Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Base controlled diverse reactivity of allyl cyanide for synthesis of multi-substituted benzenes

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Table of content

Screening of reaction condition

Table 1. Screening of base and temperature[a]

Entry	Base	Temperature (°C)	Yield (%)[b]	
			3j	**4j**
1	KOH	R.T.	-	-
2	NaOH	R.T.	-	-
3	LiOH	R.T.	-	-
4	K_2CO_3	R.T.	-	-
5	Cs_2CO_3	R.T.	-	-
6	K_3PO_4	R.T.	-	-
7	KO^{t}Bu	R.T.	-	-
8	NaH	R.T.	-	-
9	$NaNH_2$	R.T.	-	-
10	DBU	R.T.	-	-
11	n-BuLi	-78	Complex mixture	
12	Et_3N	R.T.	-	-
13	***KOH***	***60***	***15***	***68***
14	NaOH	60	10	24
15	***LiOH***	***60***	***15***	***75***
16	LiOH	100	12	65
17[c]	LiOH	100	15	62
18	K_2CO_3	60	trace	15
19	Cs_2CO_3	60	12	45
20	K_3PO_4	60	15	35
21	KO^{t}Bu	60	20	34
22	***NaH***	***60***	***82***	***-***
23	NaH	100	62	-
24[c]	NaH	100	65	-

25	***$NaNH_2$***	***60***	***52***	
26	DBU	60	-	-
27	Et_3N	60	-	-

[a] The reaction was conducted with 6-phenyl-4-piperidin-1-yl-2*H*-pyran-2-one-3-carbonitrile**1c** (0.5 mmol), allyl cyanide **2** (0.6 mmol), base (0.75 mmol) using DMF (5.0 mL); [b] Yield of isolated product;[c]Reaction was performed under microwave heating.

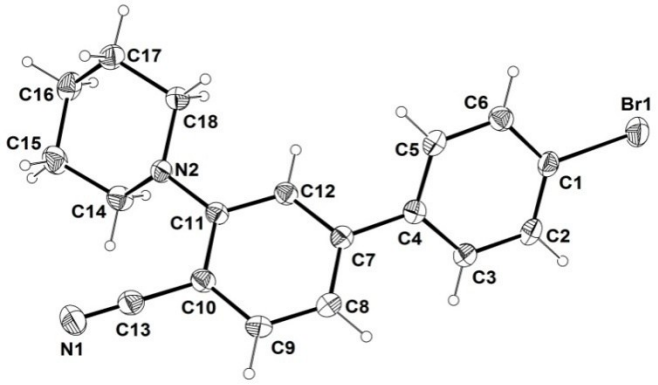
Table 2. Screening of solvent for cyanoallylationreaction[a]

Entry	**Base**	**Solvent**	**Yield (%)**[b]	
			3j	**4j**
1	***NaH***	***DMF***	**82**	**-**
2	NaH	DMSO	40	-
3	NaH	DMAc	55	
4	NaH	NMP	25	
5	NaH	MeCN	-	-
6	NaH	THF	50	
7	NaH	Toluene	-	-
8	***LiOH***	***DMF***	**15**	**75**
9	LiOH	DMSO	12	40
10	LiOH	DMAc	trace	35
11	LiOH	NMP	-	-
12	LiOH	MeCN	-	-
13	LiOH	THF	-	-
14	LiOH	Toluene	-	-

[a]The reaction was conducted with 6-phenyl-4-piperidin-1-yl-2*H*-pyran-2-one-3-carbonitrile**1c** (0.5 mmol), allyl cyanide **2** (0.6 mmol), base (0.75 mmol) using solvent (5.0 mL) at 60 ^{o}C; [b] Yield of isolated product.

X-ray Crystallography

Intensity data for both the compounds were collected at 298(2) K on an Agilent Xcaliburdiffractometer using graphite monochromated Mo-Kα radiation λ = 0.71073 Å. Unit cell determination, data collection and data reduction were performed with CrysAlisPro.[1] The structure was solved by direct methods (SIR97)[2] and refined by a full-matrix least-squares procedure based on F^2 (Shelxl-2014).[3] All non-hydrogen atoms were refined anisotropically; hydrogen atoms were located at calculated positions and refined using a riding model. All hetero hydrogen atoms have been located in the difference Fourier map and were refined with bond lengths restraints.



Crystal Data of (3o). $C_{18}H_{17}BrN_2$, M = 341.24, Monoclinic, $P2_{1/n}$, a = 9.541(3) Å, b = 14.222(4) Å, c = 12.432(3) Å, β= 110.54(3)°, V = 1579.7(8) $Å^3$, Z=4, D_{calc}=1.435 mg m^{-3}, F(000) = 696, crystal size 0.020 × 0.020 × 0.010 mm, reflections collected 17476, independent reflections 3887 [R(int) = 0.1071], Final indices [I> 2σ(I)] R1 = 0.0650, wR2 = 0.1571, R indices (all data) R1 = 0.1354, wR2 = 0.1983, gof 1.032, Largest difference peak and hole 0.458 and -0.674 e $Å^{-3}$. CCDC No. 1520565.

1. CrysAlis CCD, RED version 1.711.13, copyright 1995-2003, Oxford Diffraction Poland Sp..
2. SIR97 - Altomare,A.; Burla,M. C.; Camalli,M.; Cascarano,G. L.; Giacovazzo,C.; Guagliardi,A.; Moliterni,A. G. G.; Polidori, G.; Spagna,R. *J. Appl. Crystallogr*.**1999**, ***32***, 115-119.
3. Sheldrick, G. M. Crystal structure refinement with *SHELXL*. *Acta Cryst*. **2015**,*C71*, 3-8.

