Supporting Information for

Cu/Nitroxyl Catalyzed Aerobic Oxidation of Primary Amines into Nitriles at Room Temperature

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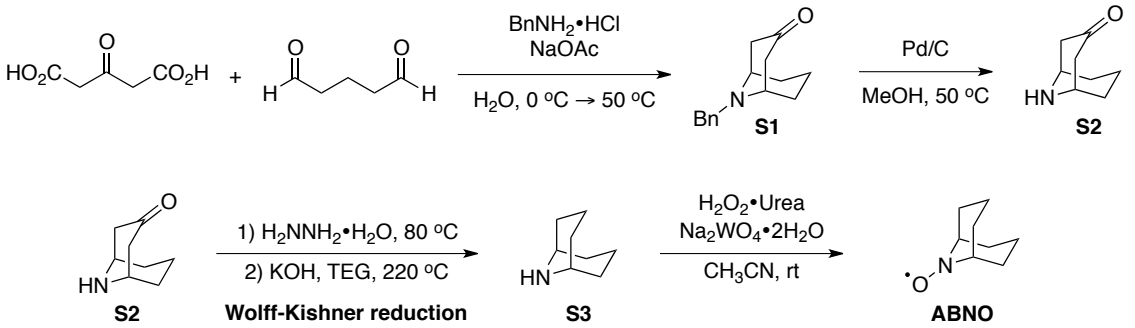
1. General Considerations.

All commercially available compounds and solvents were purchased and used as received, unless otherwise noted. ^{1}H and ^{13}C NMR spectra were recorded on Bruker Avance III 400 or Bruker Avance III 500 spectrometer. Chemical shift values are given in parts per million relative to internal TMS (0.00 ppm for ^{1}H) or $CDCl_3$ (77.16 ppm for ^{13}C). The following abbreviations were used to describe peak splitting patterns when appropriate: br = broad, s = singlet, d = doublet, t = triplet, q = quartet, p = pentet, m = multiplet, dd = double of doublet, dt = double of triplet, td = triple of doublet. Coupling constants, *J*, were reported in hertz unit (Hz). Analytical thin layer chromatography (TLC) was performed on precoated silica gel 60 F254 plates. Visualization on TLC was achieved by the use of UV light (254 nm) and treatment with phosphomolybdic acid stain followed by heating. Flash chromatography was performed using SiliaFlash® P60 (Silicycle, particle size 40-63 um, 230-400 mesh). High-resolution mass spectra were obtained by the mass spectrometry facility at the University of Wisconsin.

2. The synthesis of ABNO (9-azabicyclo[3.3.1]nonane *N*-oxyl).[1]



To a mixture of acetonedicarboxylic acid (2.9 g, 20 mmol, 1 equiv) and benzylamine hydrochloride (3.4 g, 24 mmol, 1.2 equiv) with H_2O (10 mL) in a 250 mL flask, was slowly added NaOAc aqueous solution (0.8 g, 10 mmol, 0.5 equiv in 7 mL of H_2O) at 0 °C. Then, glutaraldehyde (25% in water, 8 mL, 20 mmol) was added. After the removal of the ice bath, the mixture was stirred for 2 hours at room temperature then stirred for 12 hours at 50 °C. The mixture was cooled to room temperature. The mixture was extracted with CH_2Cl_2 several times. The combined organic layer was washed with brine and dried over $MgSO_4$, filtered, and concentrated in *vacuo*. The residue was purified by column chromatography using ethyl acetate/hexane (1/3) to give **S1** as a brown solid in 84% yield (3.84 g, 16.8 mmol).

A 250 mL flask which was equipped with a magnetic stir bar and charged with **S1** (3.84 g, 16.8 mmol) and Pd/C (5 % Pd, 5 mol %, 2 g) was evacuated and backfilled with hydrogen. 100 mL of MeOH was added. The reaction mixture was stirred at 50 °C for 24 hours under a hydrogen balloon, and then cooled to room temperature. The black suspension was filtered over Celite and washed with MeOH thoroughly. All volatiles were removed under reduced pressure to afford pure deprotected amine **S2** in 89% yield.

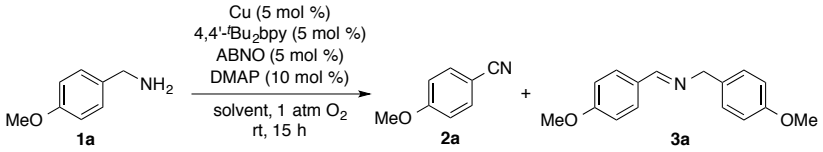
The mixture of **S2** (2.1 g, 15 mmol) and $H_2NNH_2{\cdot}H_2O$ (2.5 mL, 45.1 mmol, 3 equiv) was stirred at 80 °C for 2 h. To a solution of KOH (8.4 g, 150 mmol, 10 equiv) in triethyleneglycol (21 mL) in three-neck round bottom flask setting up distillation apparatus, the solution of **S2** and $H_2NNH_2{\cdot}H_2O$ was added dropwise. After the mixture was stirred at 220 °C for 30 min, H_2O (50 mL) was added dropwise over 2 h at 220 °C. During the reaction, the product, amine **S3**, was distillated with H_2O under azeotropic condition. The resulting aqueous solution was extracted with CH_2Cl_2 and dried over $MgSO_4$. Evaporation of the solvent afforded **S3** (1.48 g) as a colorless oil, which was used in the next reaction without further purification.

To a solution of the crude **S3** (1.48 g) in MeCN (10 mL) was added $Na_2WO_4{\cdot}H_2O$ (0.39 g, 1.18 mmol, 0.1 equiv) at ambient temperature and the mixture was stirred for 30 min. After cooling to 0 °C, urea hydrogen peroxide (3.3 g, 35.4 mmol, 3 equiv) was added and the reaction mixture was stirred at 0 °C for 1 h and at ambient temperature for 4 h. H_2O was added to the reaction mixture and the aqueous solution was extracted with CH_2Cl_2. The organic layer was dried over $MgSO_4$ and concentrated. The residue was purified by silica gel column chromatography using ethyl acetate/hexane (1/1) to yield ABNO (1.15 g, 8.2 mmol) as a red solid.

3. Optimization of Cu/nitroxyl catalyzed oxidation of primary amines to nitriles.

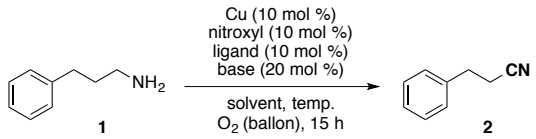
Optimization for benzylamines (Table 1) A 16 mm culture tube, which was equipped with a magnetic stir bar and charged with Cu (0.025 mmol), nitroxyl (0.025 mmol), ligand (0.025 mmol) and base (0.05 mmol) was evacuated and backfilled with oxygen (this process was repeated a total of 3 times). 4-methoxybenzylamine (0.5 mmol) was added with CH_3CN (2.0 mL). The solution was stirred for 15 h at room temperature under O_2 balloon, then the reaction was diluted by adding EtOAc and aqueous NH_4Cl solution. Two layers were separated, and the aqueous layer was extracted with EtOAc. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated in *vacuo*. The ^1H NMR yield of desired product was determined by integration using an internal standard (1,1,2,2-tetrachloroethane).

Table S1. Solvent effect on Cu/ABNO-catalyzed amine oxidation.

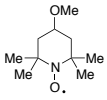
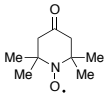
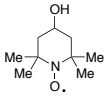
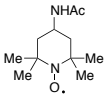
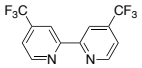
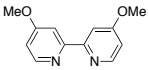
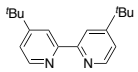
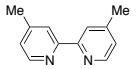


entry	solvent	yield (%)	
		2a	**3a**
1	CH_3CN	90	5
2	THF	48	46
3	EtOH	2	12
4	dioxane	62	30
5	DMF	51	44
6	toluene	13	54

Table S2. Optimization of Cu/nitroxyl catalyzed aliphatic amines oxidation.



entry	Cu source	nitroxyl	ligand	base	solvent	temp. (^oC)	yield (%)
1	CuCl	TEMPO	bpy	-	CH_3CN	60	18
2	CuBr	TEMPO	bpy	-	CH_3CN	60	25
3	CuI	TEMPO	bpy	-	CH_3CN	60	41
4	$Cu(CH_3CN)_4OTf$	TEMPO	bpy	-	CH_3CN	60	13
5	$CuCl_2$	TEMPO	bpy	-	CH_3CN	60	0
6	$CuBr_2$	TEMPO	bpy	-	CH_3CN	60	0
7	$Cu(OAc)_2$	TEMPO	bpy	-	CH_3CN	60	0
8	$Cu(OTf)_2$	TEMPO	bpy	-	CH_3CN	60	0
9	CuI	-	bpy	-	CH_3CN	60	28

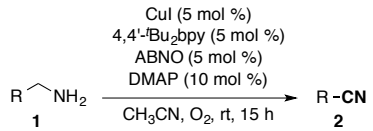
10	CuI	 ABNO	bpy	-	CH_3CN	60	62
11	CuI	 ketoABNO	bpy	-	CH_3CN	60	52
12	CuI	AZADO	bpy	-	CH_3CN	60	53
13	CuI		bpy	-	CH_3CN	60	43
14	CuI		bpy	-	CH_3CN	60	20
15	CuI		bpy	-	CH_3CN	60	34
16	CuI		bpy	-	CH_3CN	60	41
17	CuI	ABNO	-	-	CH_3CN	60	31
18	CuI	ABNO		-	CH_3CN	60	34
19	CuI	ABNO	 4,4'-OMe_2bpy	-	CH_3CN	60	51
20	CuI	ABNO	 4,4'-^{t}Bu_2bpy	-	CH_3CN	60	79
21	CuI	ABNO	 4,4'-Me_2bpy	-	CH_3CN	60	67
22	CuI	ABNO	4,4'-di^{t}Bubpy	-	THF	60	29
23	CuI	ABNO	4,4'-di^{t}Bubpy	-	DMF	60	60
24	CuI	ABNO	4,4'-di^{t}Bubpy	-	toluene	60	47
25	CuI	ABNO	4,4'-di^{t}Bubpy	 NMI	CH_3CN	60	76
26	CuI	ABNO	4,4'-di^{t}Bubpy		CH_3CN	60	75
27	CuI	ABNO	4,4'-di^{t}Bubpy	 DMAP	CH_3CN	60	85

28	CuI	ABNO	4,4'-di^{t}Bubpy		CH_3CN	60	57
39	**CuI**	**ABNO**	**4,4'-^{t}Bu$_2$bpy**	**DMAP**	**CH_3CN**	**rt**	**90**
30[a]	$Cu(CH_3CN)_4OTf$	TEMPO	bpy	NMI	CH_3CN	rt	5
31[a]	CuI	TEMPO	bpy	NMI	CH_3CN	rt	8
32[a]	CuI	ABNO	bpy	NMI	CH_3CN	rt	55
33[a]	CuI	ketoABNO	bpy	NMI	CH_3CN	rt	18
34[a]	CuI	AZADO	bpy	NMI	CH_3CN	rt	47
35[a]	CuI	ABNO	4,4'-OMe_2bpy	NMI	CH_3CN	rt	31
36[a]	CuI	ABNO	4,4'-Me_2bpy	NMI	CH_3CN	rt	63
37[a]	CuI	ABNO	4,4'-^{t}Bu$_2$bpy	NMI	CH_3CN	rt	65
38[a]	**CuI**	**ABNO**	**4,4'-^{t}Bu$_2$bpy**	**DMAP**	**CH_3CN**	**rt**	**73**
40[a]	CuI	ABNO	4,4'-^{t}Bu$_2$bpy	-	CH_3CN	rt	66
41[a,b]	CuI	ABNO	4,4'-^{t}Bu$_2$bpy	DMAP	CH_3CN	rt	60

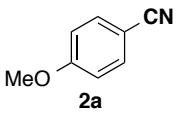
[a] 5 mol % of Cu, nitroxyl, ligand, and 10 mol % of base were employed. [b] Carried out under air.

4. CuI/ABNO catalyzed aerobic amine oxidation to nitrile

All amines were purchased and used as received. 4-Nitrobenzylamine **1f** was prepared by neutralization of the commercially available 4-nitrobenzylamine hydrochloride salt. Allylic amine **1p** was prepared by neutralization of its hydrochloride salt, which was synthesized by a literature procedure.[2]

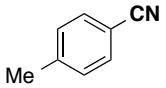


A 16 mm culture tube, which was equipped with a magnetic stir bar and charged with CuI (0.025 mmol), ABNO (0.025 mmol), 4,4'-^{t}Bu$_2$bpy (0.025 mmol) and DMAP (0.05 mmol) was evacuated and backfilled with oxygen (this process was repeated a total of 3 times). Amines (0.5 mmol) were added with CH_3CN (2.0 mL). The solution was stirred for 15 h at room temperature under O_2 balloon, and then the reaction was diluted by adding EtOAc and aqueous NH_4Cl solution. Two layers were separated, and the aqueous layer was extracted with EtOAc. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The residue was purified by column chromatography to give a nitrile product. Spectral properties of all products are consistent with literature values.



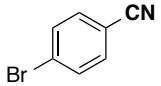
2a

4-Methoxybenzonitrile[3] (**2a**, 89%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 8.8 Hz, 2H), 6.95 (d, *J* = 8.8 Hz, 2H), 3.86 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.84, 133.97, 119.24, 114.75, 103.94, 55.55.



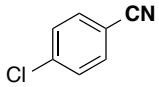
2b

4-Methylbenzonitrile[3] (**2b**, 91%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, J = 7.9 Hz, 2H), 7.27 (d, J = 7.8 Hz, 2H), 2.42 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.69, 132.04, 129.83, 119.16, 109.31, 21.84.



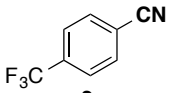
2c

4-Bromobenzonitrile[3] (**2c**, 95%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 8.5 Hz, 2H), 7.53 (d, J = 8.5 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 133.39, 132.62, 127.99, 118.04, 111.23.



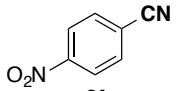
2d

4-Chlorobenzonitrile[3] (**2d**, 85%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, J = 8.2 Hz, 2H), 7.47 (d, J = 8.2 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 139.55, 133.38, 129.70, 117.97, 110.79.



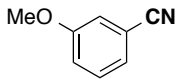
2e

4-Trifluorobenzonitrile[3] (**2e**, 92%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (d, J = 8.3 Hz, 2H), 7.77 (d, J = 8.3 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 134.59 (q, J_2 = 33.4 Hz), 132.74, 126.23 (q, J_3 = 3.7 Hz), 123.09 (q, J_1 = 273.1 Hz), 117.49, 116.11.



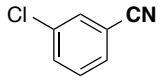
2f

4-Nitrobenzonitrile[4] (**2f**, 95%); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.38 (d, J = 8.8 Hz, 2H), 7.91 (d, J = 8.8 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 150.03, 133.51, 124.30, 118.32, 116.84.



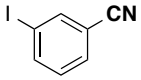
2g

3-Methoxybenzonitrile[5] (**2g**, 84%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.34 (m, 1H), 7.28-7.23 (m, 1H), 7.16-7.10 (m, 2H), 3.84 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.63, 130.32, 124.50, 119.33, 118.75, 116.82, 113.21, 55.53.



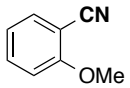
2h

3-Chlorobenzonitrile[3] (**2h**, 95%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (t, J = 1.8 Hz, 1H), 7.62-7.54 (m, 2H), 7.44 (t, J = 7.9 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 135.25, 133.24, 131.92, 130.50, 130.30, 117.44, 113.97.



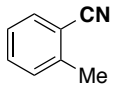
2i

3-Iodobenzonitrile[6] (**2i**, 89%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (t, *J* = 1.7 Hz, 1H), 7.95 (dt, *J* = 8.1, 1.4 Hz, 1H), 7.64 (dt, *J* = 7.9, 1.3 Hz, 1H), 7.22 (t, *J* = 7.9 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.89, 140.41, 131.18, 130.53, 117.09, 114.21, 93.86.



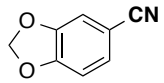
2j

2-Methoxybenzonitrile[3] (**2j**, 80%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56-7.53 (m, 2H), 7.07-6.91 (m, 2H), 3.93 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.22, 134.42, 133.73, 120.76, 116.52, 111.30, 101.75, 56.00.



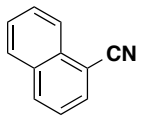
2k

2-Methylbenzonitrile[3] (**2k**, 85%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62-7.57 (m, 1H), 7.48 (td, *J* = 7.7, 1.4 Hz, 1H), 7.35-7.23 (m, 2H), 2.55 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.93, 132.63, 132.50, 130.22, 126.21, 118.14, 112.77, 20.47.



