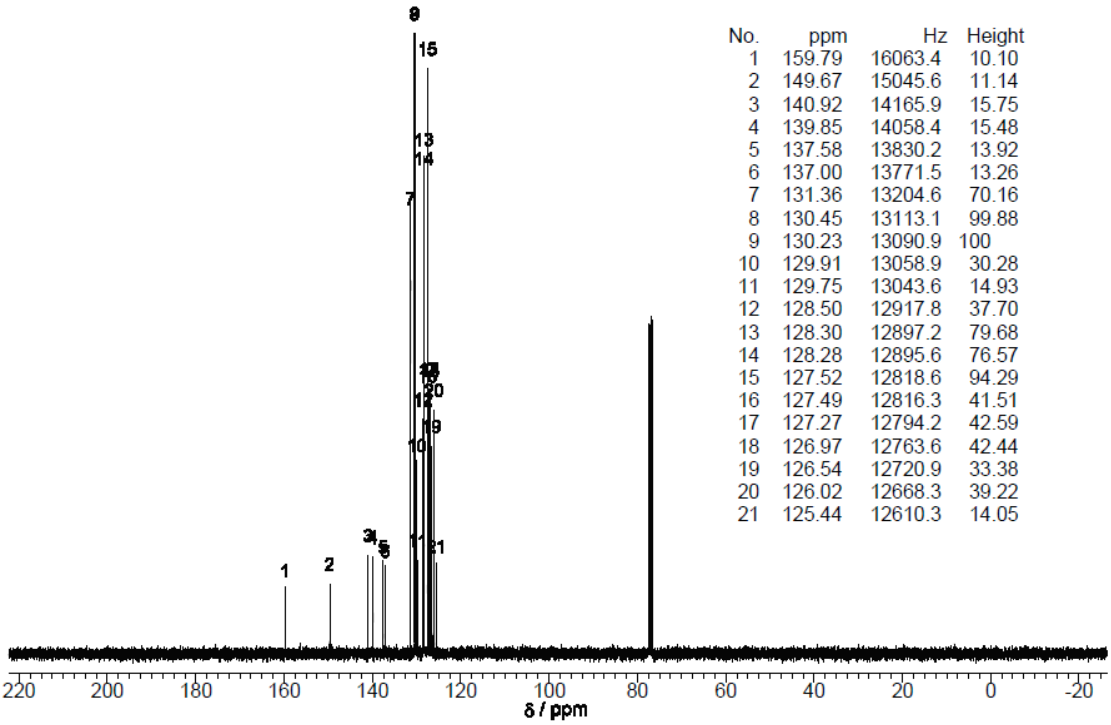
No.	ppm	Hz	Height
1	166.78	16765.3	11.81
2	152.17	15296.6	14.07
3	148.55	14932.7	15.38
4	146.32	14708.4	13.33
5	137.75	13847.0	15.76
6	130.51	13119.2	39.90
7	128.98	12965.8	100.00
8	128.73	12940.7	15.45
9	125.83	12649.2	38.80
10	125.06	12571.4	44.00
11	123.58	12422.6	42.49
12	118.63	11925.2	35.96
13	118.18	11880.2	94.48
14	27.96	2810.3	41.42
15	26.04	2618.1	42.82
16	23.43	2354.9	50.86
17	21.66	2177.1	47.75
18	14.48	1455.4	50.32
19	14.34	1441.6	47.25