NMR experiments for mechanistic insight

Experiment 1

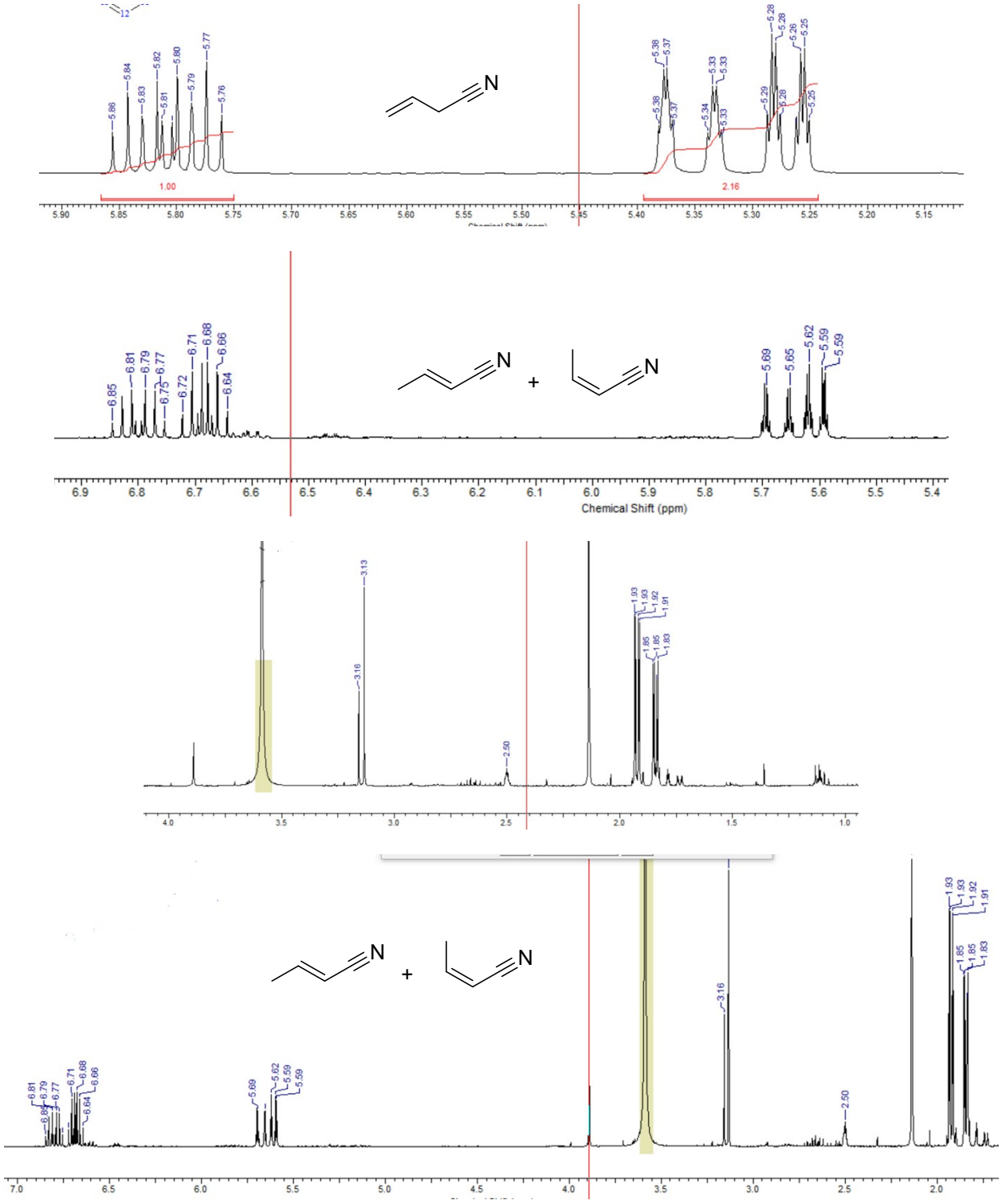
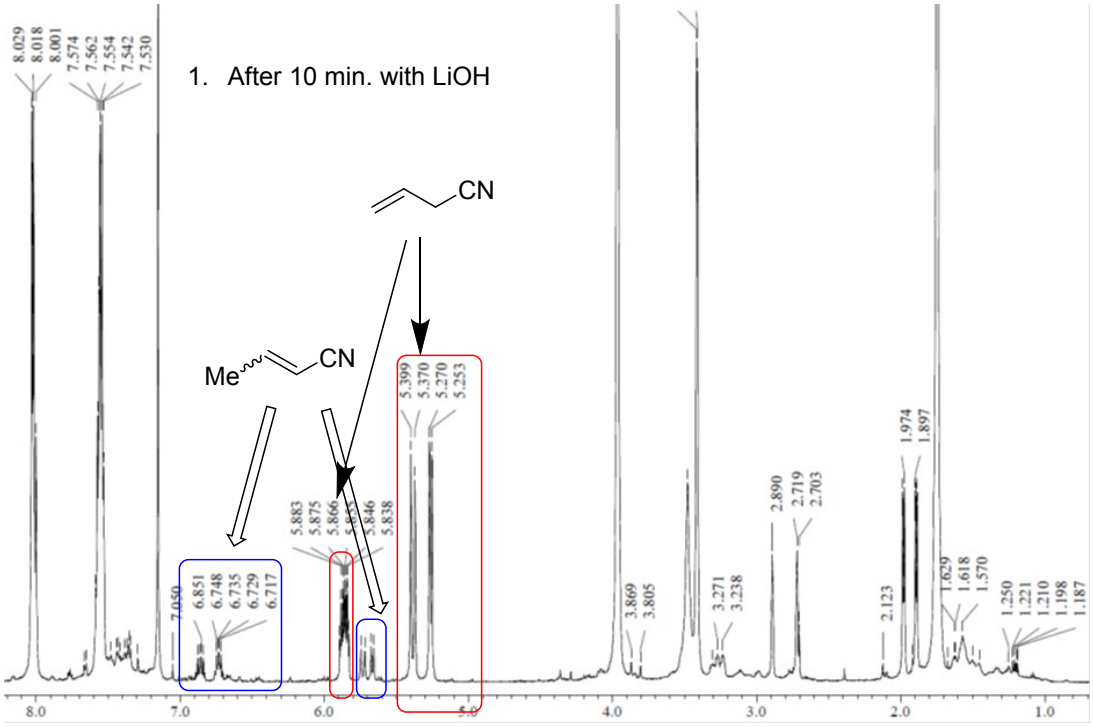
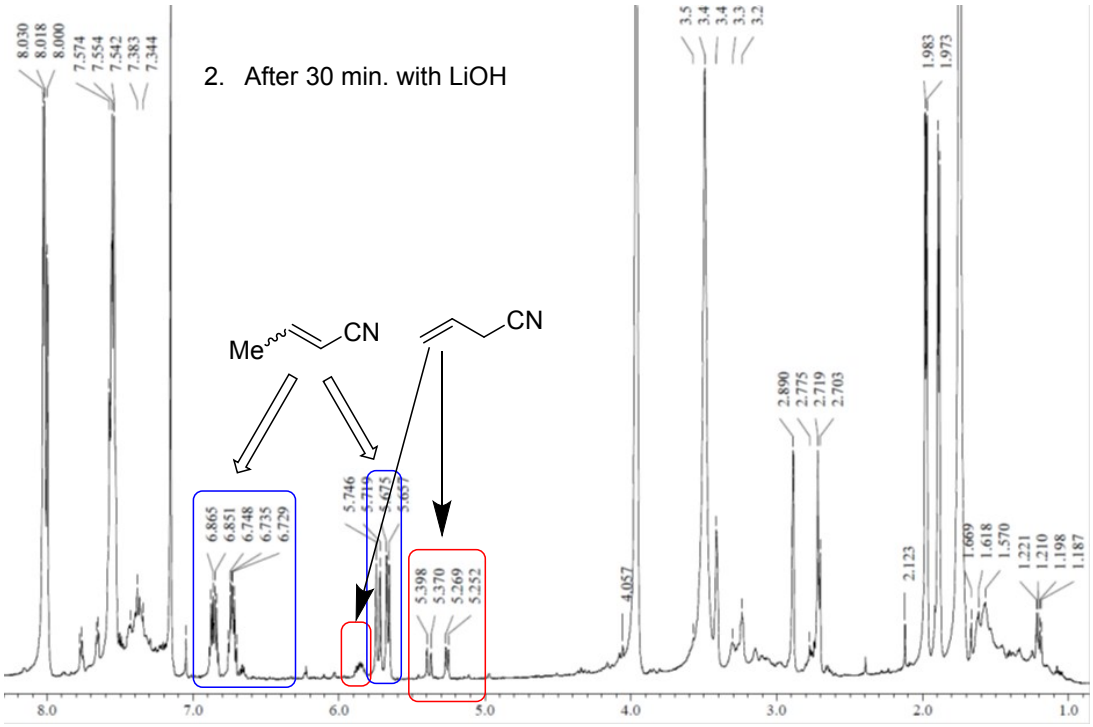