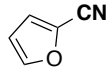
2l

Piperonylonitrile[7] (**2l**, 97%); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.21 (dd, *J* = 8.1, 1.6 Hz, 1H), 7.03 (d, *J* = 1.6 Hz, 1H), 6.87 (d, *J* = 8.0 Hz, 1H), 6.07 (s, 2H); ^{13}C NMR (126 MHz, CDCl3) δ 151.54, 148.03, 128.22, 118.90, 111.40, 109.14, 104.94, 102.23.



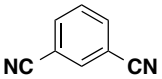
2m

1-Naphthonitrile[3] (**2m**, 98%); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.23 (dd, *J* = 8.4, 1.0 Hz, 1H), 8.09–8.05 (m, 1H), 7.94–7.87 (m, 2H), 7.68 (ddd, *J* = 8.4, 6.9, 1.3 Hz, 1H), 7.61 (ddd, *J* = 8.2, 6.9, 1.2 Hz, 1H), 7.51 (dd, *J* = 8.3, 7.1 Hz, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 133.27, 132.89, 132.61, 132.32, 128.64, 128.58, 127.53, 125.12, 124.91, 117.81, 110.15.



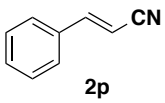
2n

2-Furonitrile[8] (**2n**, 82%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (d, *J* = 1.7 Hz, 1H), 7.11 (d, *J* = 3.6 Hz, 1H), 6.54 (dd, *J* = 3.6, 1.8 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.33, 126.34, 121.99, 111.45.



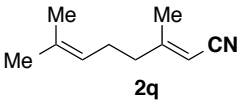
2o

1,3-Dicyanobenzene[11] (**2o**, 90%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (t, *J* = 1.6 Hz, 1H), 7.91 (dd, *J* = 8.0, 1.6 Hz, 2H), 7.66 (t, *J* = 7.9 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 136.01, 135.43, 130.36, 116.60, 114.21.



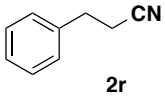
2p

Cinnamonitrile[3] (**2p**, 70%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67-7.19 (m, 6H), 5.88 (d, *J* = 16.7 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 150.61, 133.54, 131.25, 129.15, 127.39, 118.19, 96.37.



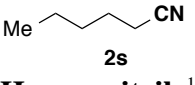
2q

3,7-Dimethyl-2,6-octadienenitrile (**2q**, 95%, E:Z=10:1); ^{1}H NMR (400 MHz, $CDCl_3$, major product) δ 5.11 (s, 1H), 5.02 (s, 1H), 2.21-2.17 (m, 4H), 2.05 (s, 3H), 1.69 (s, 3H), 1.61 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$, major product) δ 165.02, 133.22, 122.18, 117.29, 95.24, 38.58, 25.66, 25.62, 21.05, 17.74; HRMS (EI) *m/z* calcd for $C_{10}H_{15}N$ $[M]^+$: 149.1204, found 149.1199



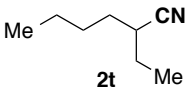
2r

3-Phenylpropionitrile[10] (**2r**, 91%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56-7.06 (m, 5H), 2.95 (t, *J* = 7.4 Hz, 2H), 2.61 (t, *J* = 7.4 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 138.04, 128.87, 128.25, 127.23, 119.12, 31.57, 19.36.



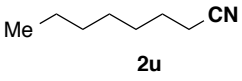
2s

Hexanenitrile[11] (**2s**, 90%); yield was determined by ^{1}H NMR (400 MHz, $CDCl_3$) spectroscopy from the crude mixture.



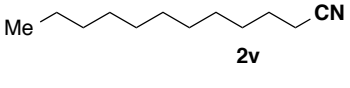
2t

2-Ethylhexanenitrile[12] (**2t**, 72%); yield was determined by ^{1}H NMR (400 MHz, $CDCl_3$) spectroscopy from the crude mixture.



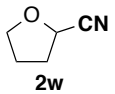
2u

Octanenitrile[13] (**2u**, 85%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.34 (t, *J* = 7.1 Hz, 2H), 1.66 (p, *J* = 7.2 Hz, 2H), 1.50-1.39 (m, 2H), 1.37-1.24 (m, 6H), 0.89 (t, *J* = 6.7 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 119.88, 31.49, 28.63, 28.44, 25.39, 22.53, 17.14, 14.02.



2v

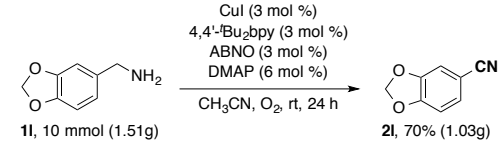
Dodecanenitrile[3] (**2v**, 92%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.33 (t, *J* = 7.1 Hz, 2H), 1.73-1.60 (m, 2H), 1.44 (t, *J* = 7.5 Hz, 2H), 1.28 (m, 14H), 0.88 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 119.89, 31.91, 29.57, 29.52, 29.32, 29.31, 28.79, 28.69, 25.40, 22.70, 17.15, 14.13.



2w

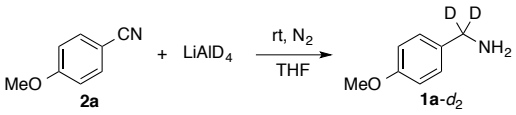
Tetrahydrofuran-2-carbonitrile[12] (**2w**, 47%); yield was determined by ^{1}H NMR (400 MHz, $CDCl_3$) spectroscopy from the crude mixture.

5. Experimental procedure for 10 mmol-scale reaction



A 250 mL round-bottom flask, which was equipped with a magnetic stir bar and charged with CuI (0.3 mmol), ABNO (0.3 mmol), 4,4'-^{t}Bu$_2$bpy (0.3 mmol) and DMAP (0.6 mmol) was evacuated and backfilled with oxygen (this process was repeated 3 times). Amine **1l** (10 mmol) was added with CH_3CN (40 mL). The solution was stirred for 15 h at room temperature under O_2 balloon, then the reaction was diluted by adding EtOAc and aqueous NH_4Cl solution. The two layers were separated, and the aqueous layer was extracted with EtOAc. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The residue was purified by recrystallization with ethyl acetate and hexane to give a nitrile product.

6. KIE study using gas uptake



2a **1a**-d_2

Synthesis of deuterated benzylamine 1a-d_2: 4-$MeOC_6H_4CD_2NH_2$ was synthesized by reduction of 4-methoxybenzonitrile (538 mg, 4 mmol) dissolved in ice cooled THF (2.5 mL) with lithium aluminum deuteride (185 mg, 4.4 mmol) at room temperature under nitrogen. After 12 h, CH_2Cl_2 (5 mL) and 1 M NaOH aqueous solution were added in ice cooled bath. The two layers were separated, and the aqueous layer was extracted with CH_2Cl_2. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated in *vacuo* to produce **1a**-d_2 in 33% yield. The isotopic purity determined by ^{1}H NMR was 99%.

Gas uptake kinetic measurements method for KIE study: Each set of data was collected using a 6-well gas uptake apparatus which holds individually calibrated 25 mL round bottom flasks, each connected to a pressure transducer designed to measure the gas pressure within each sealed reaction vessel. Five vessels contained various reaction mixtures, and the sixth well used as a solvent control for variations in pressure. The apparatus was evacuated and filled with O_2 to 800 torr three times. The pressure was established at 500 torr and the flasks heated to 27 °C. A solution of **1a** (0.5 mmol) in CH_3CN (1.5 mL) and **1a**-d_2 (0.5 mmol) in CH_3CN (1.5 mL) was added to separate wells via syringe through a septum, and the pressure and temperature were

allowed to equilibrate. When the pressure (approximately 600 torr) and temperature (27 °C) stabilized, a solution of catalyst (0.05 mmol of CuI, ^{t}Bu$_2$bpy, ABNO, and 0.1 mmol of DMAP) in CH_3CN (0.5 mL) was added to each well via syringe through a septum. Data were acquired using custom software written within LabVIEW (National Instruments).

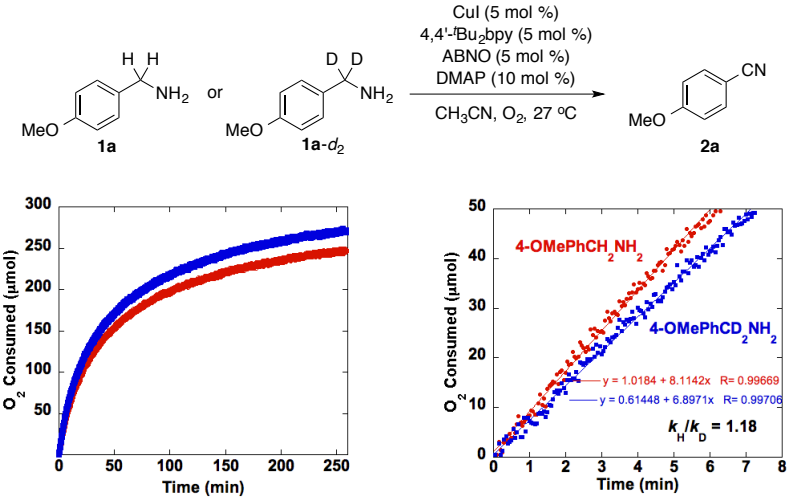
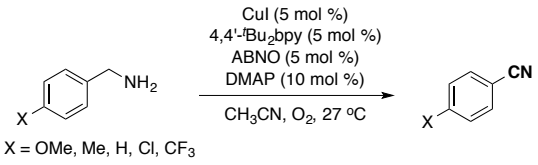


Figure S1. Representative data from a KIE study using gas uptake methods.

7. Hammett study using gas uptake

Gas uptake kinetic measurements method for Hammett study: Each set of data was collected using a 6-well gas uptake apparatus which holds individually calibrated 25 mL round bottom flasks, each connected to a pressure transducer designed to measure the gas pressure within each sealed reaction vessel. Five vessels contained various reaction mixtures, and the sixth well used as a solvent control for variations in pressure. The apparatus was evacuated and filled with O_2 to 800 torr three times. The pressure was established at 500 torr and the flasks heated to 27 °C. A solution of **1a** (0.5 mmol) in CH_3CN (1.5 mL), **1b** (0.5 mmol) in CH_3CN (1.5 mL), benzylamine (0.5 mmol) in CH_3CN, **1d** (0.5 mmol) in CH_3CN (1.5 mL), and **1e** (0.5 mmol) in CH_3CN (1.5 mL) was added to separate well via syringe through a septum, and the pressure and temperature allowed to equilibrate. When the pressure (approximately 600 torr) and temperature (27 °C) stabilized, a solution of catalyst (0.05 mmol of CuI, ^{t}Bu$_2$bpy, ABNO, and 0.1 mmol of DMAP) in CH_3CN (0.5 mL) was added to each well via syringe through a septum. Data were acquired using custom software written within LabVIEW (National Instruments).



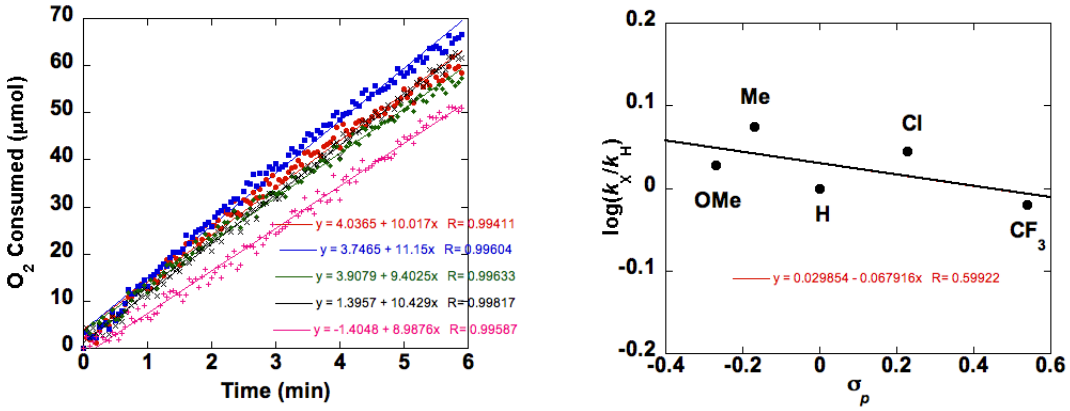
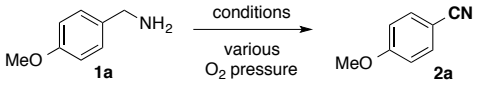


Figure S2. Hammett study with various *para*-substituted benzylamines using gas-uptake methods.

8. O_2 kinetic dependence

Each set of data was collected using a 6-well gas uptake apparatus which holds individually calibrated 25 mL round bottom flasks, each connected to a pressure transducer designed to measure the gas pressure within each sealed reaction vessel. Five vessels contained various reaction mixtures, and the sixth well used as a solvent control for variations in pressure. The apparatus was evacuated and filled with O_2 to 800 torr three times. The pressure was established at about 300, 330, 370, and 400 torr for each well and the flasks heated to 27 °C. A solution of **1a** (0.5 mmol) in CH_3CN (1.5 mL) was added to separate well via syringe through a septum, and the pressure and temperature allowed to equilibrate. When the pressure (373.8, 406.7, 454.23, and 503.8) and temperature (27 °C) stabilized, a solution of catalyst (0.05 mmol of CuI, ^{t}Bu$_2$bpy, ABNO, and 0.1 mmol of DMAP) in CH_3CN (0.5 mL) was added to each well via syringe through a septum. Data were acquired using custom software written within LabVIEW (National Instruments).



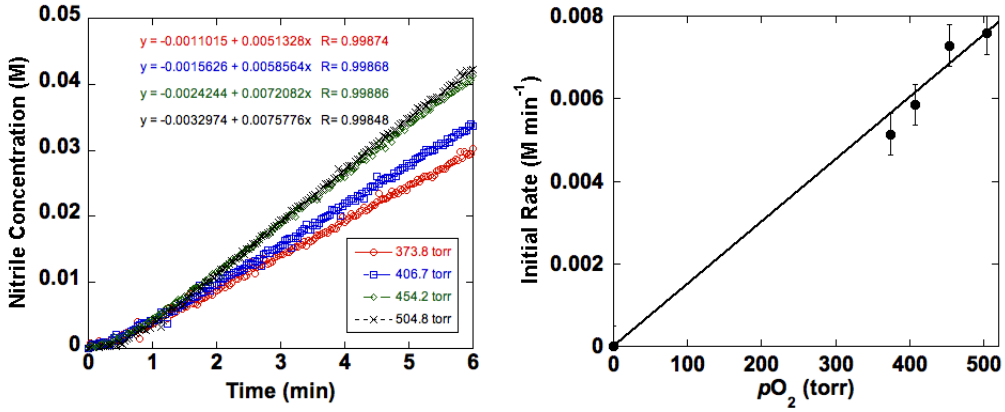


Figure S3. O_2 dependence rate measurements using gas uptake methods.

9. Investigation of possible intermediates and reaction profile

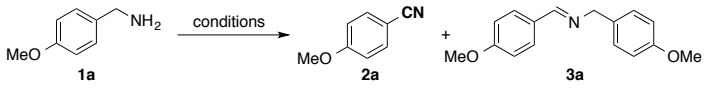
Investigation of possible intermediates

Homocoupled imine **3a** was synthesized by a literature procedure.[14]

A 16 mm culture tube, which was equipped with a magnetic stir bar and charged with CuI (0.025 mmol), ABNO (0.025 mmol), 4,4'-^{t}Bu$_2$bpy (0.025 mmol) and DMAP (0.05 mmol) was evacuated and backfilled with oxygen (this process was repeated a total of 3 times). Homo-coupled imine **3a** (0.25 mmol) in CH_3CN (2.0 mL) was added with the indicated amount of aqueous ammonia. The solution was stirred for 15 h at room temperature under an O_2 balloon, then the reaction was diluted by adding EtOAc and aqueous NH_4Cl solution. Two layers were separated, and the aqueous layer was extracted with EtOAc. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The ^{1}H NMR yield of desired product was determined by integration using an internal standard (1,1,2,2-tetrachloroethane).

Reaction profile

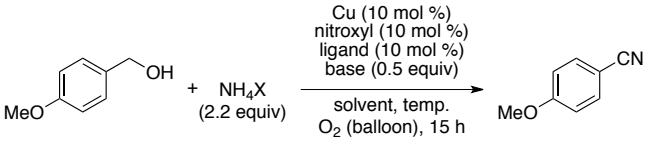
A 16 mm culture tube, which was equipped with a magnetic stir bar and charged with CuI (0.0625 mmol), ABNO (0.0625 mmol), 4,4'-^{t}Bu$_2$bpy (0.0625 mmol) and DMAP (0.125 mmol) was evacuated and backfilled with oxygen (this process was repeated 3 times). 4-Methoxybenzylamine **1a** (1.25 mmol) in CH_3CN (5.0 mL) was added. An aliquot was taken from the reaction mixture and the product yield was monitored by ^{1}H NMR using an internal standard (1,1,2,2-tetrachloroethane) in the indicated interval.