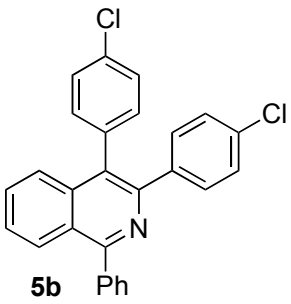


5a

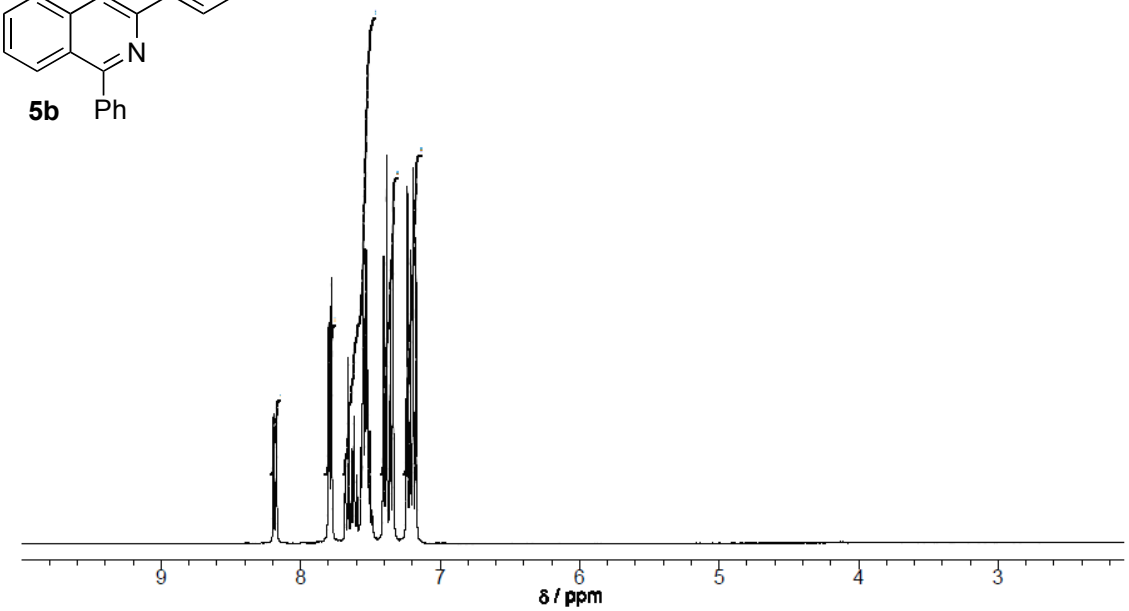


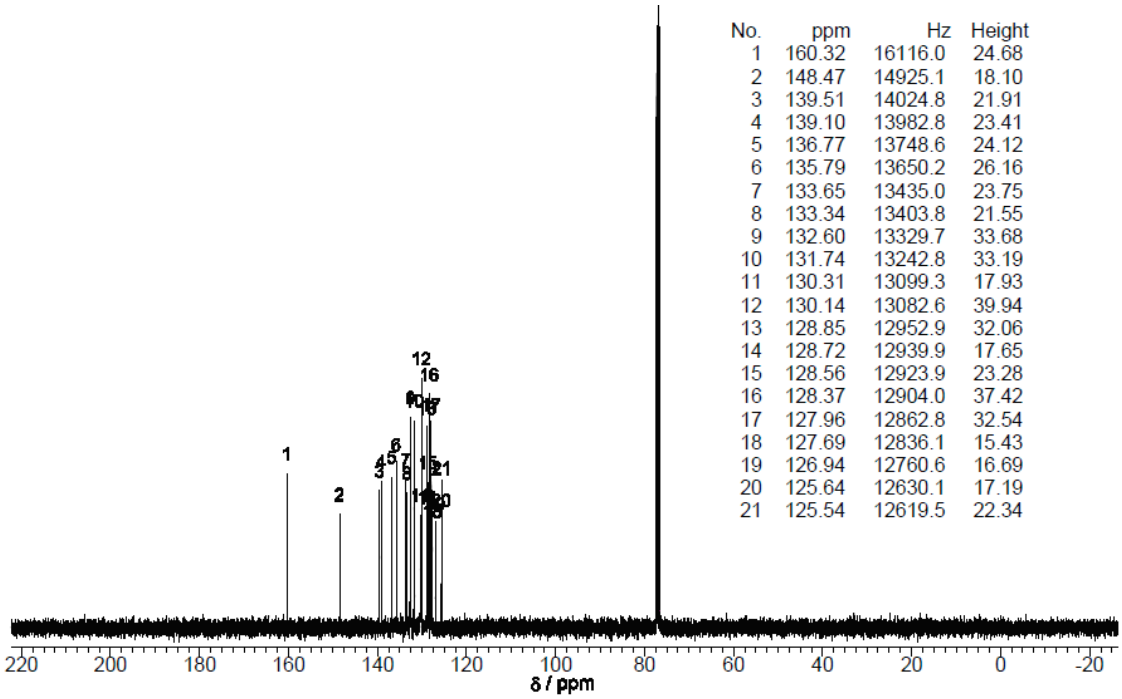


No.	ppm	Hz	Height
1	159.79	16063.4	10.10
2	149.67	15045.6	11.14
3	140.92	14165.9	15.75
4	139.85	14058.4	15.48
5	137.58	13830.2	13.92
6	137.00	13771.5	13.26
7	131.36	13204.6	70.16
8	130.45	13113.1	99.88
9	130.23	13090.9	100
10	129.91	13058.9	30.28
11	129.75	13043.6	14.93
12	128.50	12917.8	37.70
13	128.30	12897.2	79.68
14	128.28	12895.6	76.57
15	127.52	12818.6	94.29
16	127.49	12816.3	41.51
17	127.27	12794.2	42.59
18	126.97	12763.6	42.44
19	126.54	12720.9	33.38
20	126.02	12668.3	39.22
21	125.44	12610.3	14.05