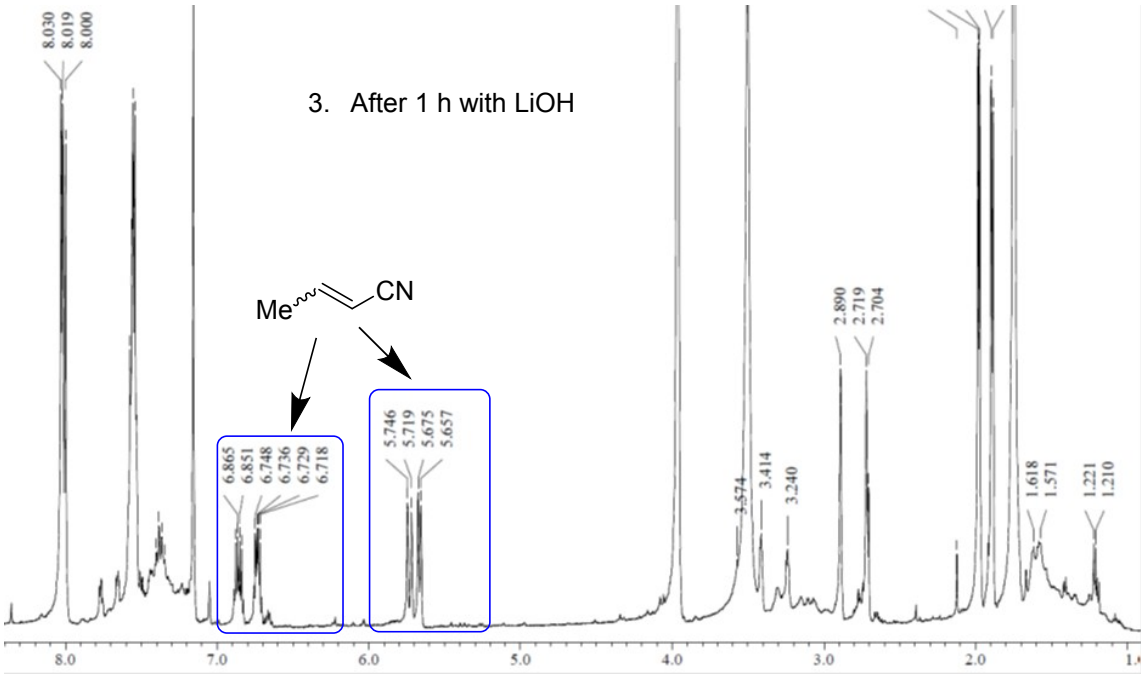
Figure 1.[1]H NMR of allyl cyanide and its reaction with base in DMSO-d_6