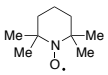
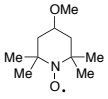
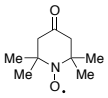
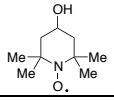


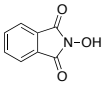
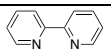
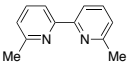
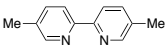
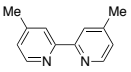
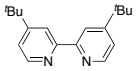
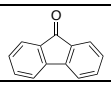
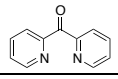
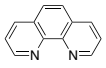
10. Cu/nitroxyl-catalyzed oxidation of alcohol to nitriles with NH_3 (aq) (Scheme 2).

A 16 mm culture tube, which was equipped with a magnetic stir bar and charged with Cu, nitroxyl, ligand, ammonium salt, and base was evacuated and backfilled with oxygen (this process was repeated a total of 3 times). After NH_3 (aq) (2.2 equiv) was added, 4-methoxybenzylamine (0.3 mmol) was added with solvent (2.0 mL). The solution was stirred for 15 h at indicated temperature under O_2 balloon, then the reaction was diluted by adding EtOAc and aqueous NH_4Cl solution. Two layers were separated, and the aqueous layer was extracted with EtOAc. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated in *vacuo*. The ^{1}H NMR yield of desired product was determined by integration using an internal standard (1,1,2,2-tetrachloroethane).

Table S3. Optimization of Cu/nitroxyl catalyzed alcohol oxidation with NH_3 (aq) into nitriles



entry	Cu source	nitroxyl	NH_4X	ligand	base	solvent	temp. (^oC)	yield (%)
1	-	 TEMPO	NH_3 (aq)	-	-	CH_3CN	60	0
2	CuCl	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	10
3	CuBr	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	20
4	CuI	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	50
5	copper(I) thiophene-2-carboxylate	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	48
6	Cu_2O	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	0
7	$Cu(CH_3CN)_4OTf$	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	61
8	$Cu(CH_3CN)_4PF_6$	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	62
9	$CuCl_2$	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	5
10	$CuBr_2$	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	16
11	$Cu(NO_3)_2{\cdot}3H_2O$	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	20
12	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	65
13	$Cu(OAc)_2$	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	30
14	$Cu(TFA)_2$	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	52
15	$Cu(acac)_2$	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	13
16	CuO	TEMPO	NH_3 (aq)	-	-	CH_3CN	60	0
17	$Cu(OTf)_2$	TEMPO	NH_4HCO_3	-	-	CH_3CN	60	39
18	$Cu(OTf)_2$	TEMPO	NH_4OAc	-	-	CH_3CN	60	3
19	$Cu(OTf)_2$	TEMPO	NH_4NO_3	-	-	CH_3CN	60	1
20	$Cu(OTf)_2$	TEMPO	NH_4BF_4	-	-	CH_3CN	60	36
21	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	-	CH_3CN	40	34
22	$Cu(OTf)_2$		NH_3 (aq)	-	-	CH_3CN	40	27
23	$Cu(OTf)_2$		NH_3 (aq)	-	-	CH_3CN	40	6
24	$Cu(OTf)_2$		NH_3 (aq)	-	-	CH_3CN	40	34
25	$Cu(OTf)_2$	 AZADO	NH_3 (aq)	-	-	CH_3CN	40	34
26	$Cu(OTf)_2$		NH_3 (aq)	-	-	CH_3CN	40	0

27	$Cu(OTf)_2$		NH_3 (aq)	-	-	CH_3CN	40	0
28	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	pyridine	-	CH_3CN	40	34
29	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	 bpy	-	CH_3CN	40	20
30	$Cu(OTf)_2$	TEMPO	NH_3 (aq)		-	CH_3CN	40	3
31	$Cu(OTf)_2$	TEMPO	NH_3 (aq)		-	CH_3CN	40	14
32	$Cu(OTf)_2$	TEMPO	NH_3 (aq)		-	CH_3CN	40	20
33	$Cu(OTf)_2$	TEMPO	NH_3 (aq)		-	CH_3CN	40	27
34	$Cu(OTf)_2$	TEMPO	NH_3 (aq)		-	CH_3CN	40	35
35	$Cu(OTf)_2$	TEMPO	NH_3 (aq)		-	CH_3CN	40	18
36	$Cu(OTf)_2$	TEMPO	NH_3 (aq)		-	CH_3CN	40	12
37	$Cu(OTf)_2$	TEMPO	NH_3 (aq)		-	CH_3CN	40	0
38	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	NaOH	CH_3CN	40	0
39	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	$NaHCO_3$	CH_3CN	40	10
40	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	Na_2CO_3	CH_3CN	40	35
41	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	KOH	CH_3CN	40	0
42	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	K_2CO_3	CH_3CN	40	0
43	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	Cs_2CO_3	CH_3CN	40	0
44	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	-	DMF	60	74
45	**$Cu(OTf)_2$**	**TEMPO**	**NH_3 (aq)**	**-**	**-**	**DMSO**	**60**	**90**
46	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	-	toluene	60	0
47	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	-	$ClCH_2CH_2Cl$	60	0
48	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	-	DME	60	16
49	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	-	ethanol	60	40
50	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	-	ethylacetate	60	15
51	$Cu(OTf)_2$	TEMPO	NH_3 (aq)	-	-	2-propanol	60	76

11. References

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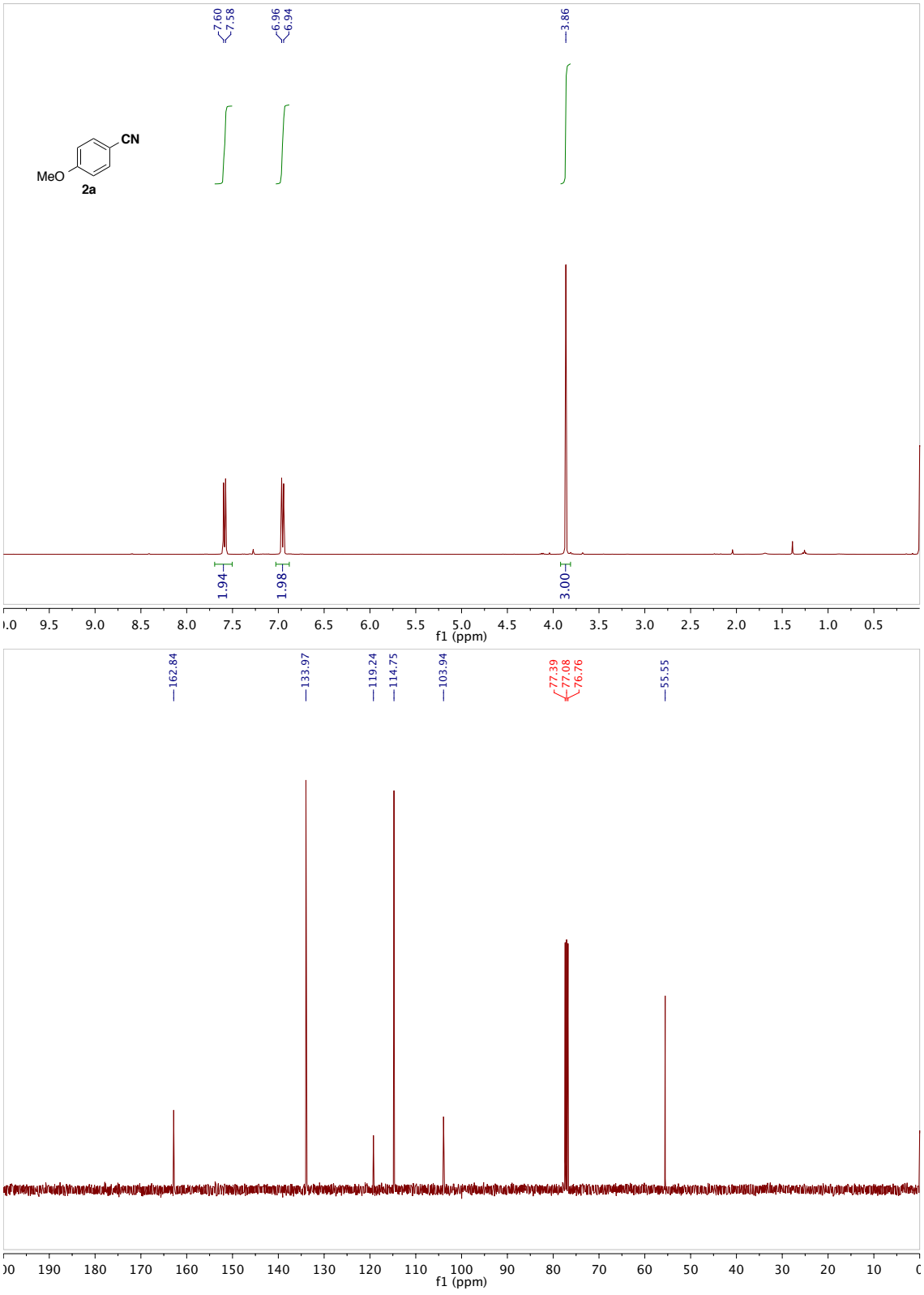
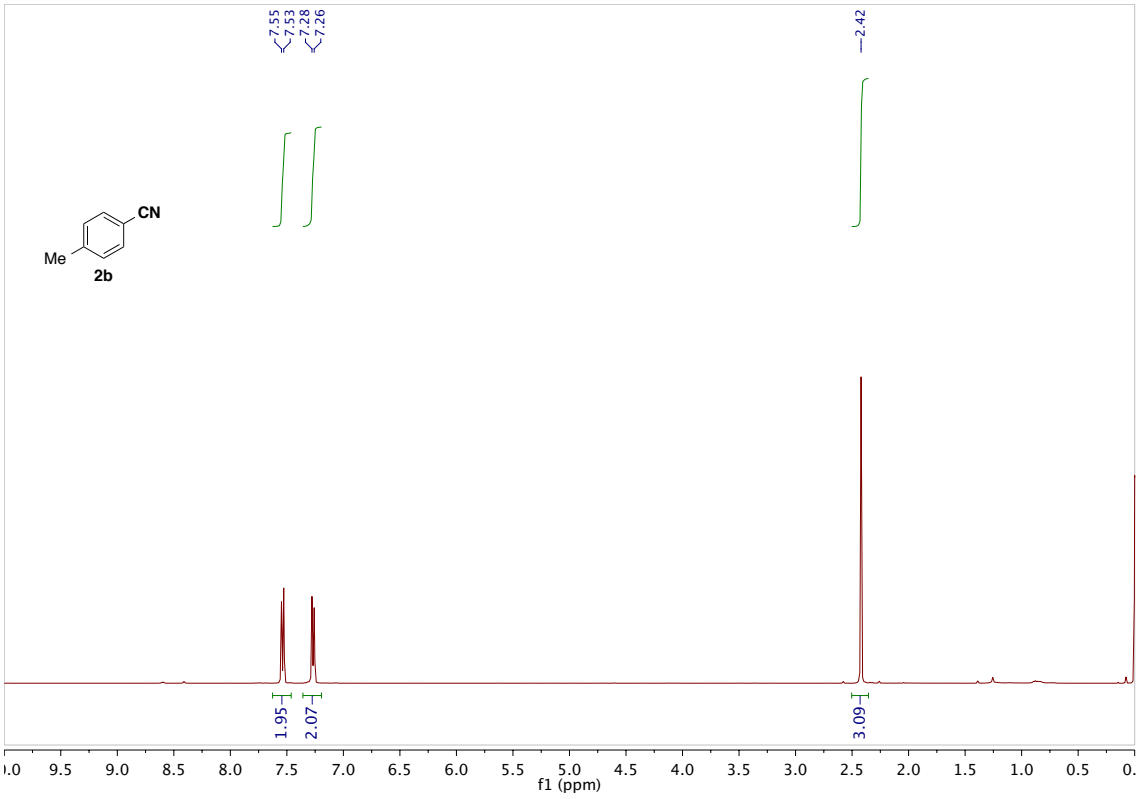
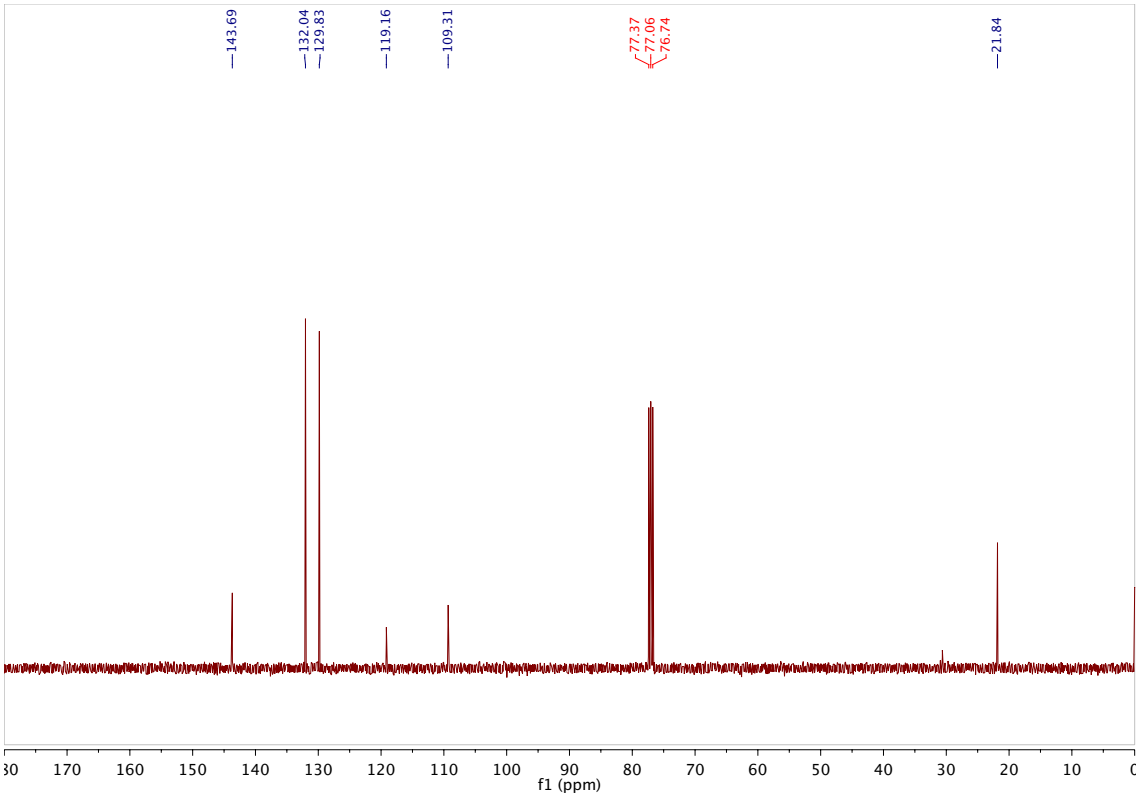
12. ^{1}H and ^{13}C NMR Spectra of Substrates