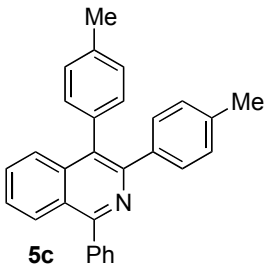


5b

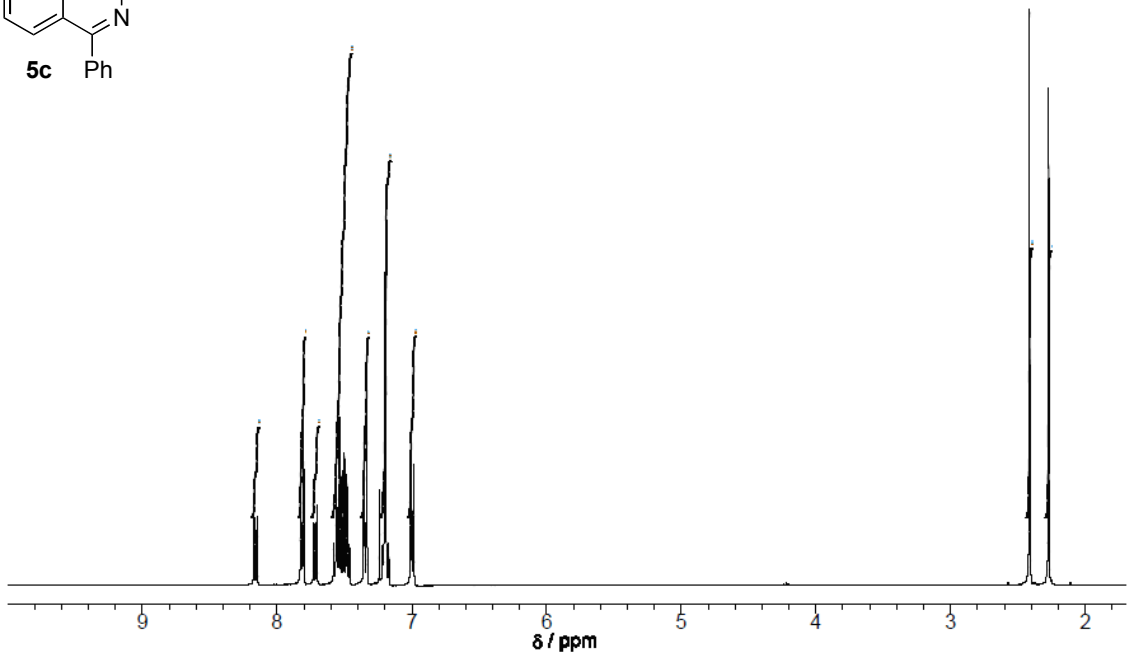




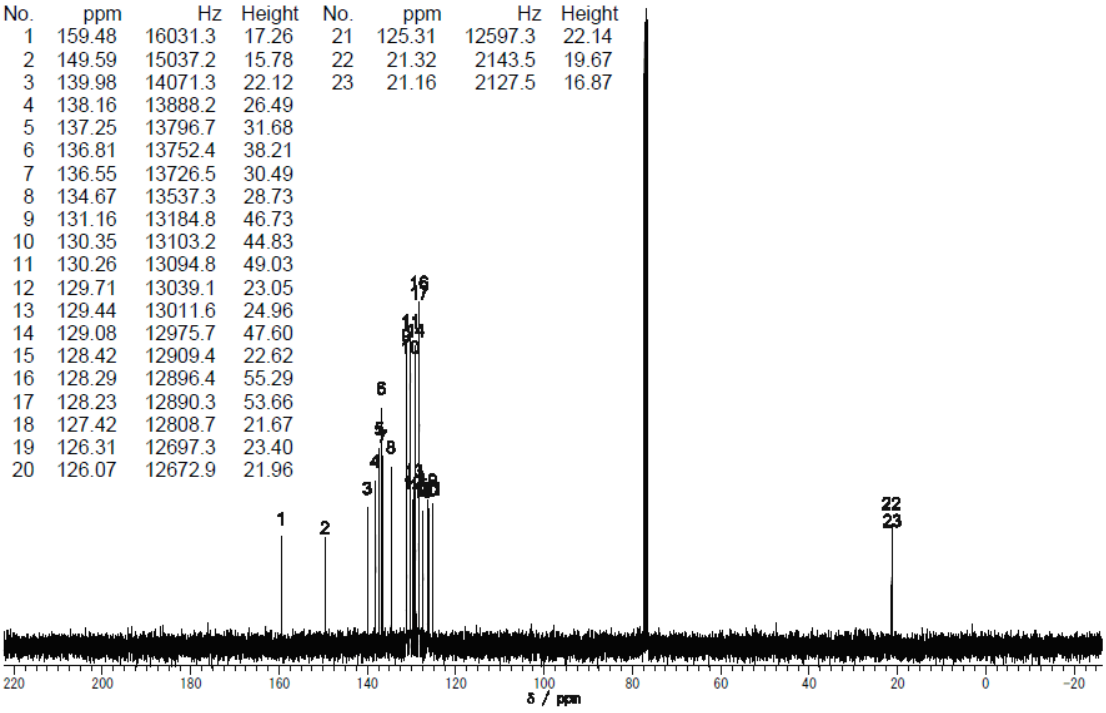
No.	ppm	Hz	Height
1	160.32	16116.0	24.68
2	148.47	14925.1	18.10
3	139.51	14024.8	21.91
4	139.10	13982.8	23.41
5	136.77	13748.6	24.12
6	135.79	13650.2	26.16
7	133.65	13435.0	23.75
8	133.34	13403.8	21.55
9	132.60	13329.7	33.68
10	131.74	13242.8	33.19
11	130.31	13099.3	17.93
12	130.14	13082.6	39.94
13	128.85	12952.9	32.06
14	128.72	12939.9	17.65
15	128.56	12923.9	23.28
16	128.37	12904.0	37.42
17	127.96	12862.8	32.54
18	127.69	12836.1	15.43
19	126.94	12760.6	16.69
20	125.64	12630.1	17.19
21	125.54	12619.5	22.34