Experiment 2

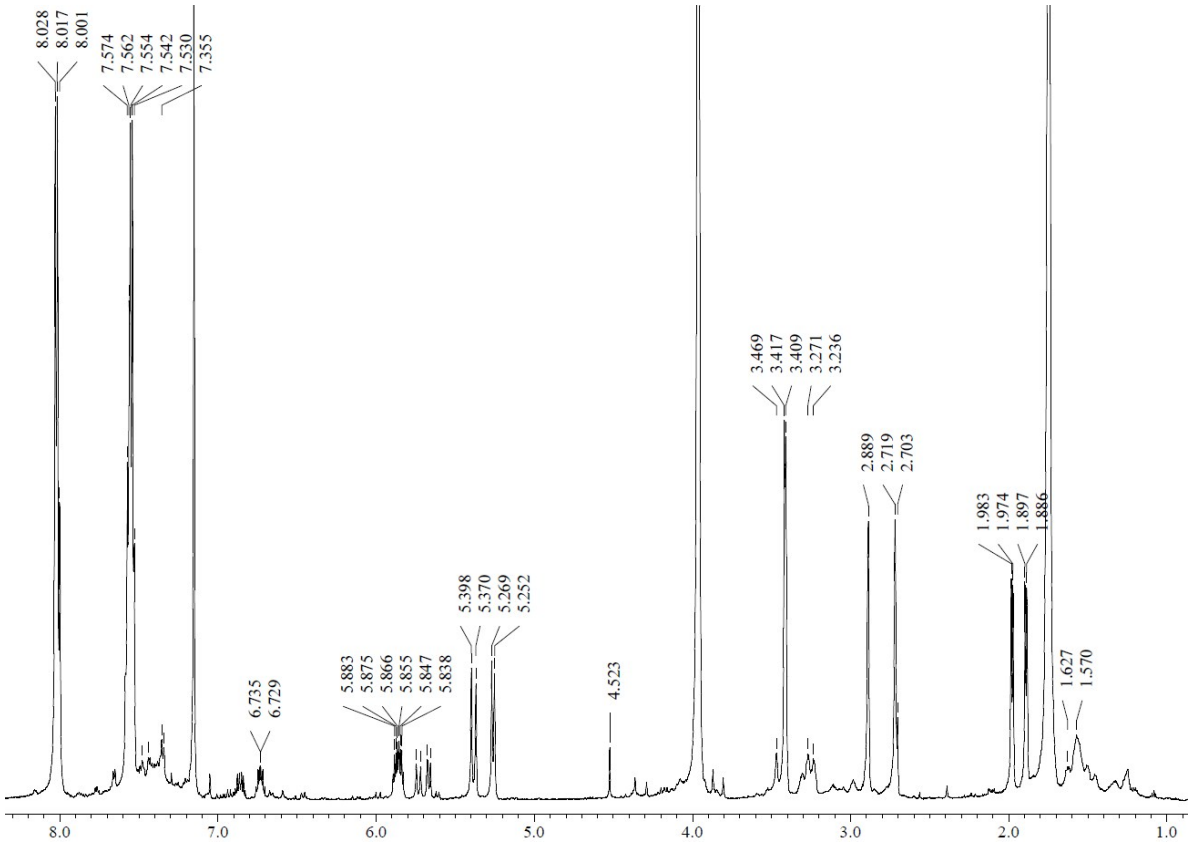
Reaction of **1c** and **2** was performed at 60 °C with LiOH/NaH in DMF-d_7 under standardized reaction condition and spectra of reaction mixture were recorded at different time intervals.