4-Methoxybenzonitrile



4-Methylbenzonitrile





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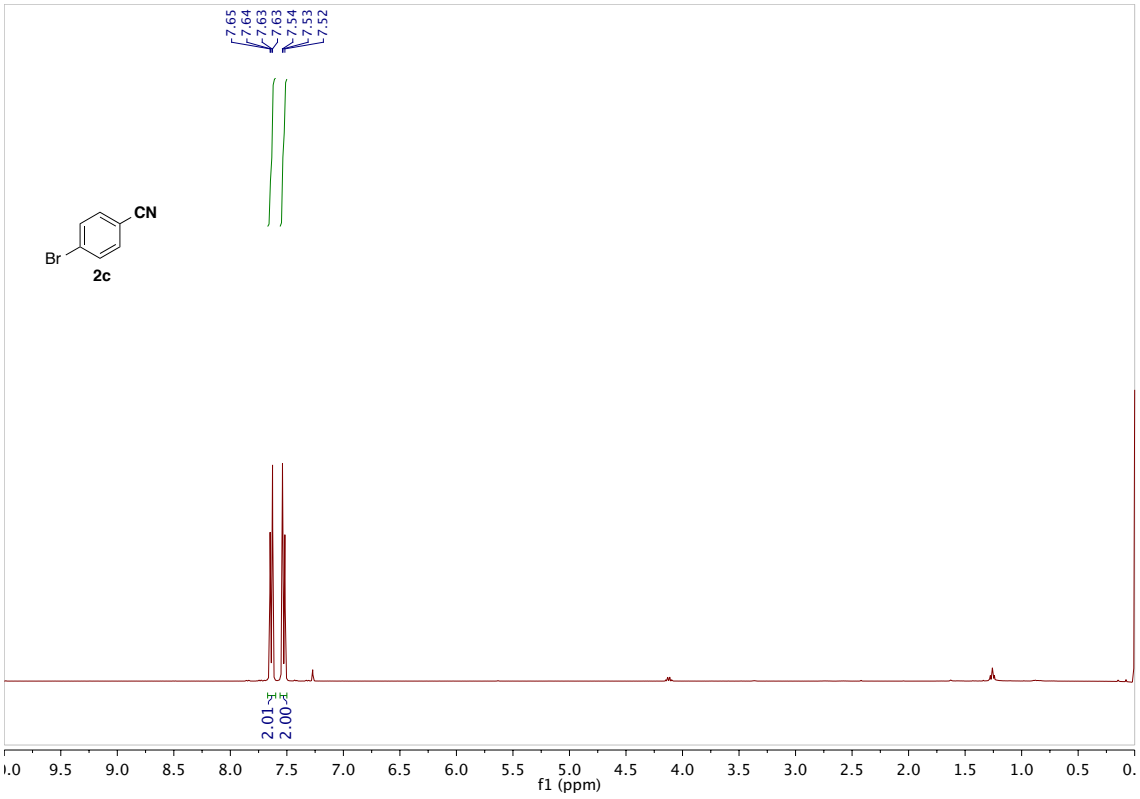
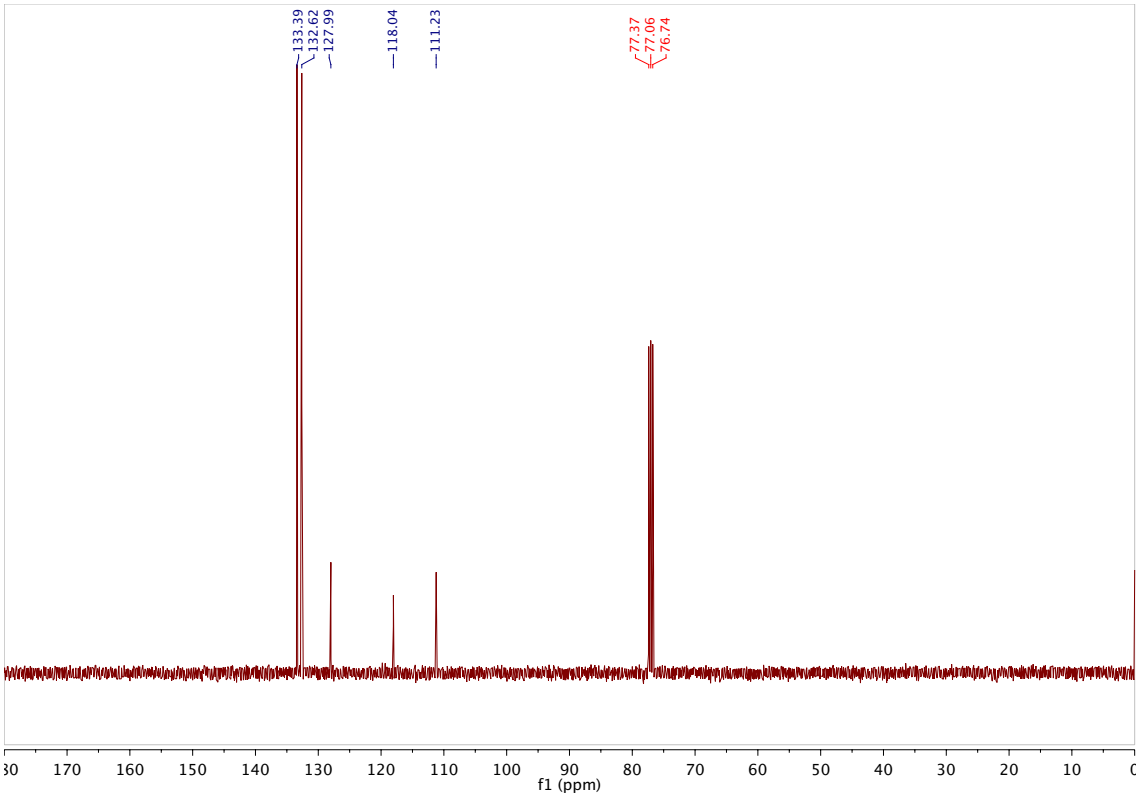
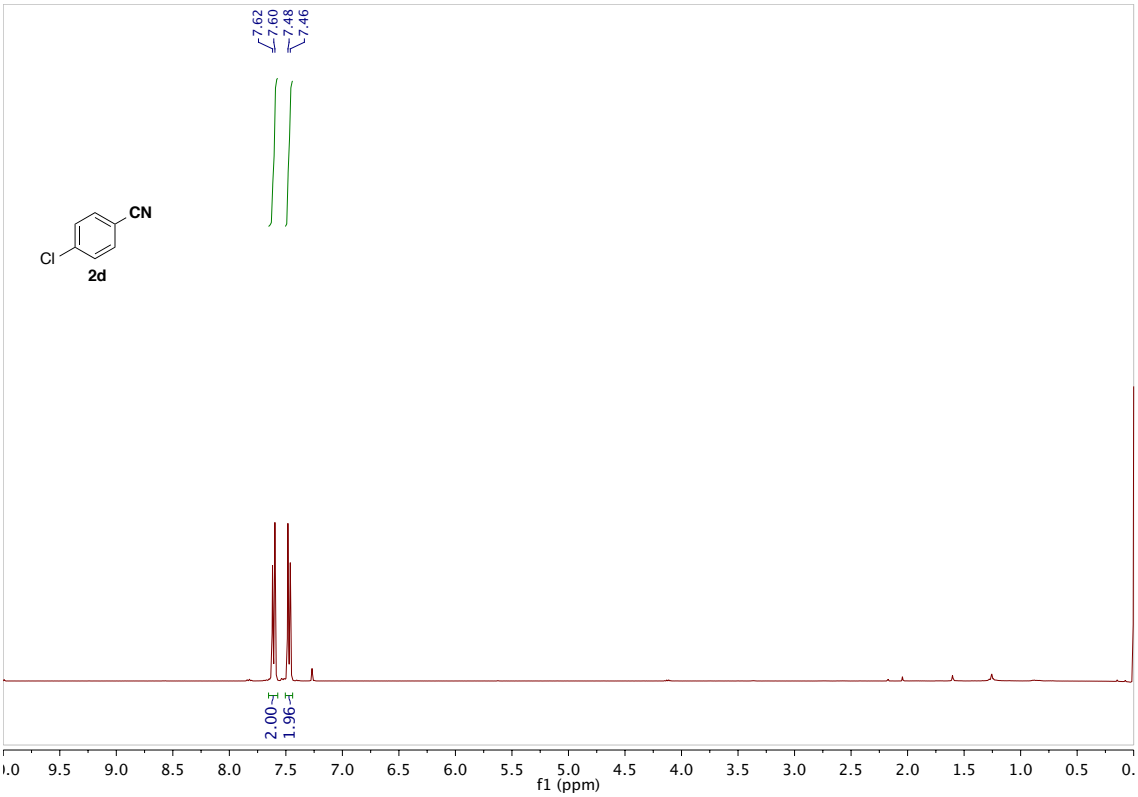
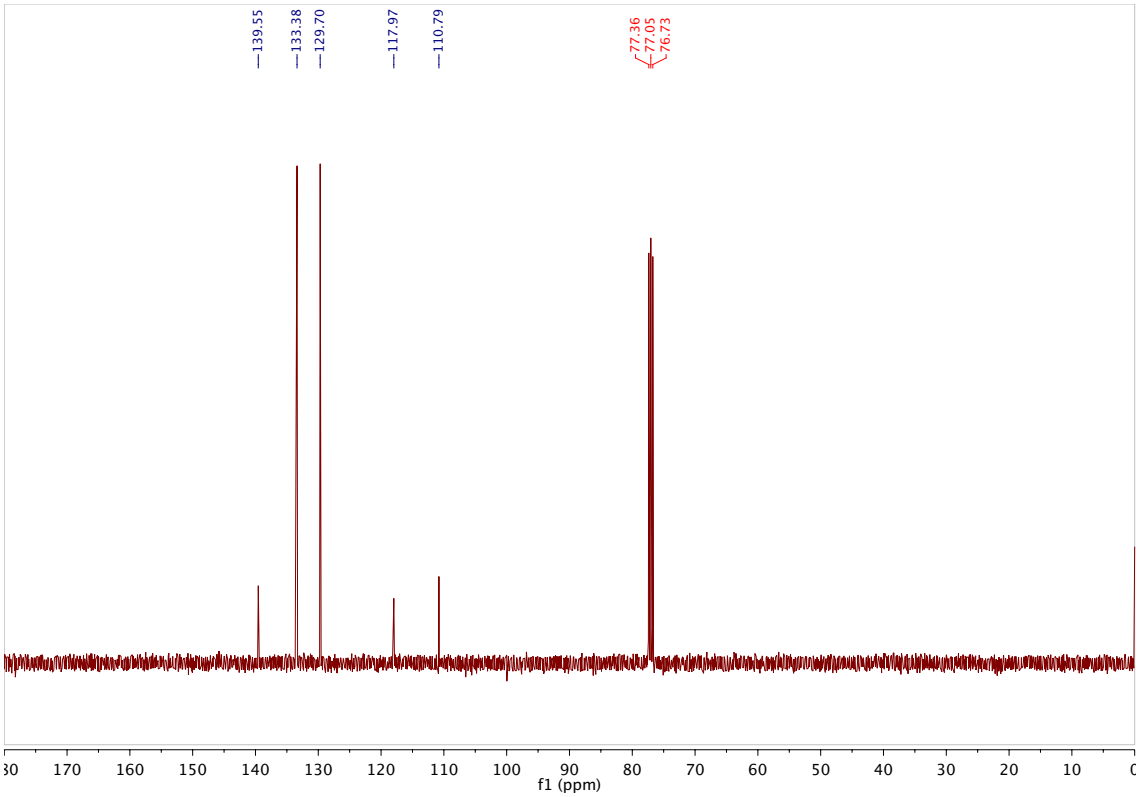


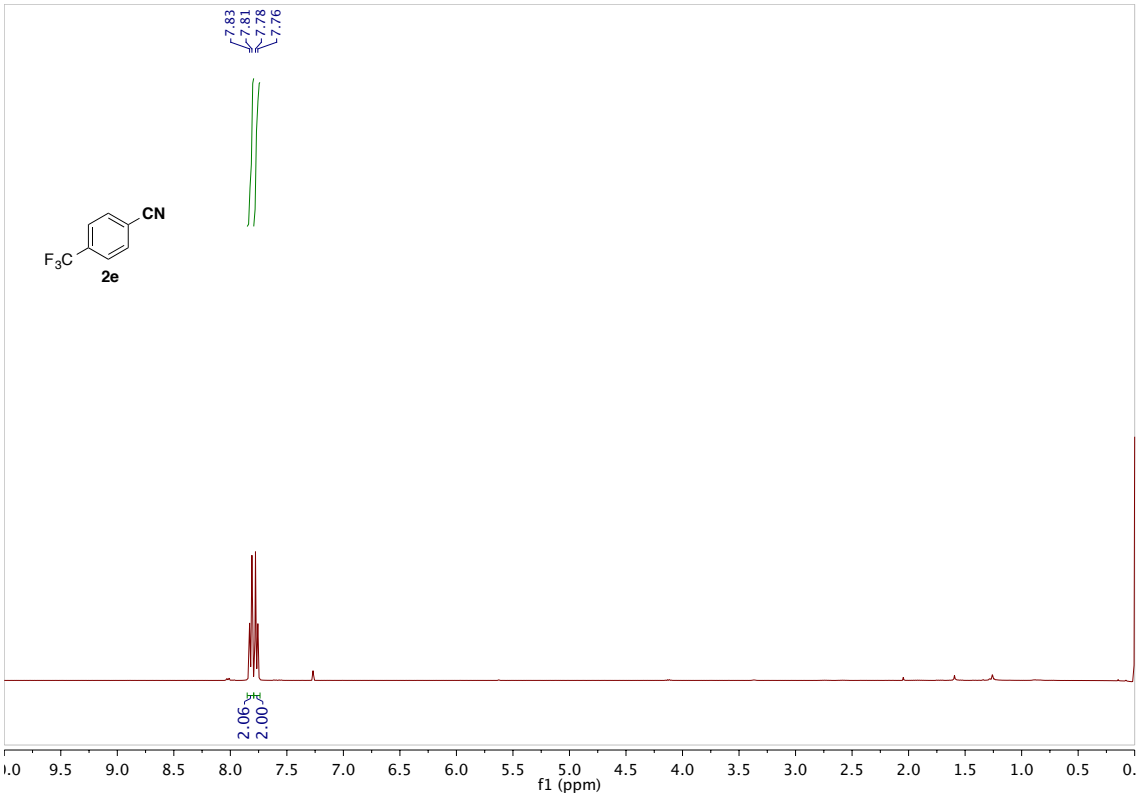


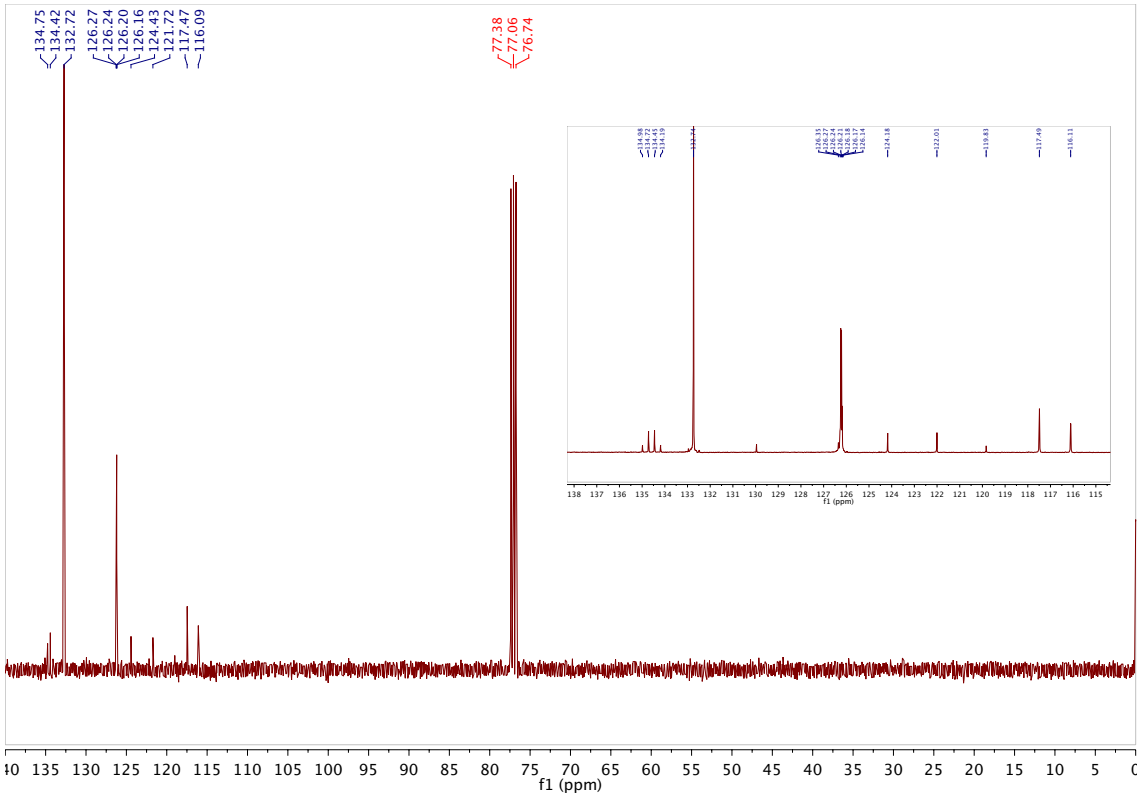
4-Chlorobenzonitrile





4-Trifluorobenzonitrile





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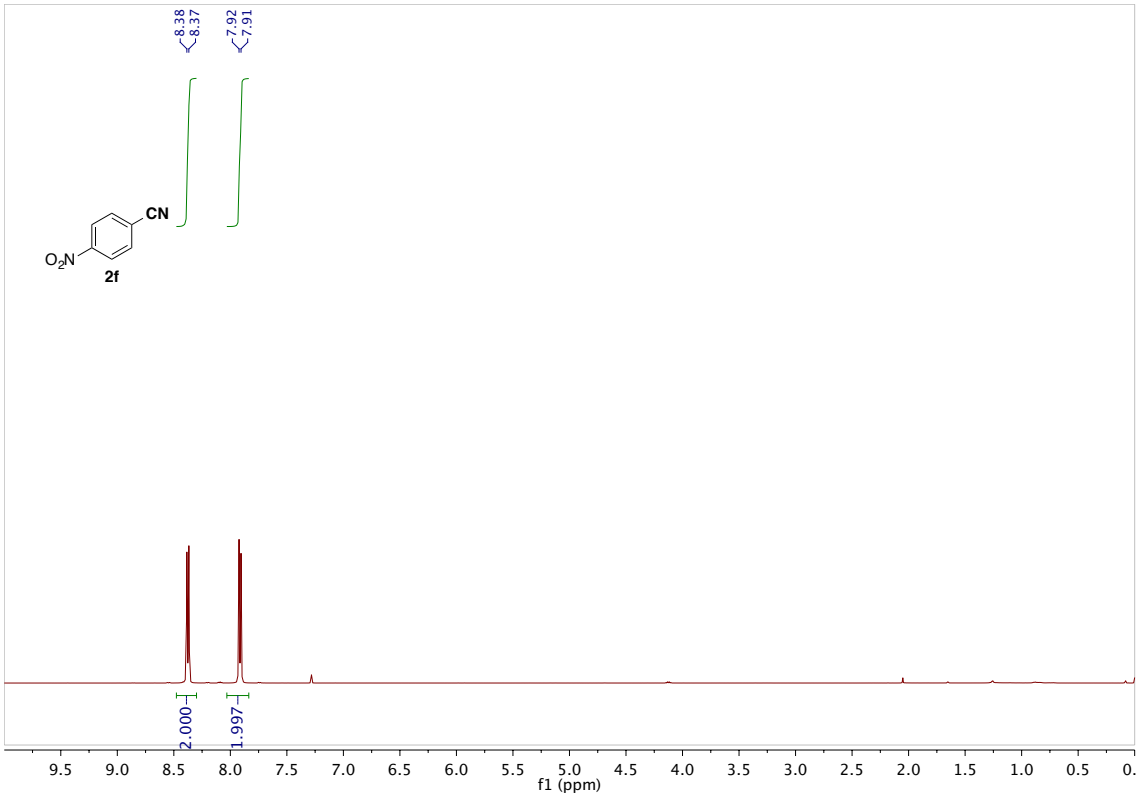