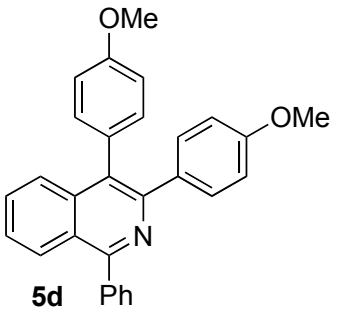


5c

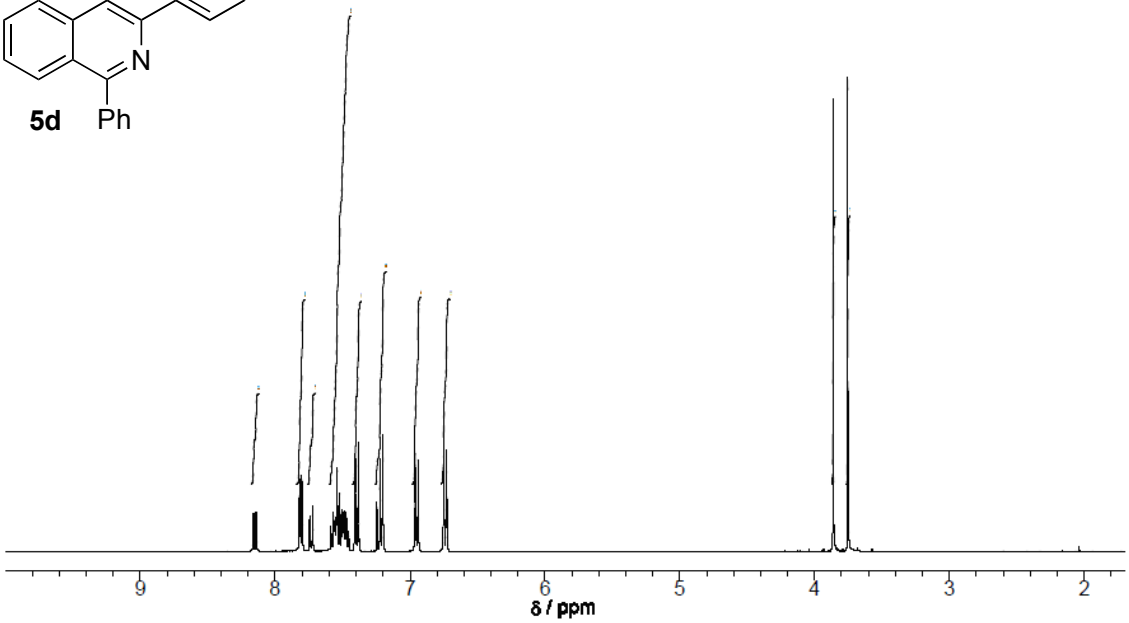


No.	ppm	Hz	Height	No.	ppm	Hz	Height
1	159.48	16031.3	17.26	21	125.31	12597.3	22.14
2	149.59	15037.2	15.78	22	21.32	2143.5	19.67
3	139.98	14071.3	22.12	23	21.16	2127.5	16.87
4	138.16	13888.2	26.49				
5	137.25	13796.7	31.68				
6	136.81	13752.4	38.21				
7	136.55	13726.5	30.49				
8	134.67	13537.3	28.73				
9	131.16	13184.8	46.73				
10	130.35	13103.2	44.83				
11	130.26	13094.8	49.03				
12	129.71	13039.1	23.05				
13	129.44	13011.6	24.96				
14	129.08	12975.7	47.60				
15	128.42	12909.4	22.62				
16	128.29	12896.4	55.29				
17	128.23	12890.3	53.66				
18	127.42	12808.7	21.67				
19	126.31	12697.3	23.40				
20	126.07	12672.9	21.96				