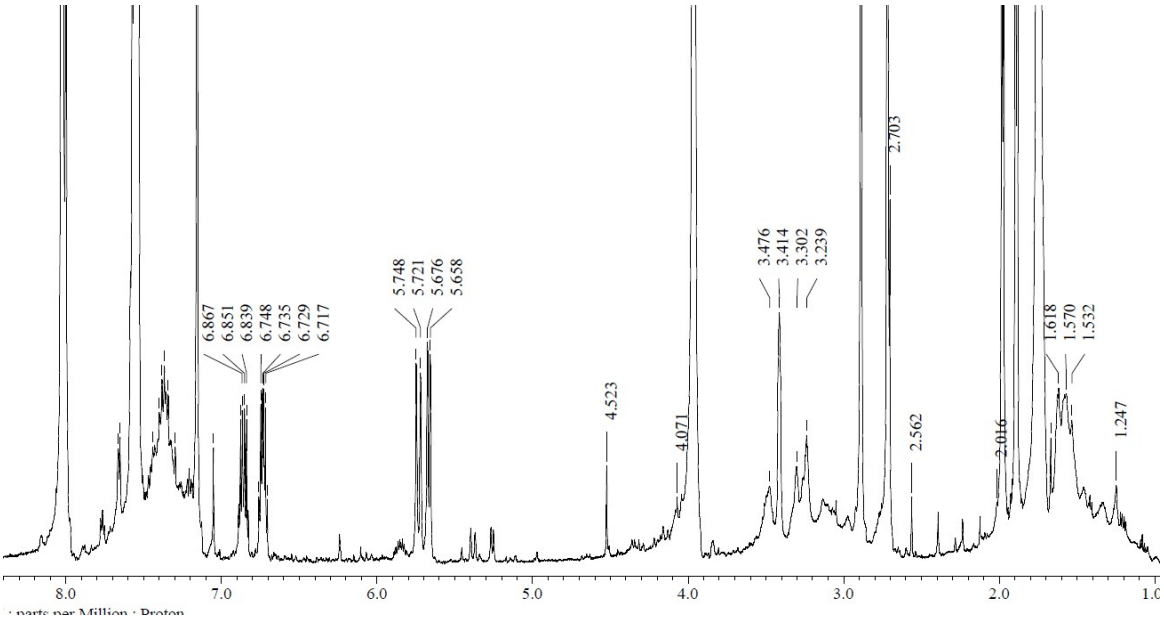




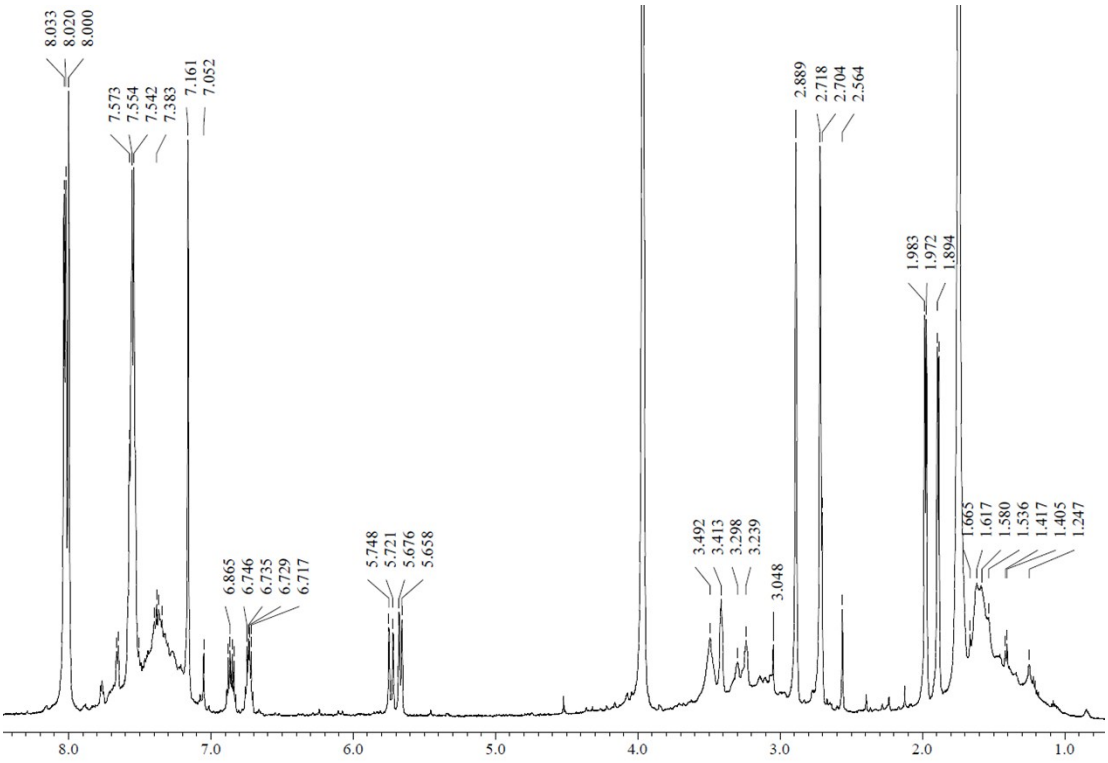
4.After 10min. with NaH



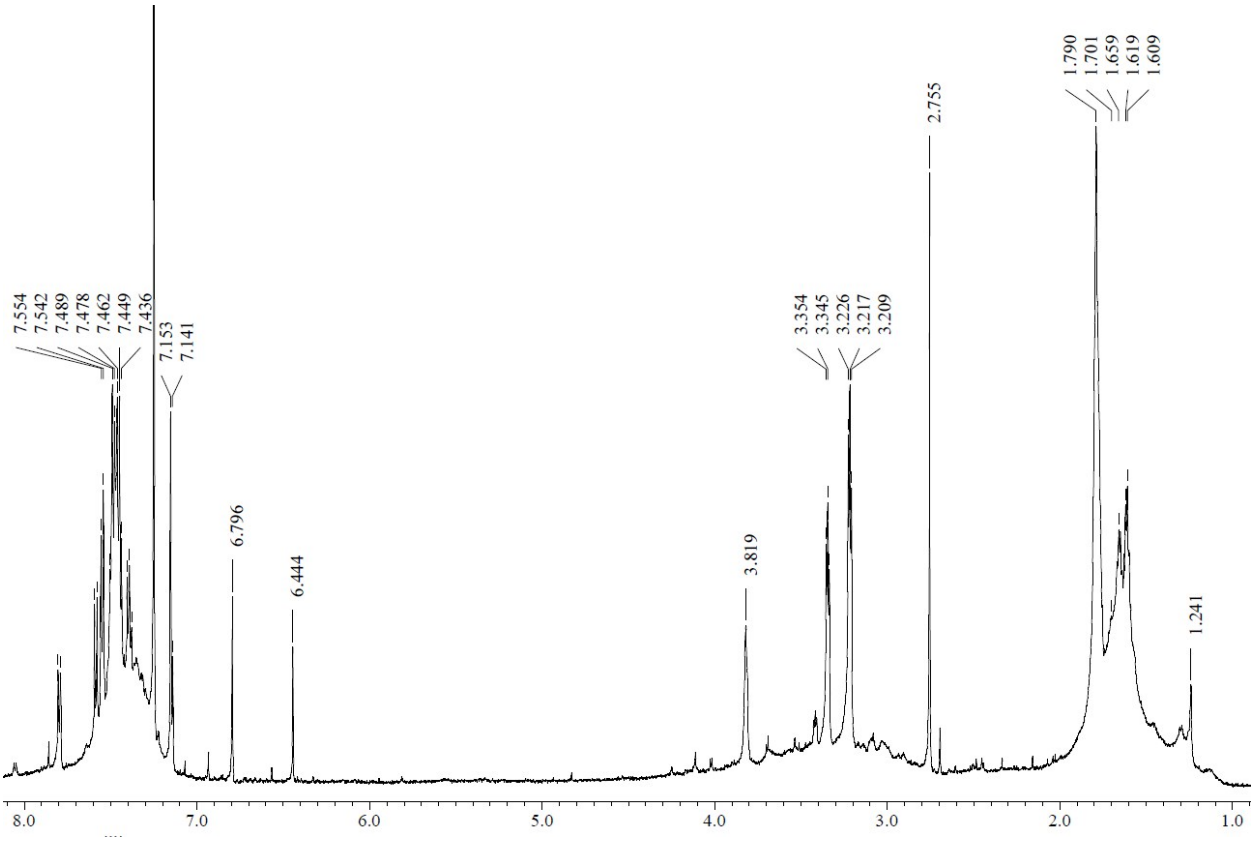
5. After30 min with NaH



6. After1h with NaH

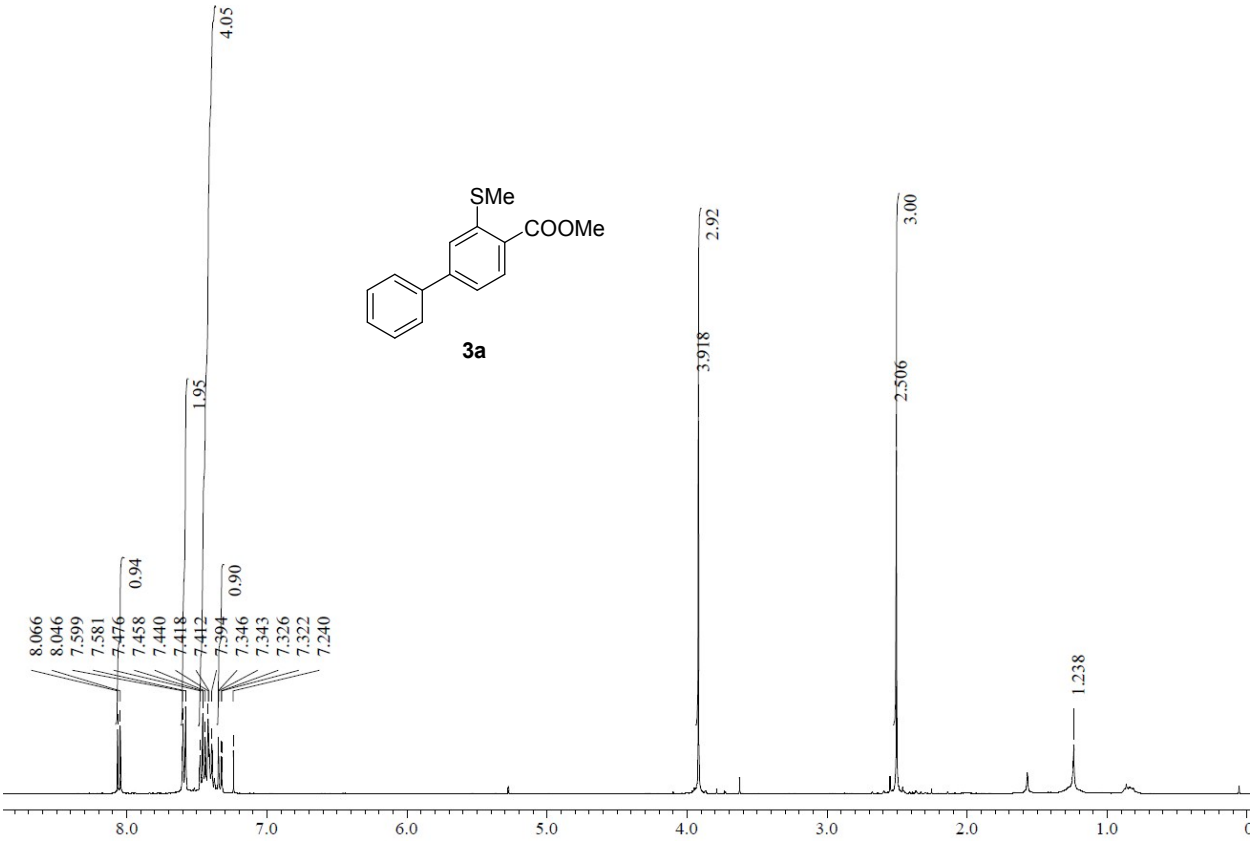


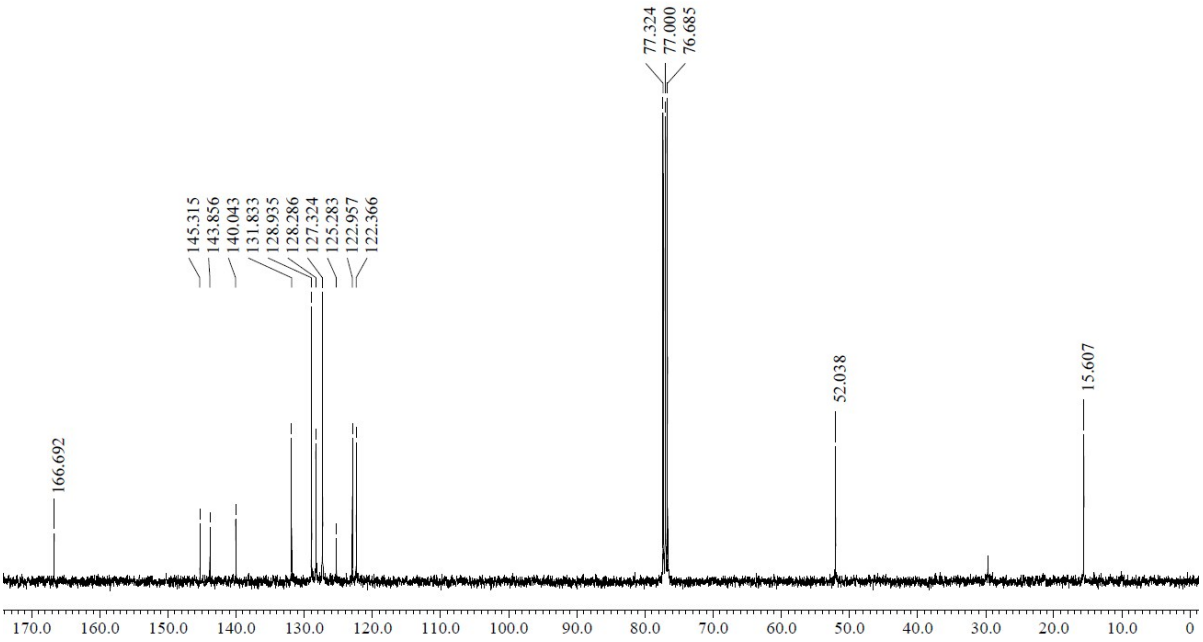
7. After completion of reaction