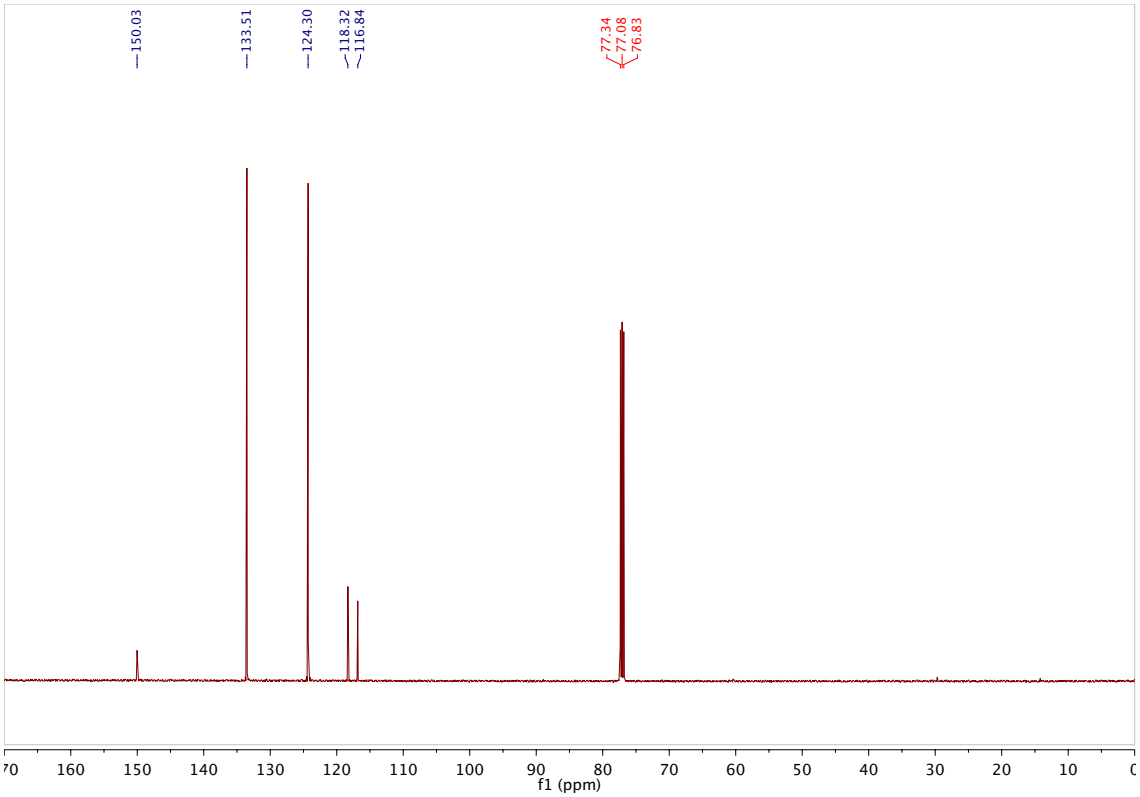

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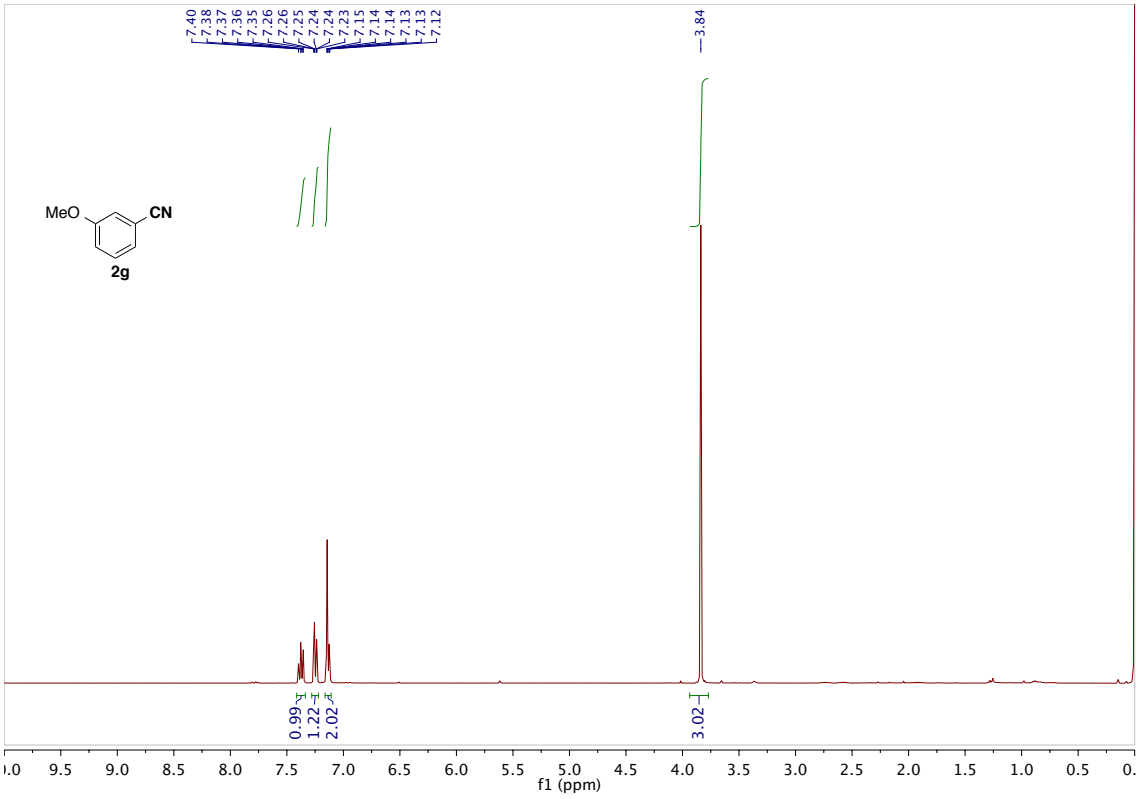

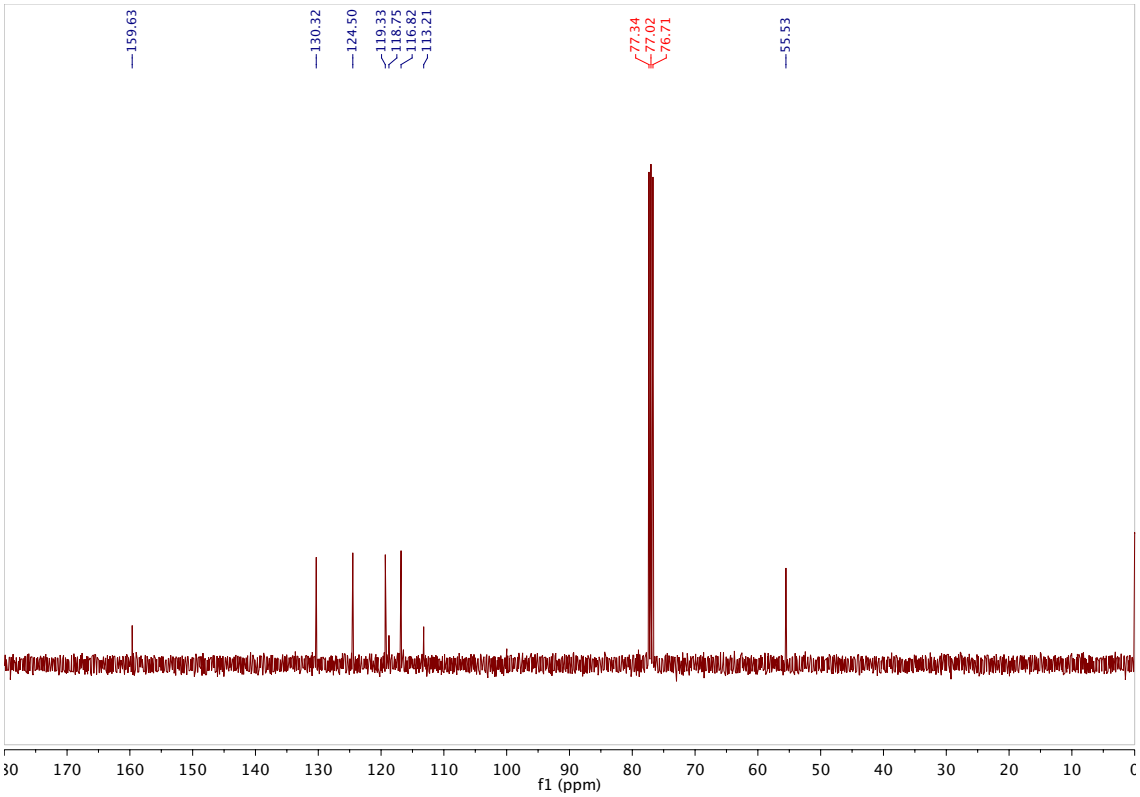

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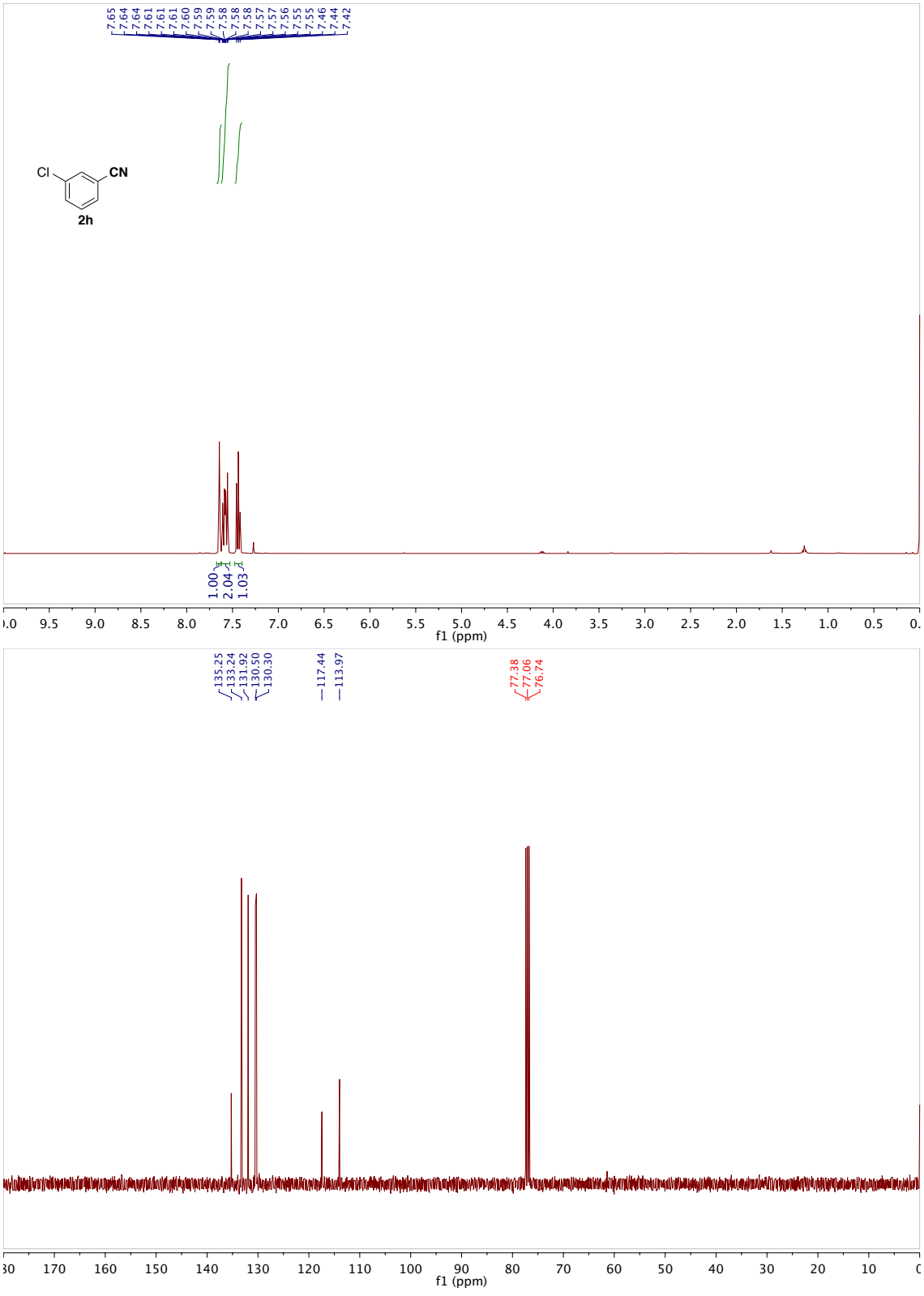

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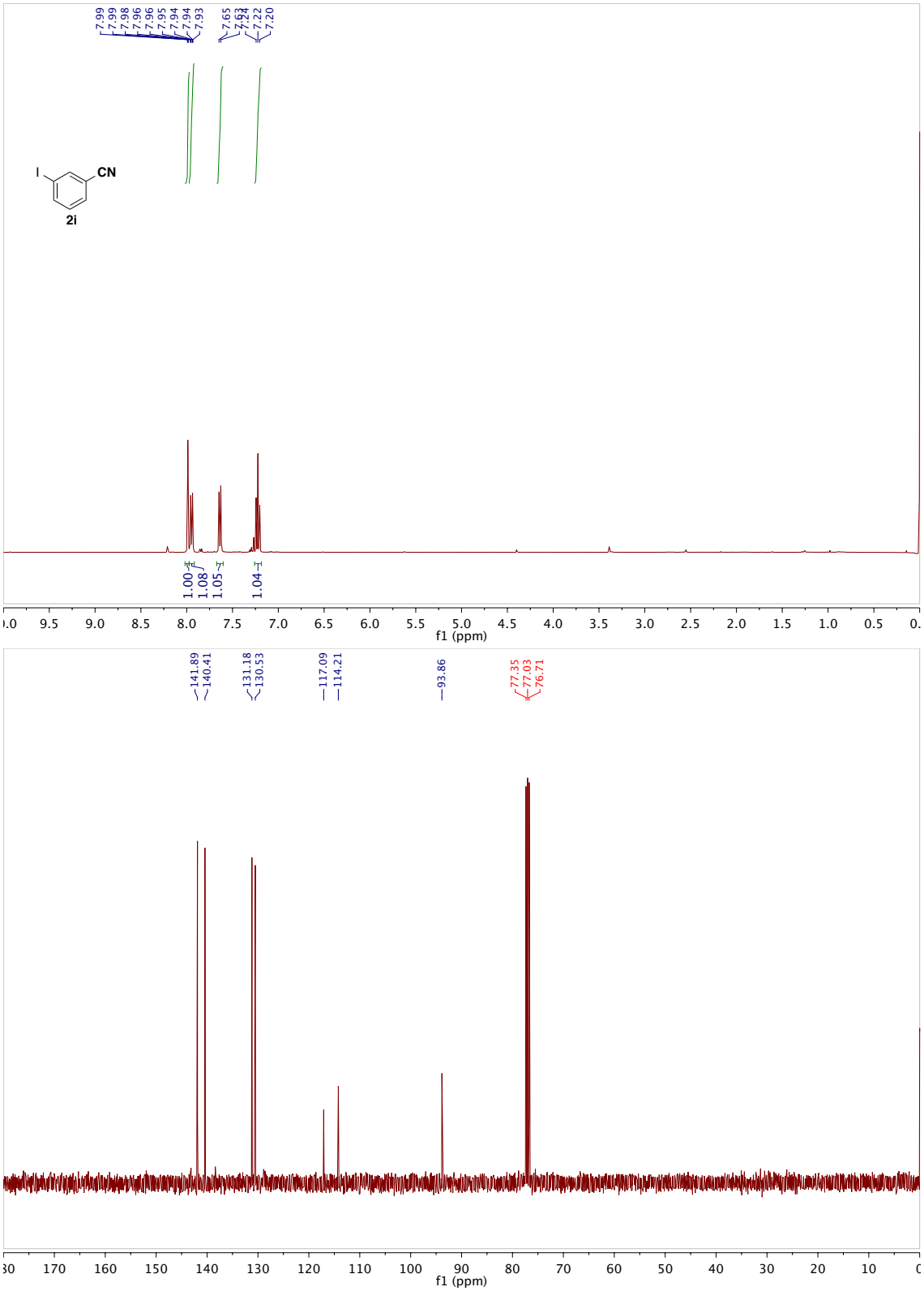