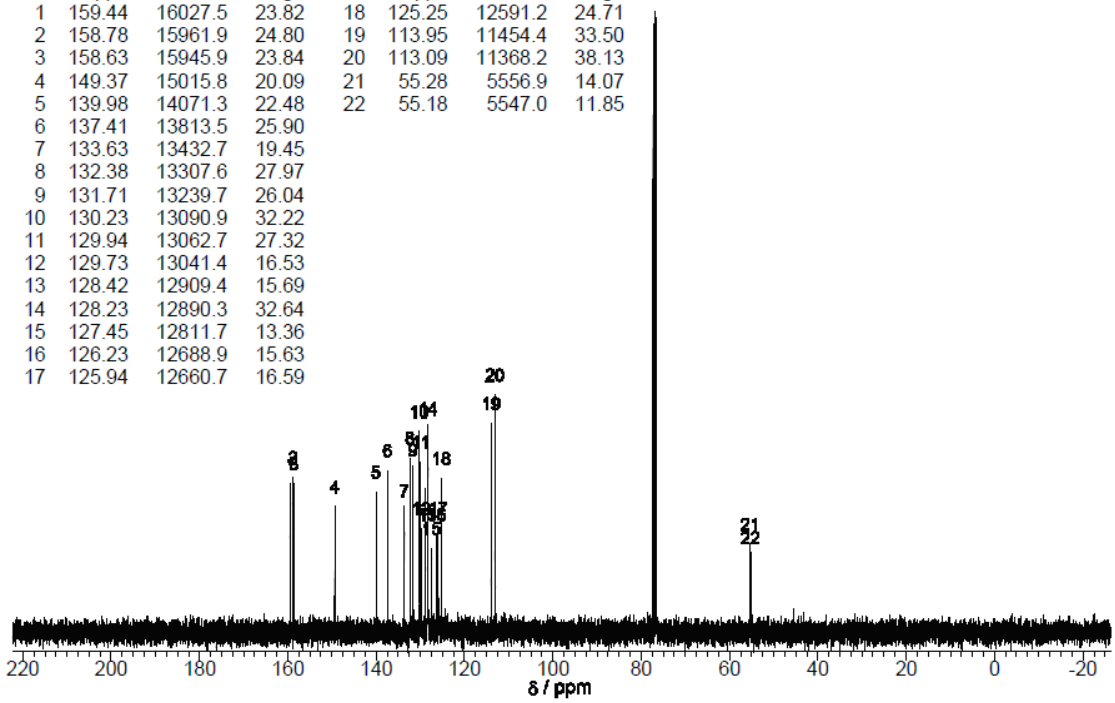


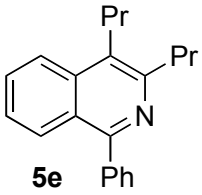


5d

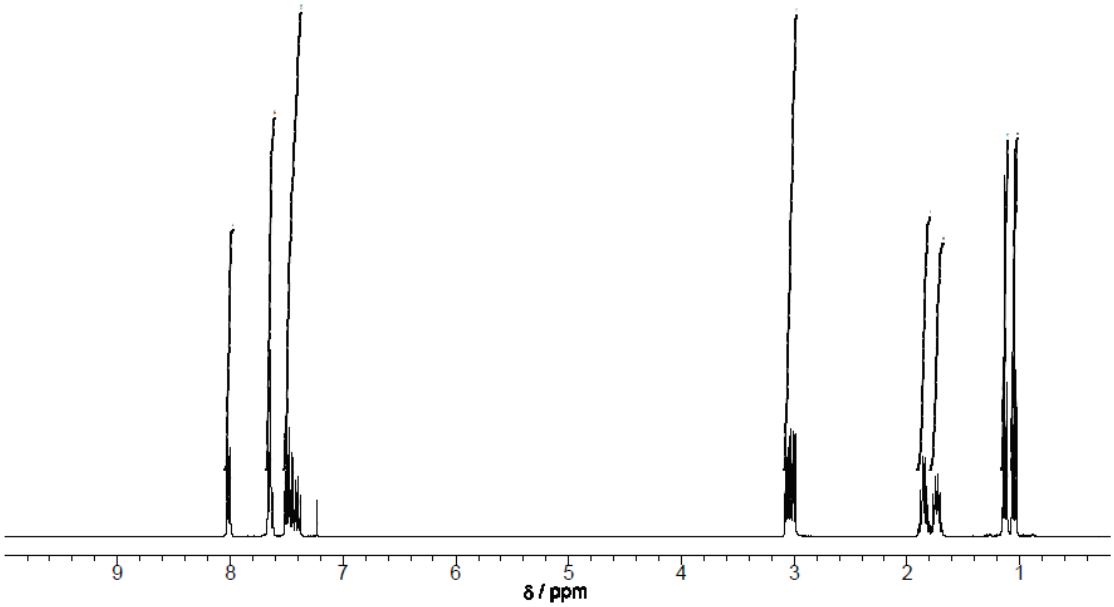


No.	ppm	Hz	Height	No.	ppm	Hz	Height
1	159.44	16027.5	23.82	18	125.25	12591.2	24.71
2	158.78	15961.9	24.80	19	113.95	11454.4	33.50
3	158.63	15945.9	23.84	20	113.09	11368.2	38.13
4	149.37	15015.8	20.09	21	55.28	5556.9	14.07
5	139.98	14071.3	22.48	22	55.18	5547.0	11.85
6	137.41	13813.5	25.90				
7	133.63	13432.7	19.45				
8	132.38	13307.6	27.97				
9	131.71	13239.7	26.04				
10	130.23	13090.9	32.22				
11	129.94	13062.7	27.32				
12	129.73	13041.4	16.53				
13	128.42	12909.4	15.69				
14	128.23	12890.3	32.64				
15	127.45	12811.7	13.36				
16	126.23	12688.9	15.63				
17	125.94	12660.7	16.59				