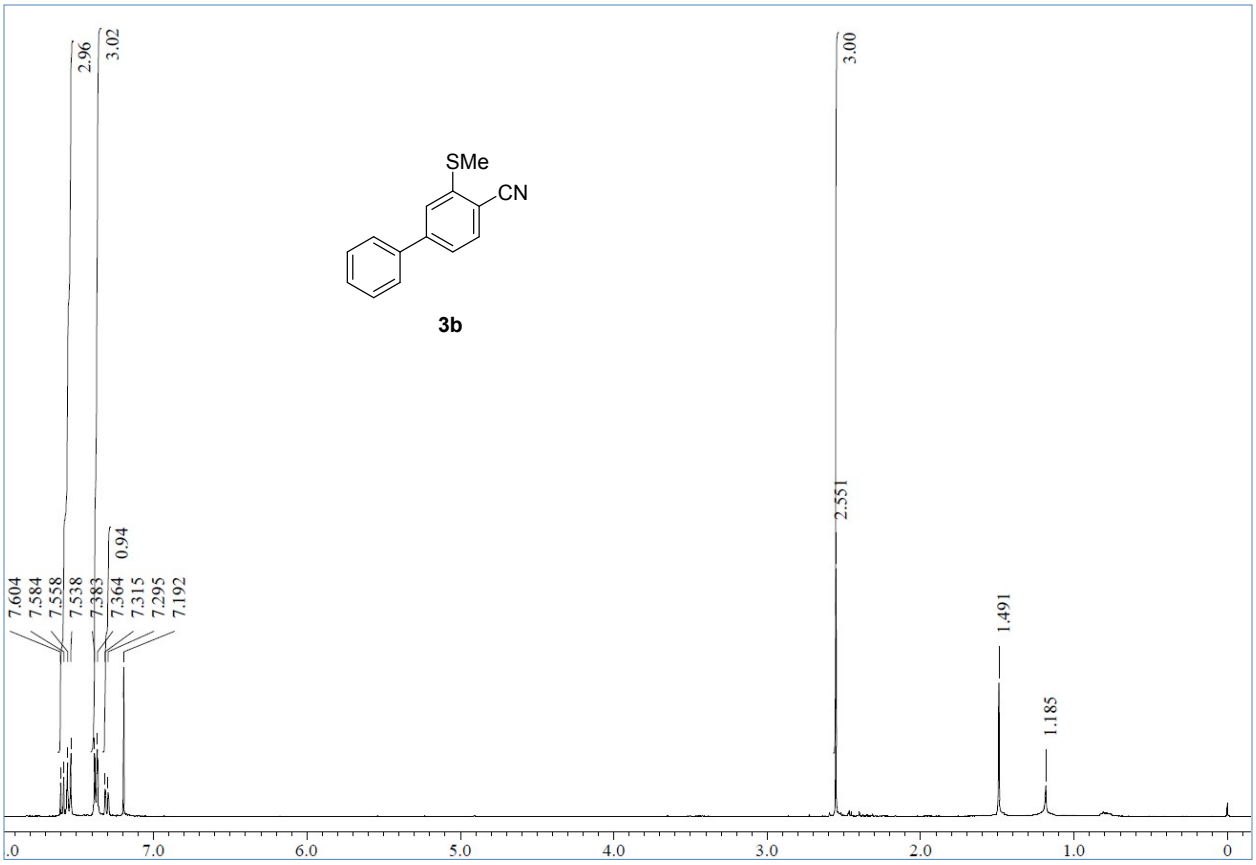
In second NMR experiment ^{1}HNMR of reaction were recorded at 10 min., 30 min., 60 min. and after completion of reaction and it was found that at 10 min allyl cyanide exist as major reactant with minor mixture of E/Z-but-2-enenitrile. After 30 min. allyl cyanide becomes minor reactant with minor mixture of E/Z-but-2-enenitrile and after 60 min. allyl cyanide disappears from the reaction mixture. The pattern remains same in both cases. This confirms that the first step is isomerization of allyl cyanide to E/Z-but-2-enenitrile which further reacts with 2*H*-pyran-2-ones.