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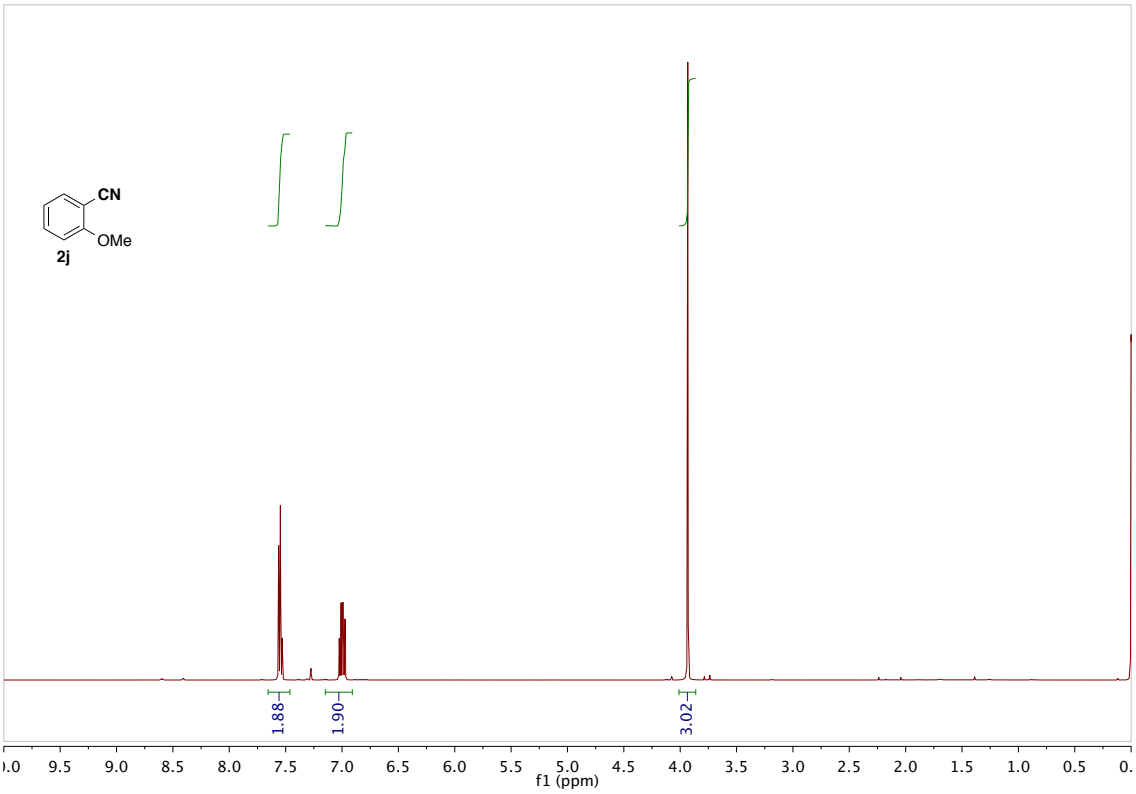

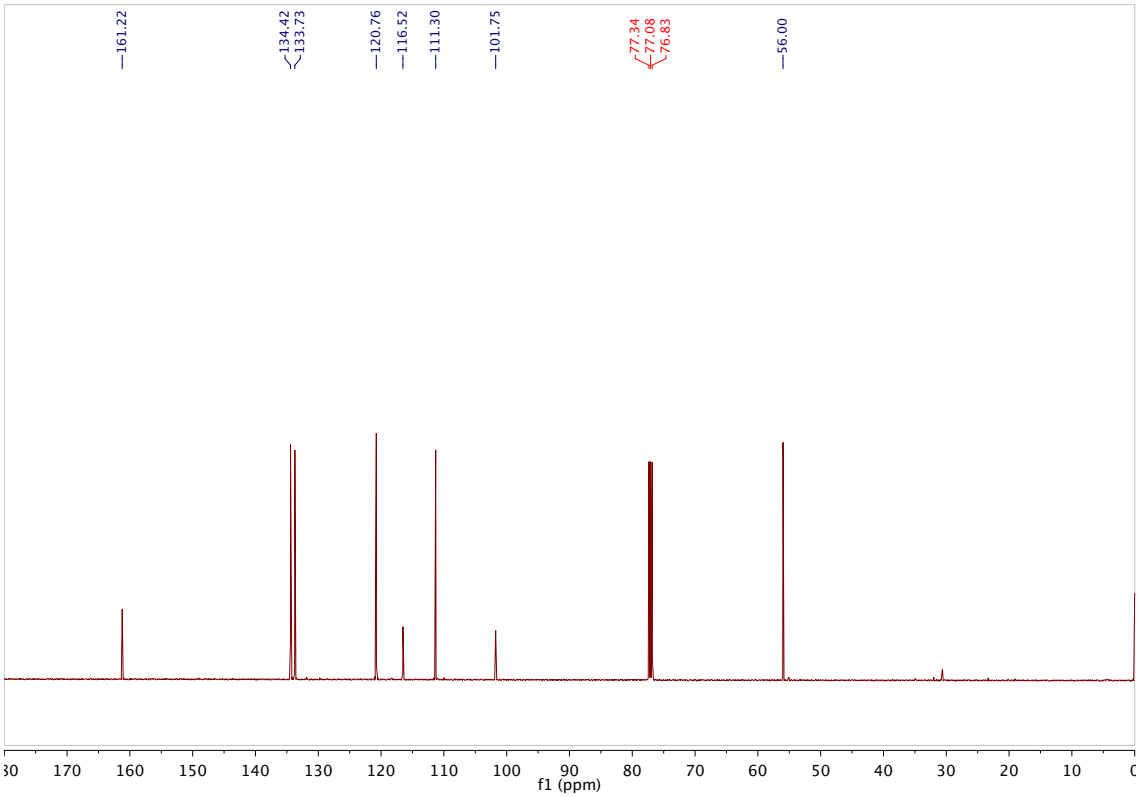

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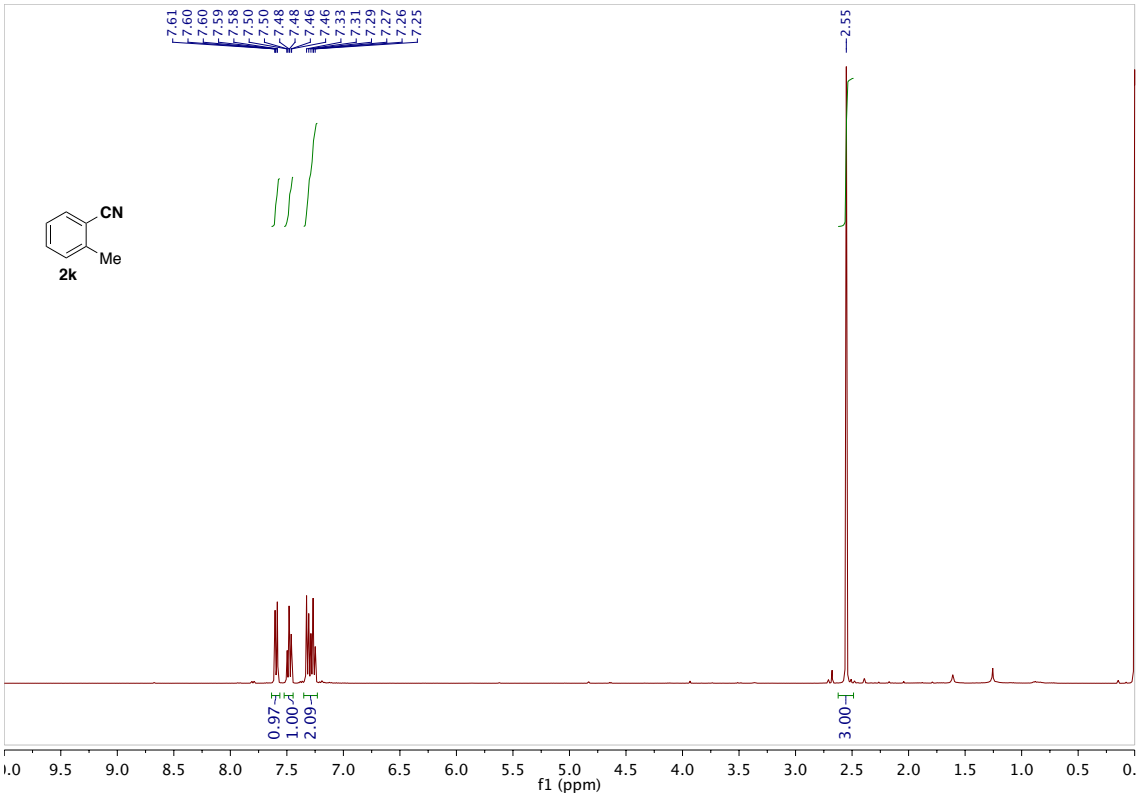

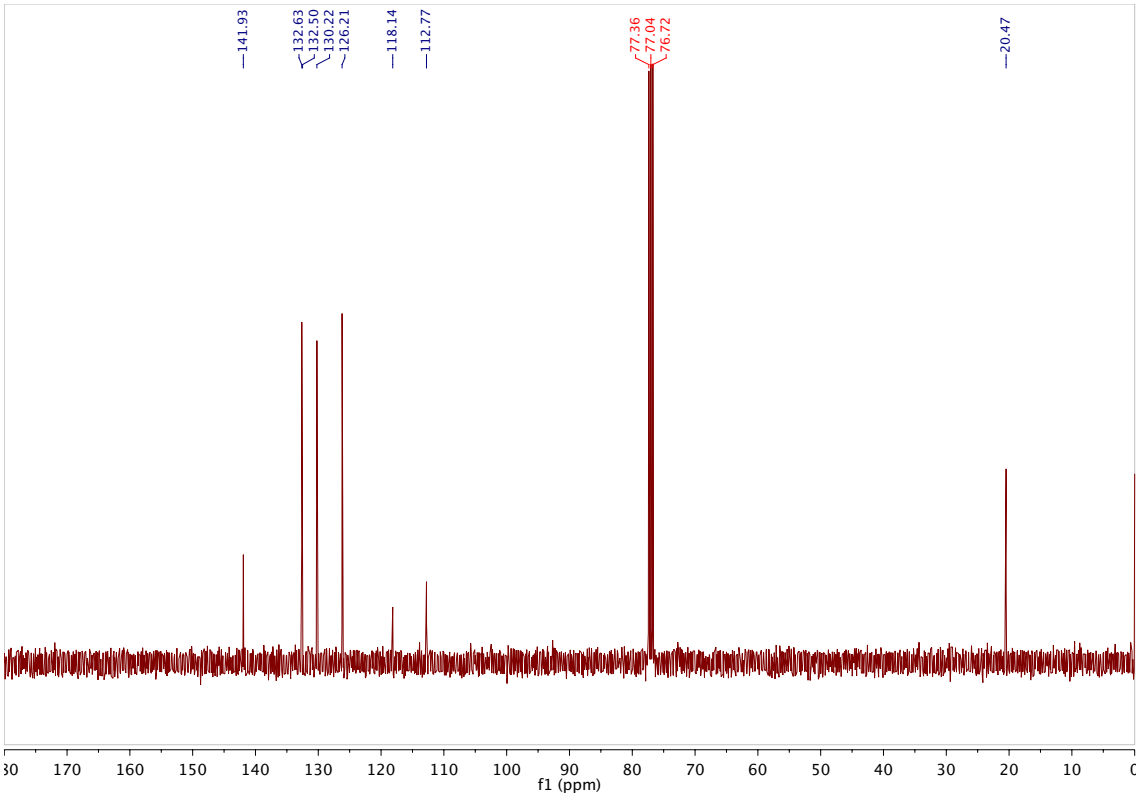

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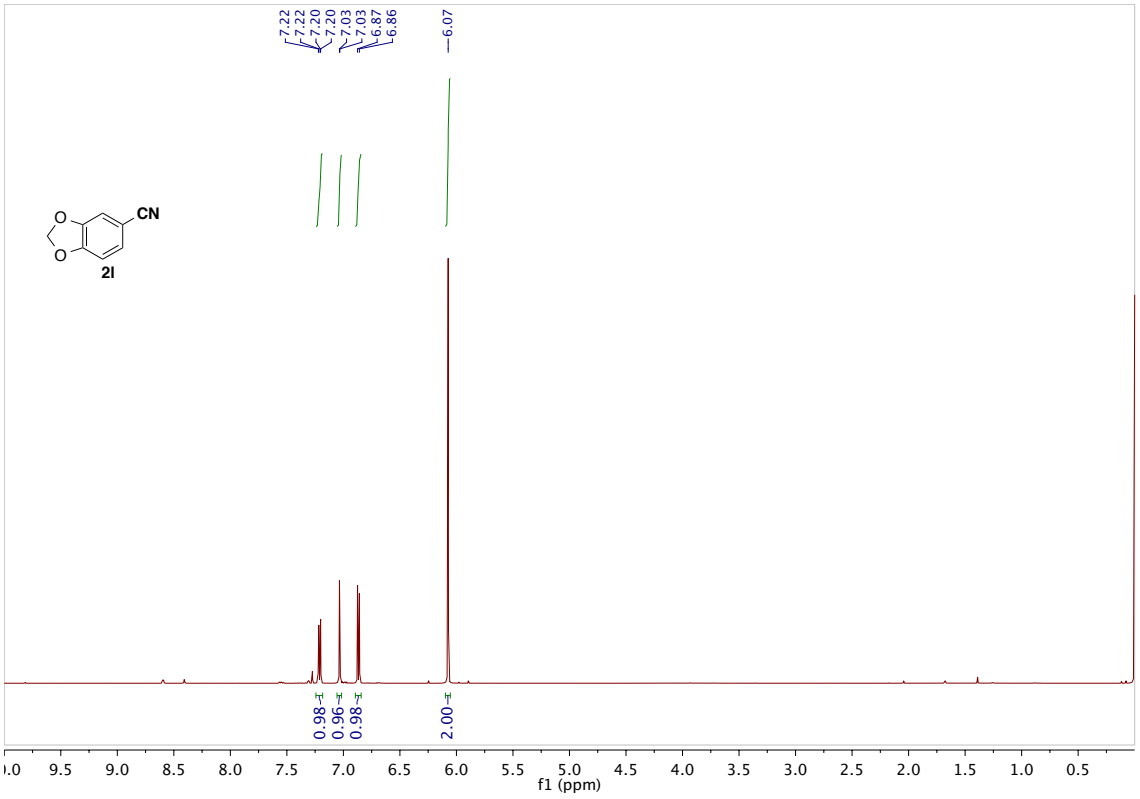