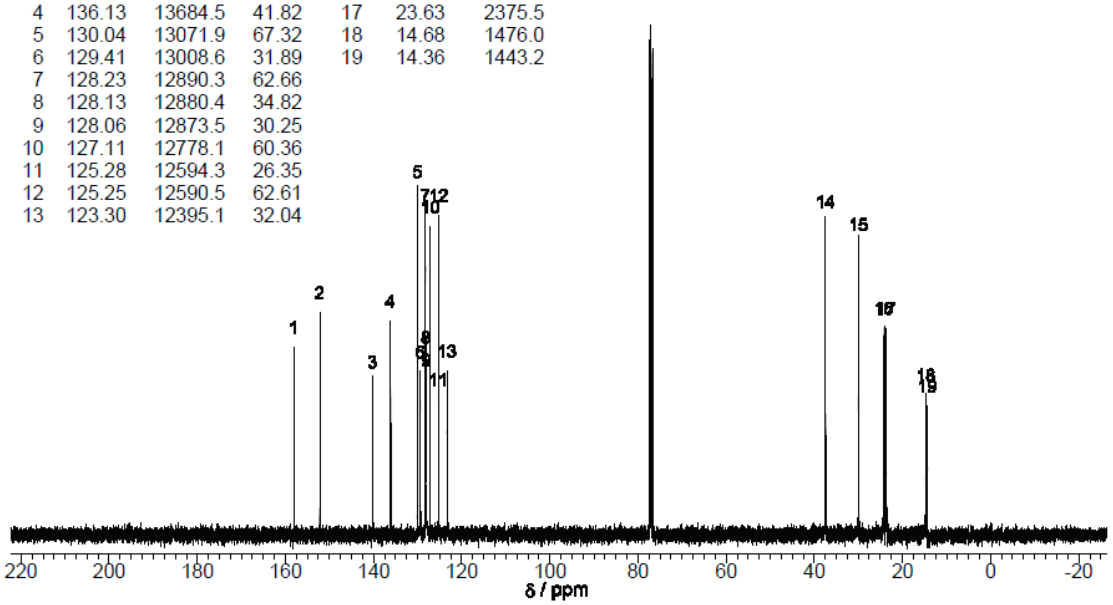


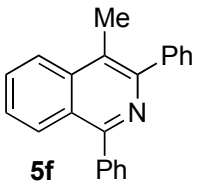


5e

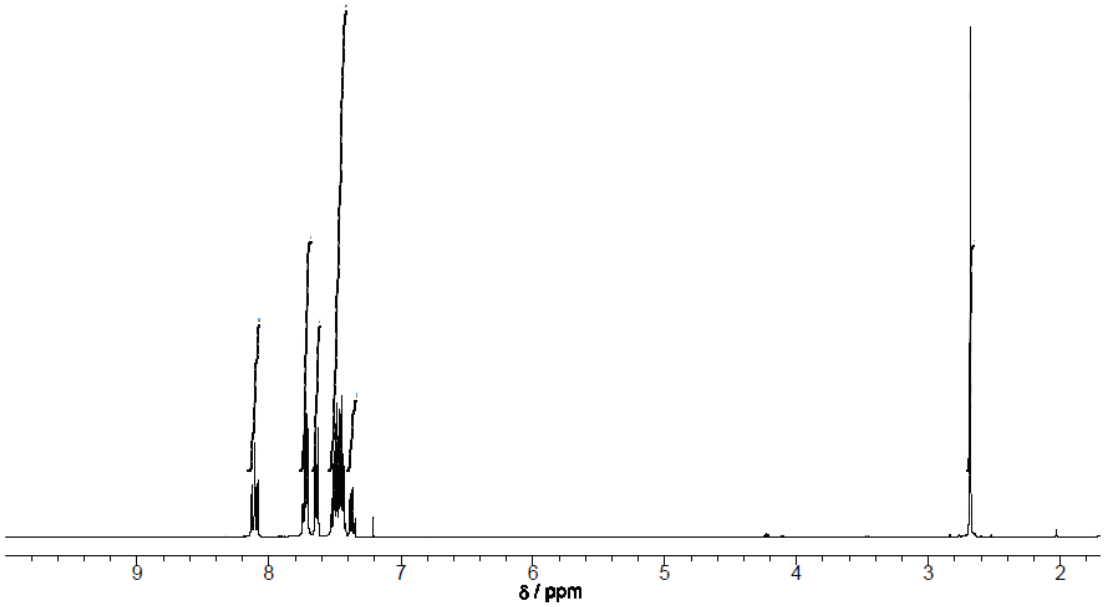


No.	ppm	Hz	Height	No.	ppm	Hz
1	158.07	15890.2	36.65	14	37.41	3761.0
2	152.26	15305.8	43.46	15	29.98	3013.3
3	140.20	14093.5	29.94	16	24.14	2426.6
4	136.13	13684.5	41.82	17	23.63	2375.5
5	130.04	13071.9	67.32	18	14.68	1476.0
6	129.41	13008.6	31.89	19	14.36	1443.2
7	128.23	12890.3	62.66			
8	128.13	12880.4	34.82			
9	128.06	12873.5	30.25			
10	127.11	12778.1	60.36			
11	125.28	12594.3	26.35			
12	125.25	12590.5	62.61			
13	123.30	12395.1	32.04			