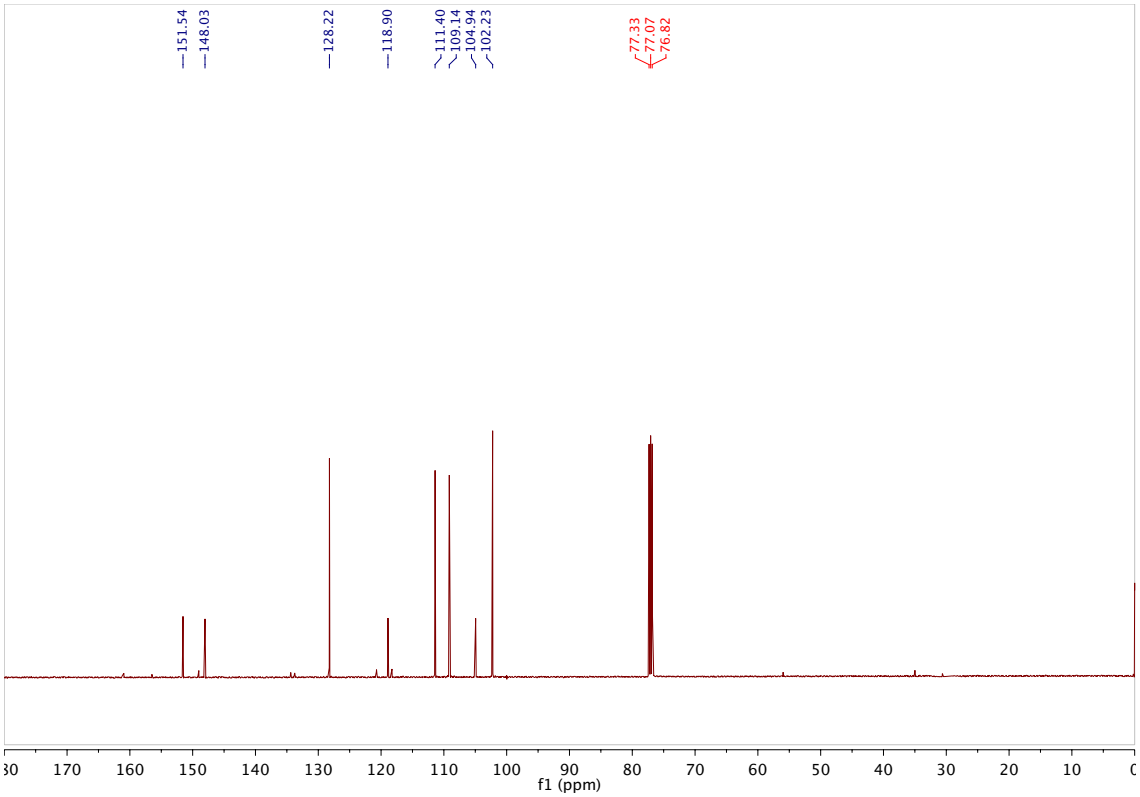

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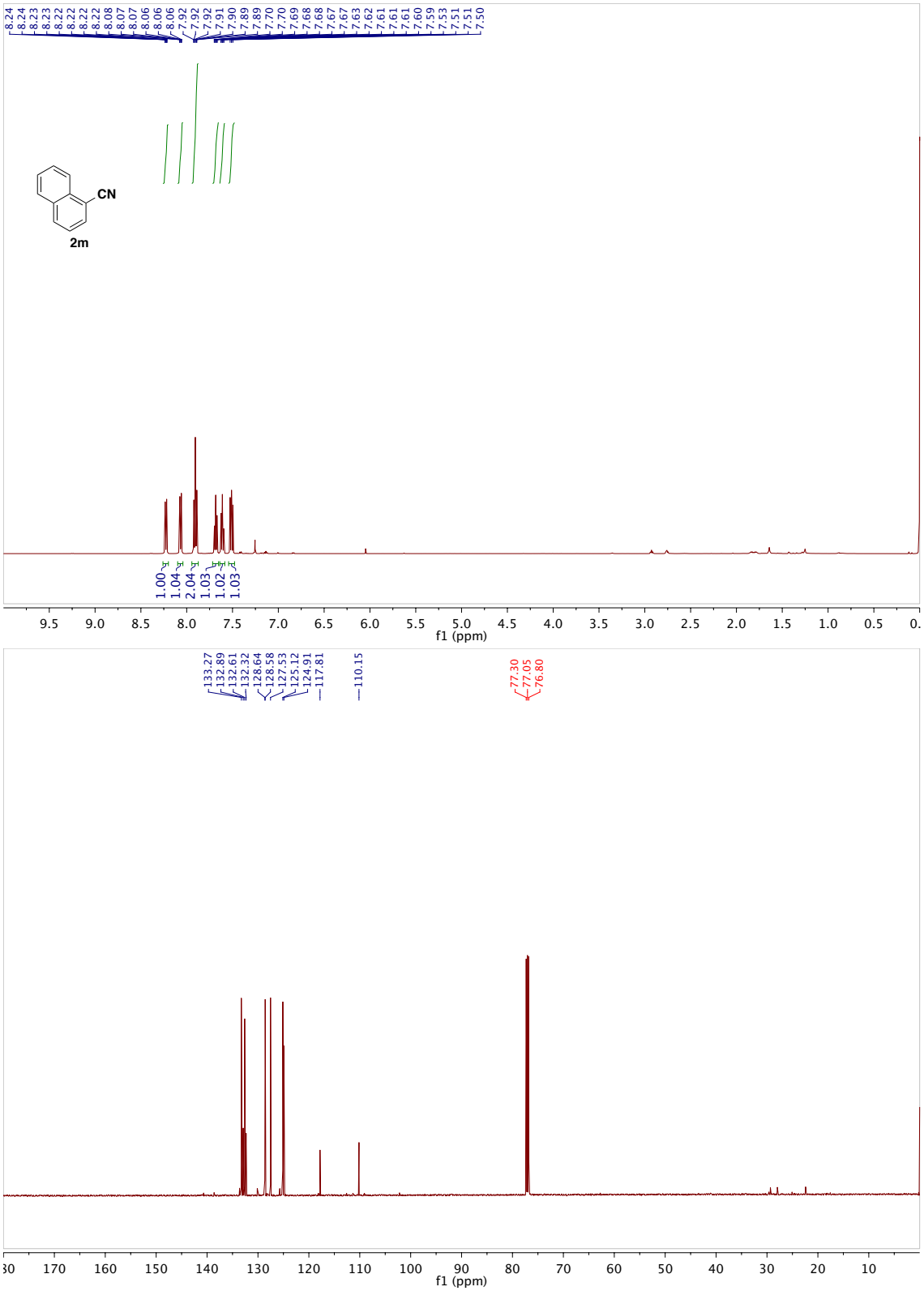
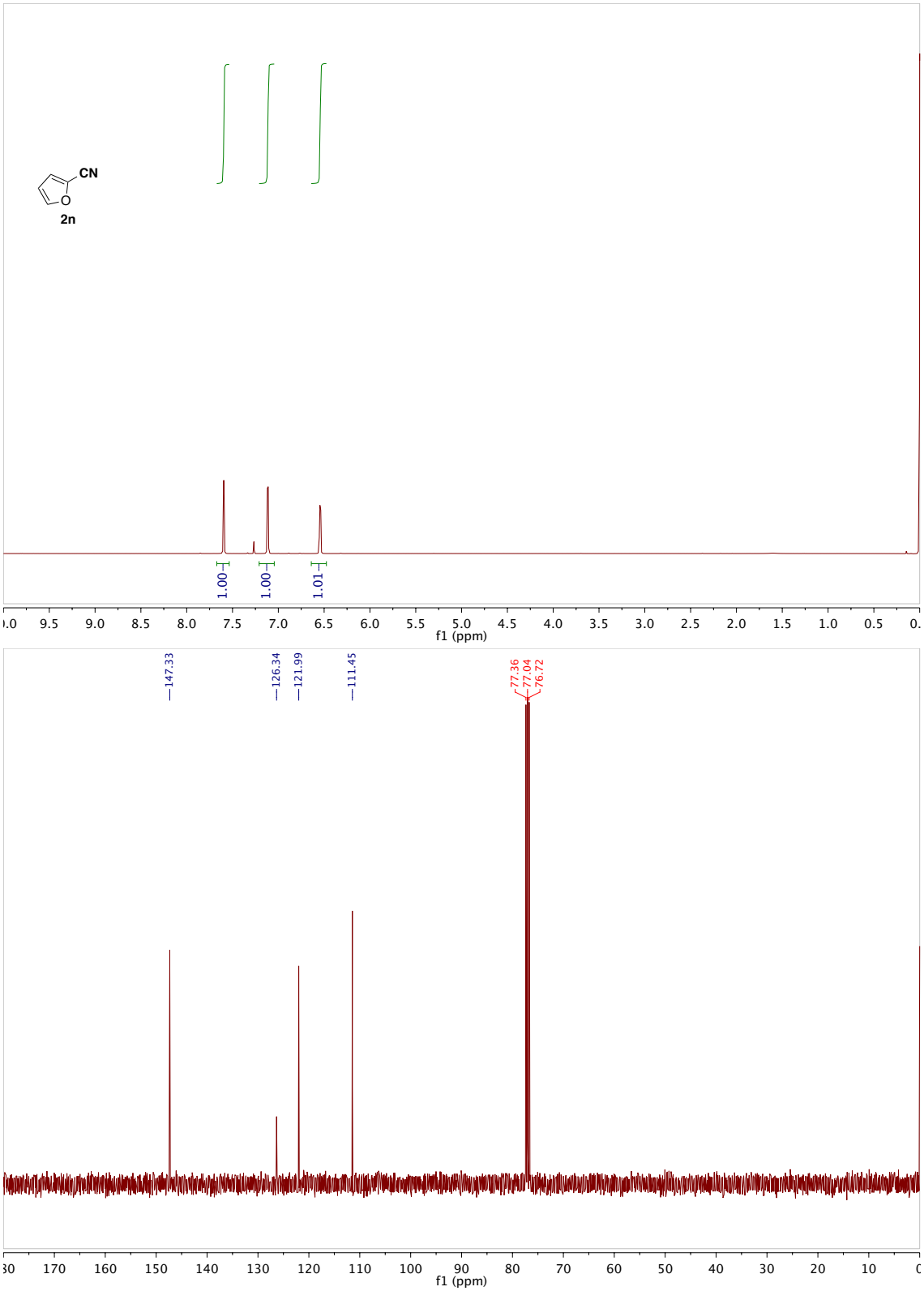
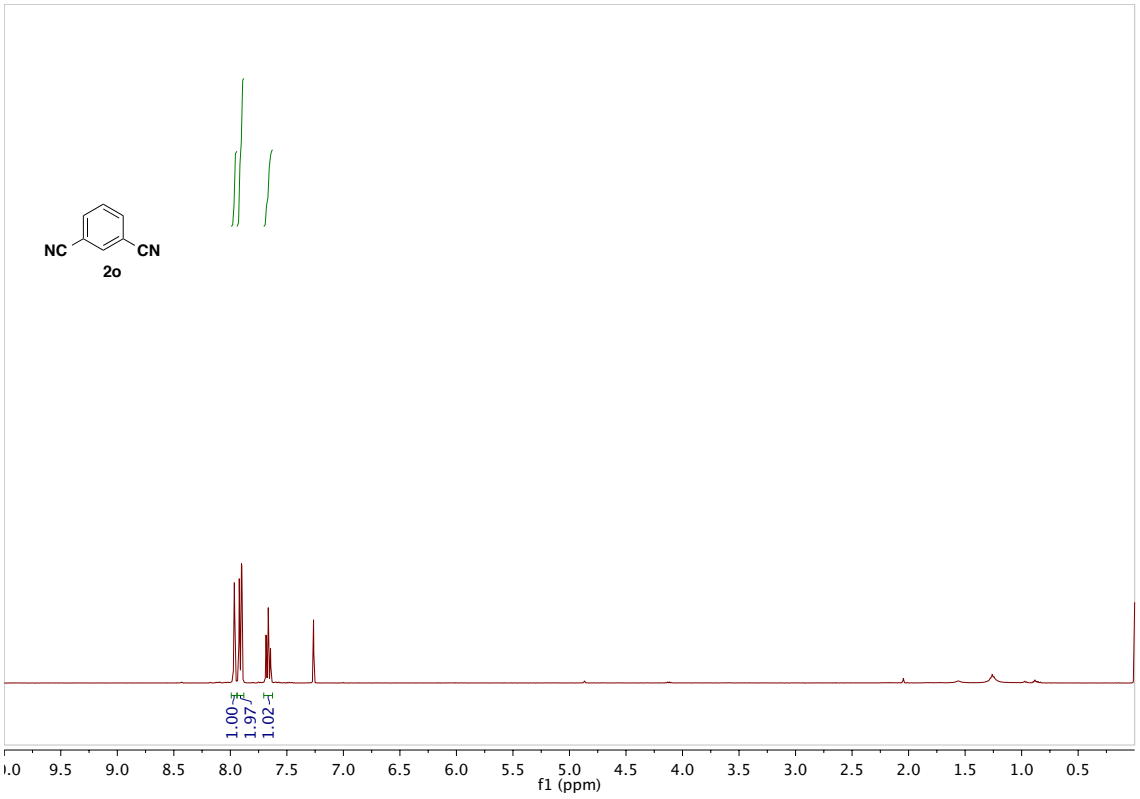
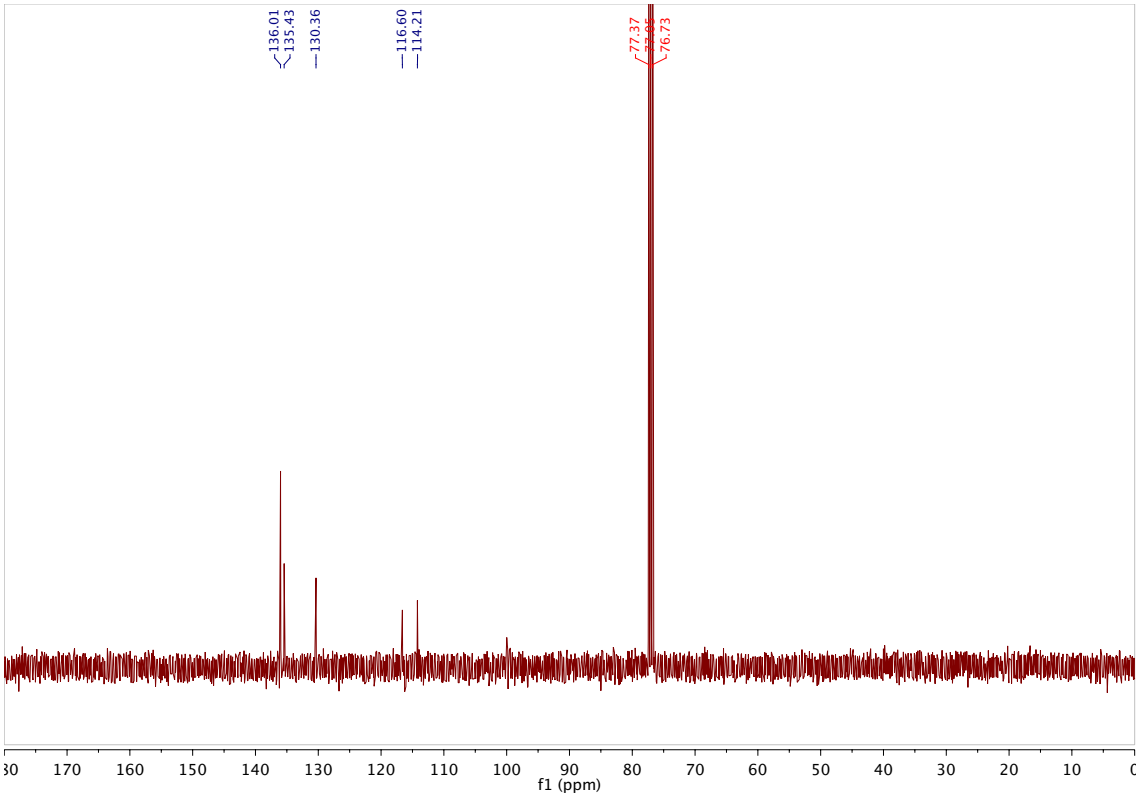