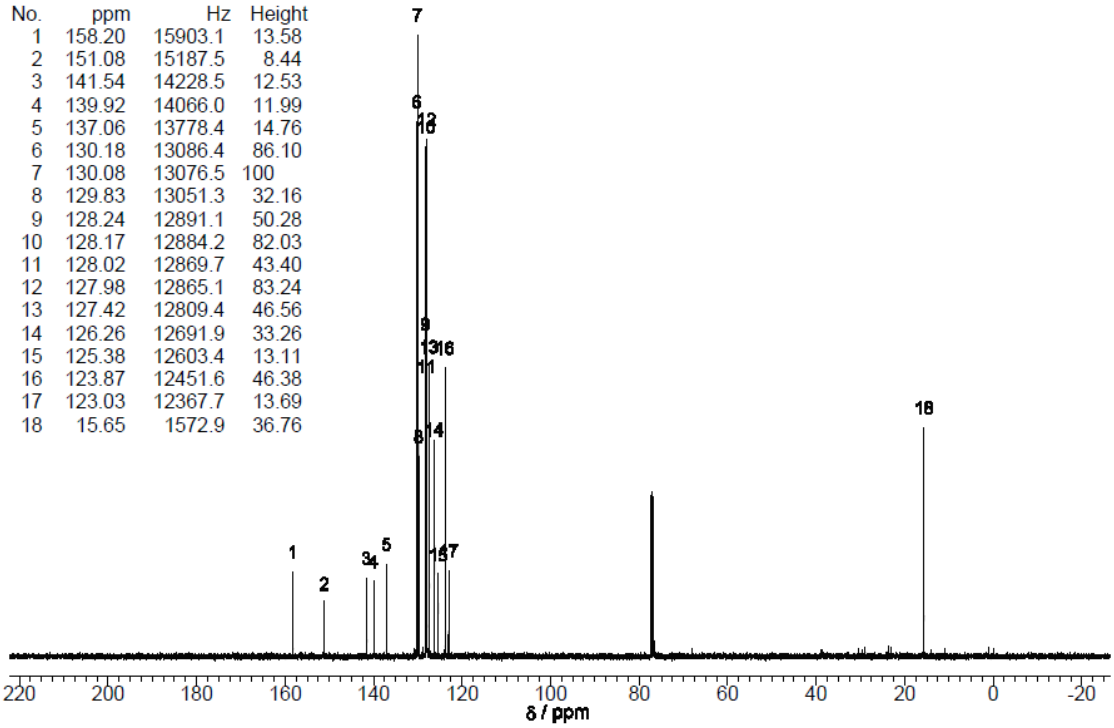


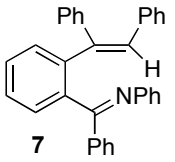


5f

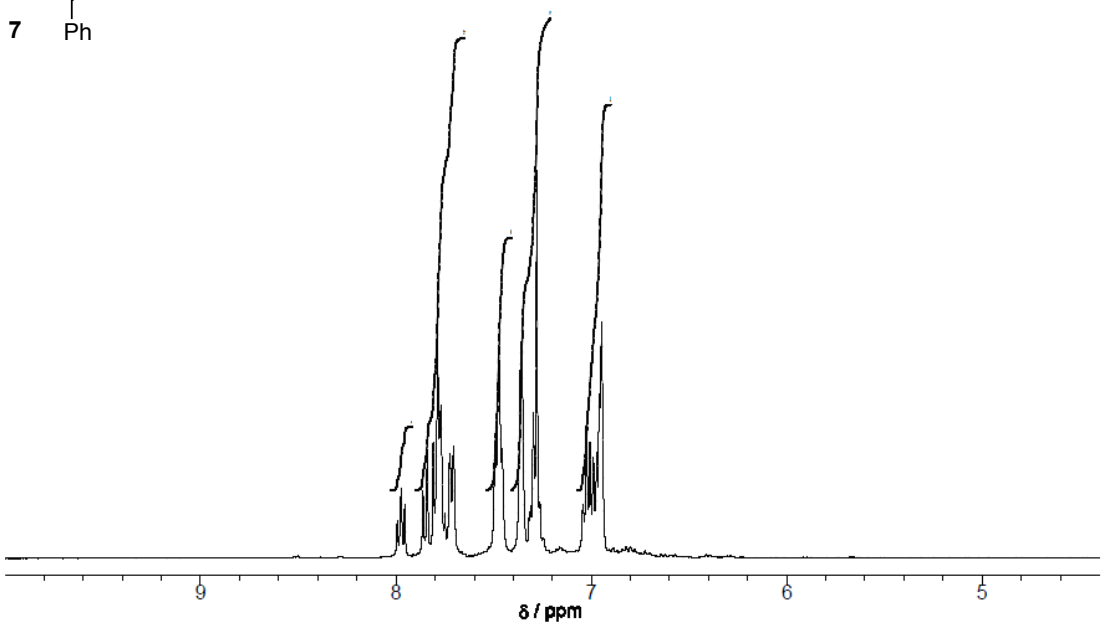


No.	ppm	Hz	Height
1	158.20	15903.1	13.58
2	151.08	15187.5	8.44
3	141.54	14228.5	12.53
4	139.92	14066.0	11.99
5	137.06	13778.4	14.76
6	130.18	13086.4	86.10
7	130.08	13076.5	100
8	129.83	13051.3	32.16
9	128.24	12891.1	50.28
10	128.17	12884.2	82.03
11	128.02	12869.7	43.40
12	127.98	12865.1	83.24
13	127.42	12809.4	46.56
14	126.26	12691.9	33.26
15	125.38	12603.4	13.11
16	123.87	12451.6	46.38
17	123.03	12367.7	13.69
18	15.65	1572.9	36.76





7



No.	ppm	Hz	Heigh
1	160.13	15938.2	6.70
2	145.59	14491.4	7.81
3	140.72	14006.7	7.89
4	139.17	13852.2	9.73
5	138.75	13810.3	6.78
6	136.39	13575.2	14.94
7	133.97	13334.7	11.14
8	132.33	13171.8	7.31
9	131.68	13106.4	20.14
10	131.15	13053.8	16.10
11	130.91	13030.3	12.40
12	130.60	12999.0	55.12
13	130.45	12984.6	11.89
14	130.08	12947.3	15.78
15	129.22	12862.1	15.60
16	128.82	12822.5	21.18
17	128.53	12792.8	13.59
18	128.28	12768.5	15.85
19	128.26	12766.2	36.34
20	128.14	12754.8	11.16
21	128.13	12753.2	36.81
22	128.11	12751.7	31.60
23	127.28	12668.8	24.69
24	126.99	12639.8	13.74