2-Furonitrile

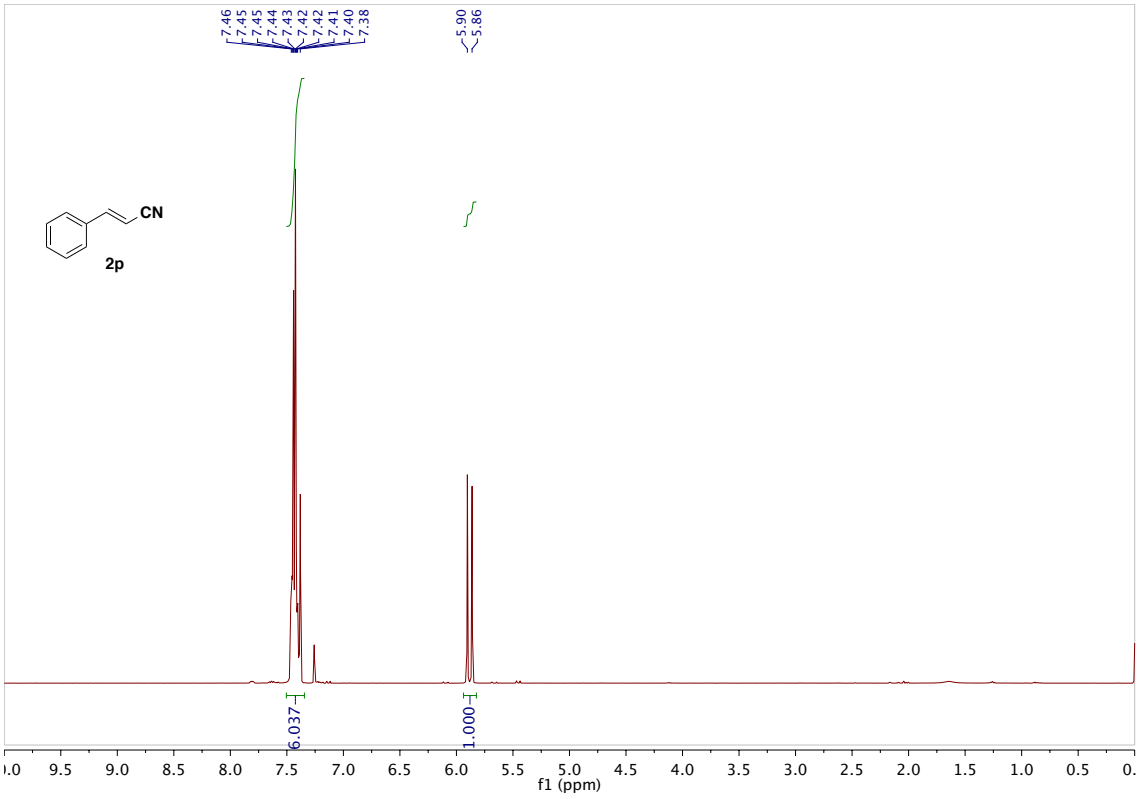


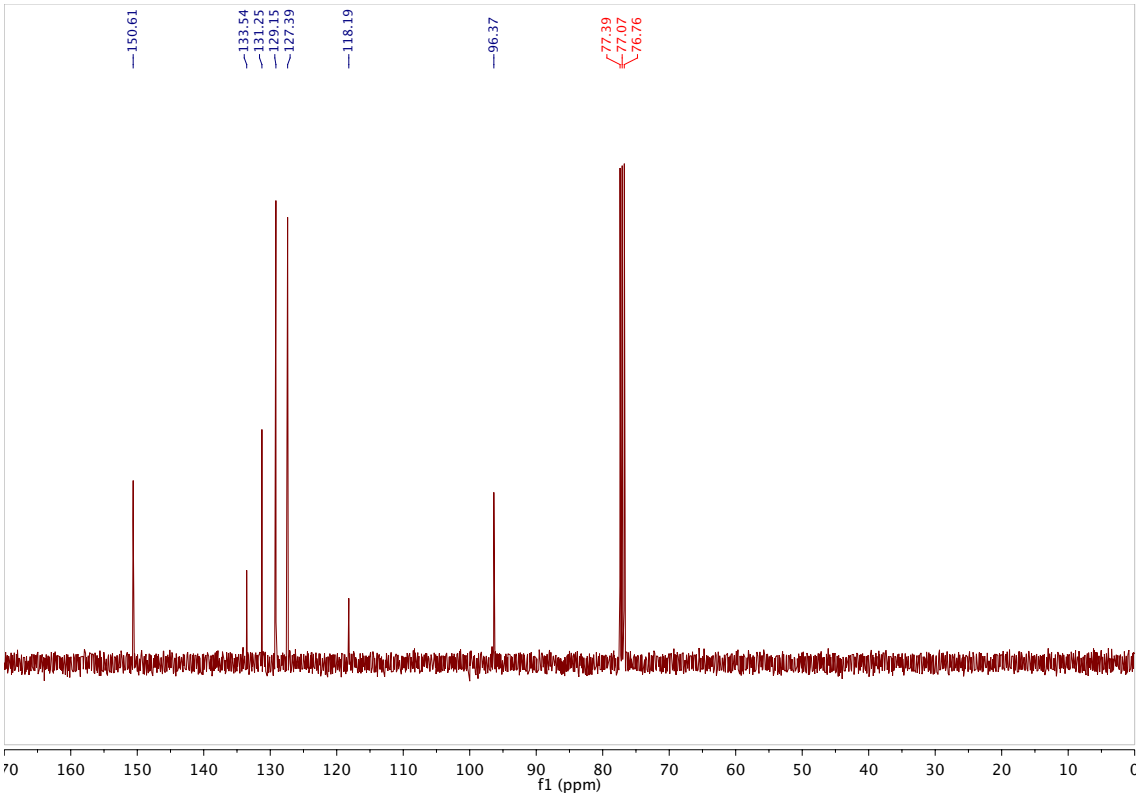
1,3-Dicyanobenzene



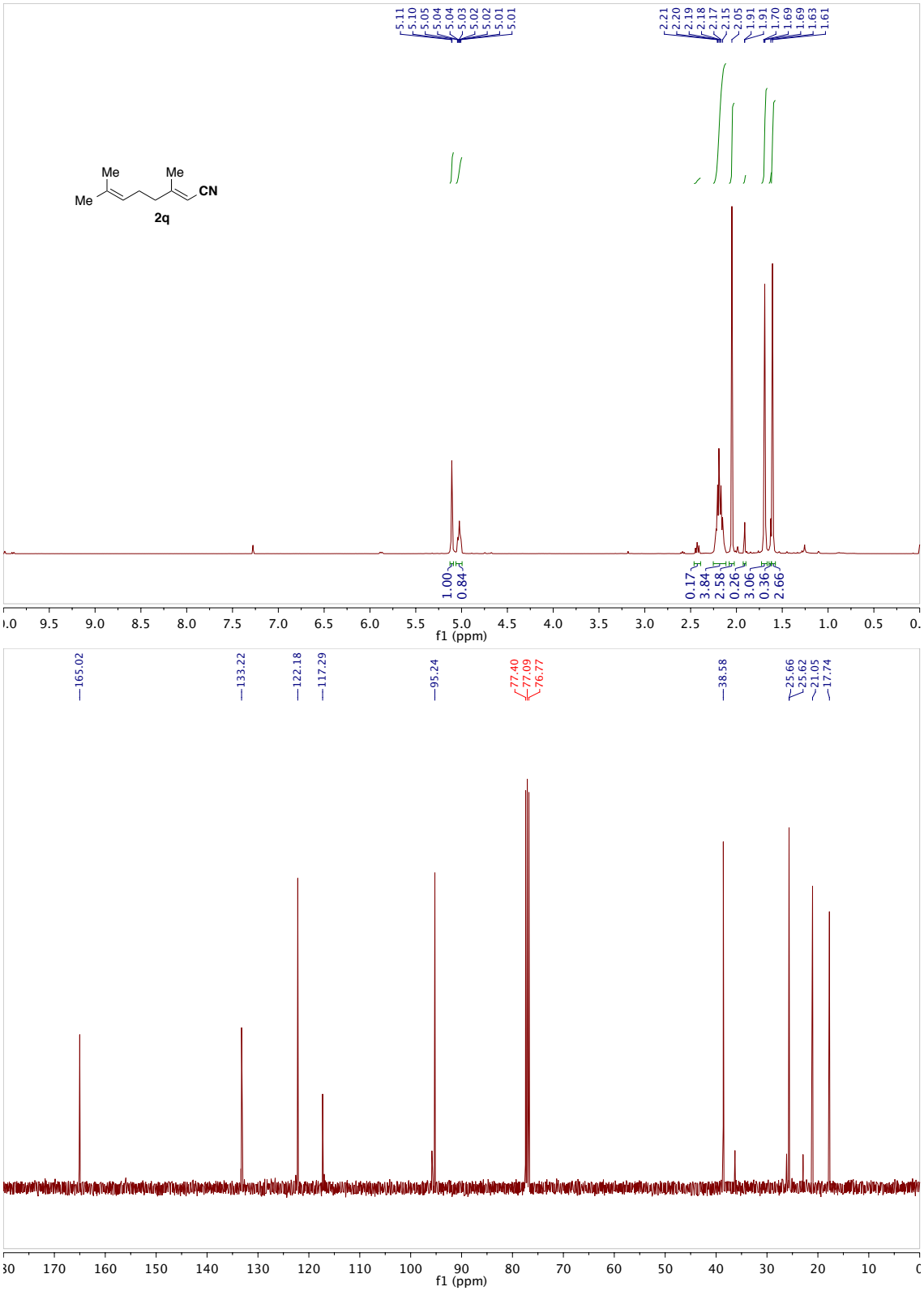


Cinnamonitrile

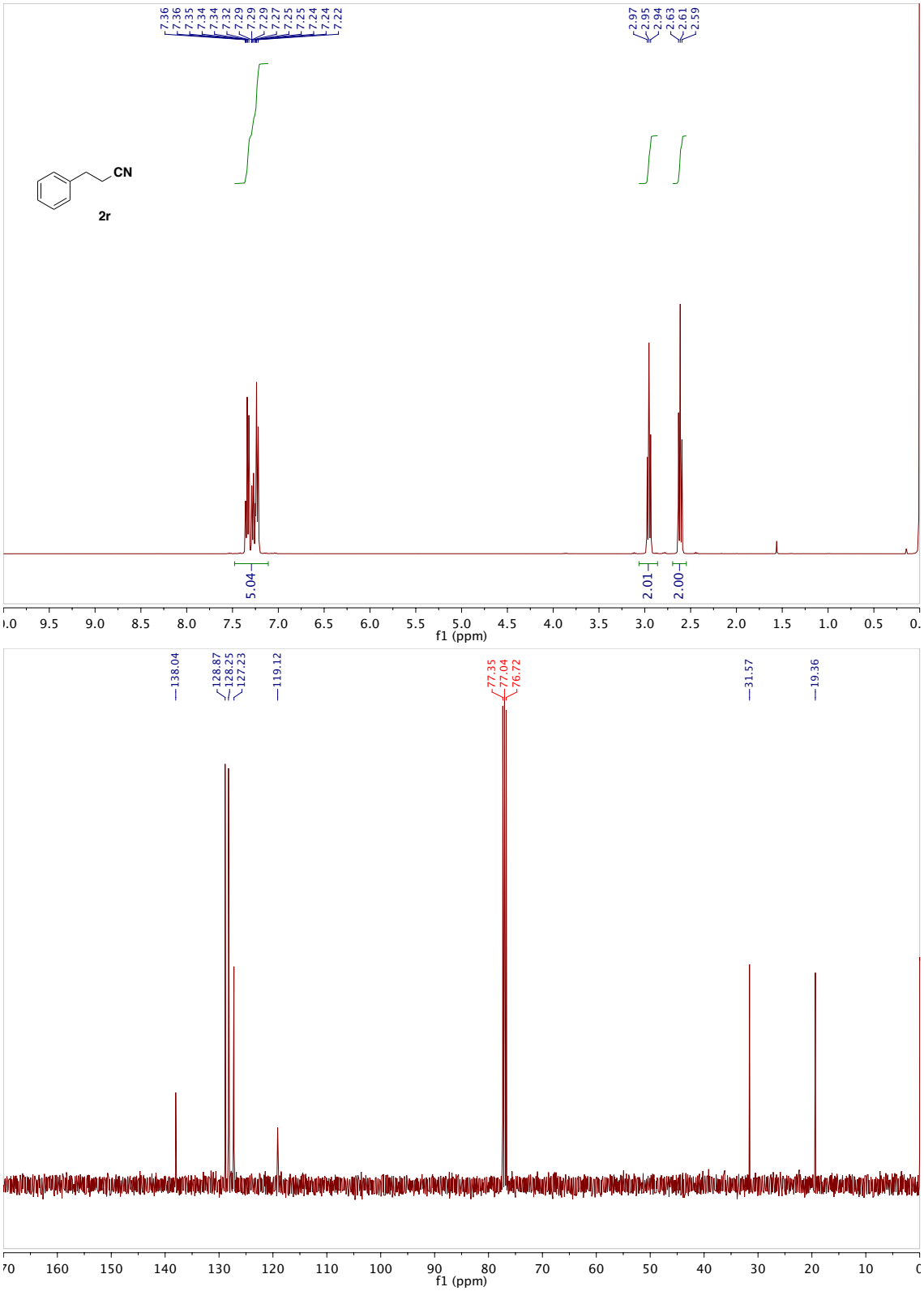




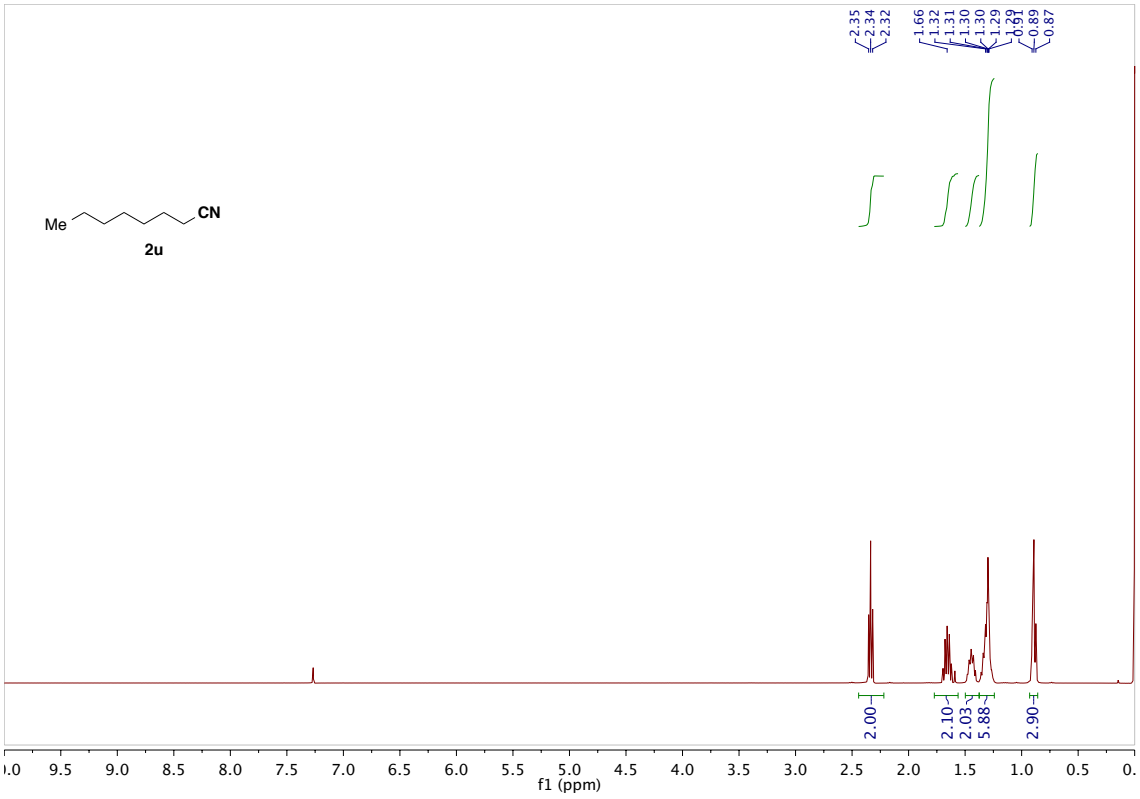
3,7-Dimethyl-2,6-octadienenitrile

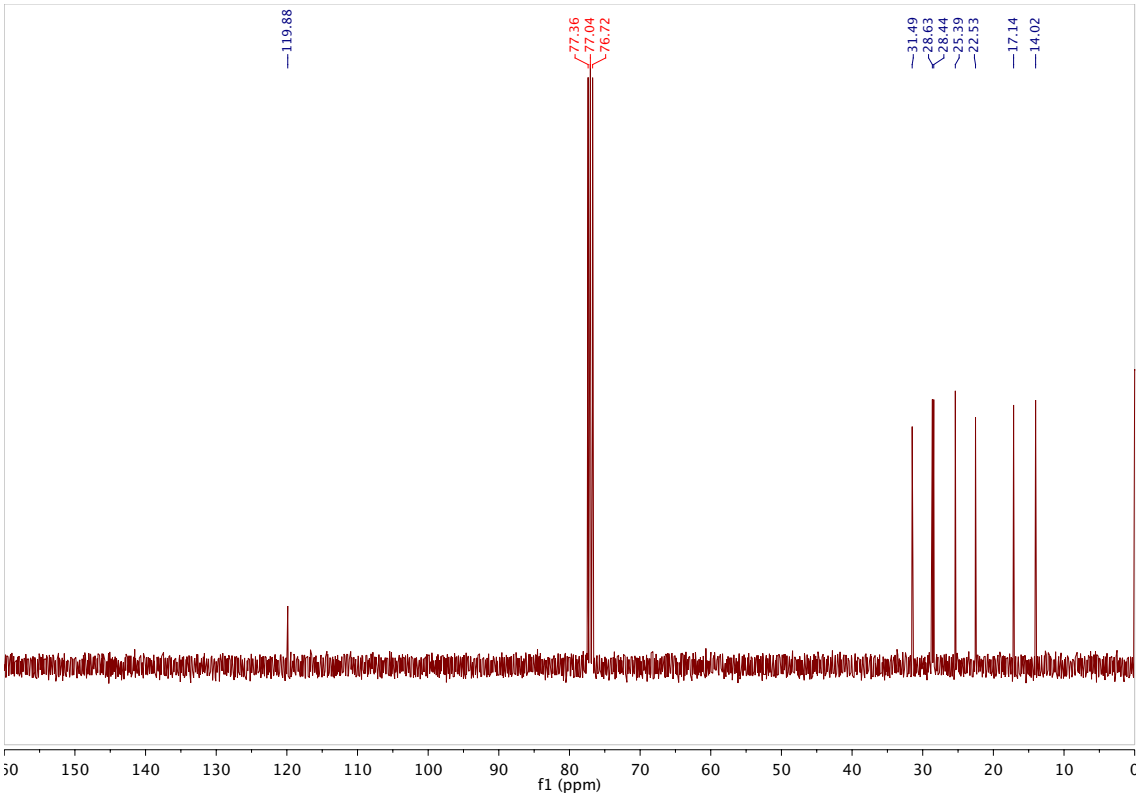


3-Phenylpropionitrile



Octanenitrile





Dodecanenitrile