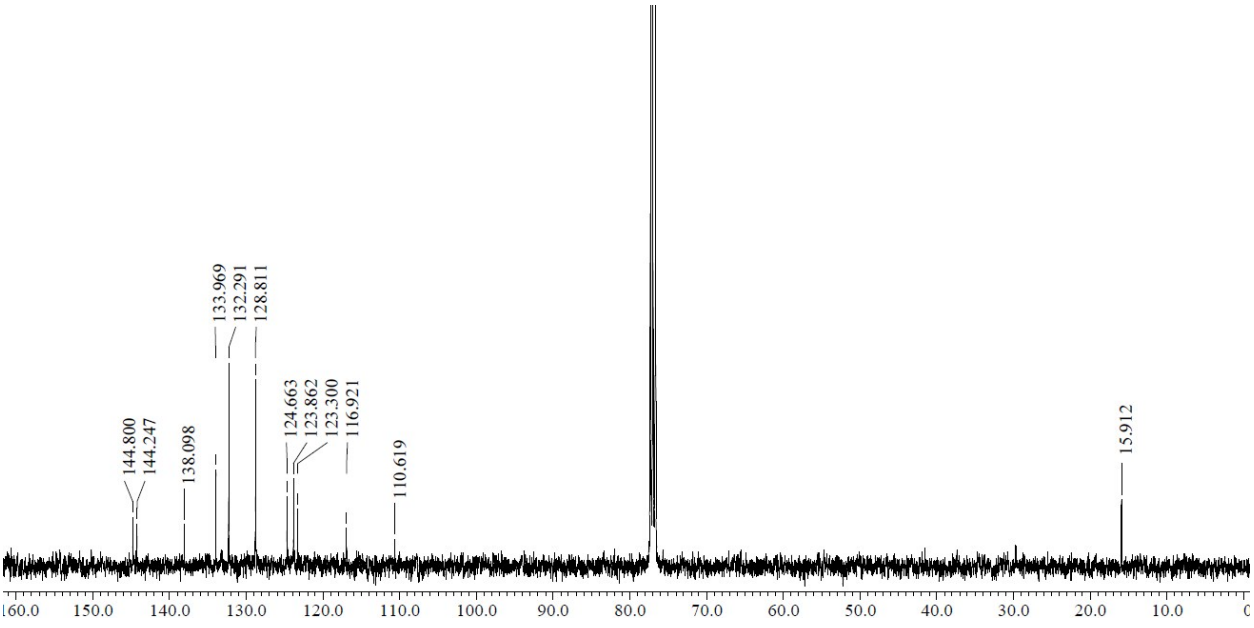
Spectral Data of Products



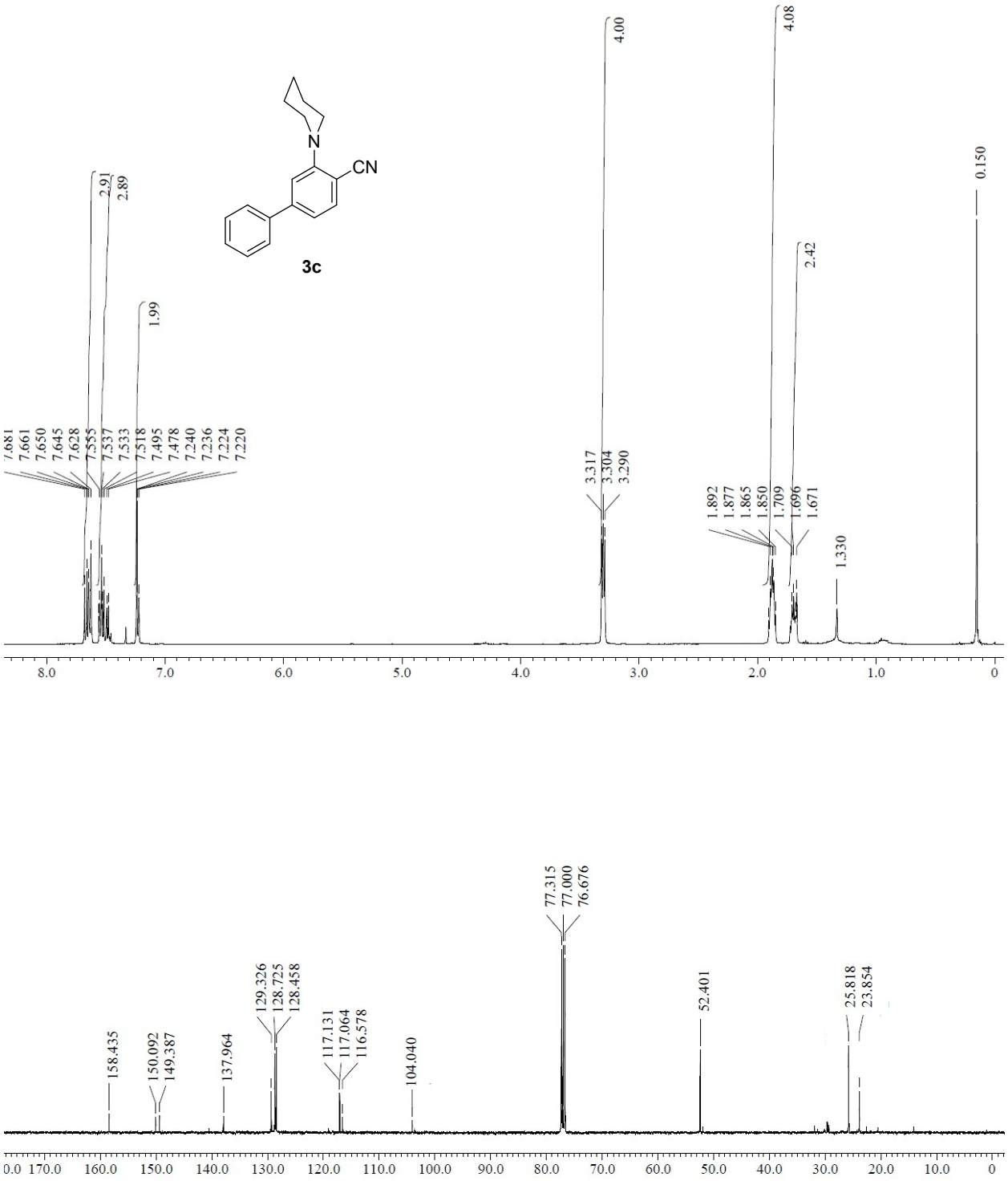


^{1}H and **^{13}C** spectra of **3a**

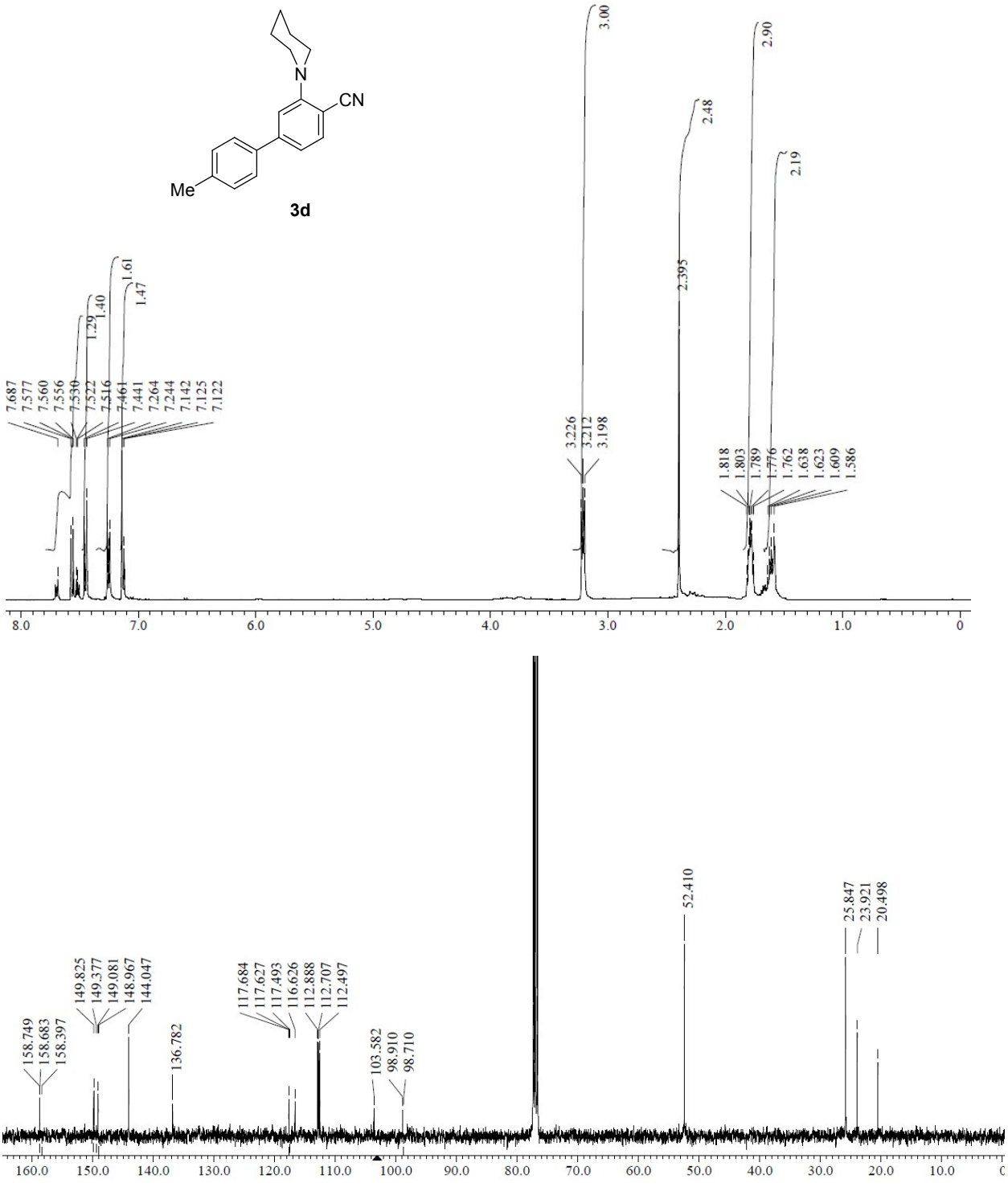




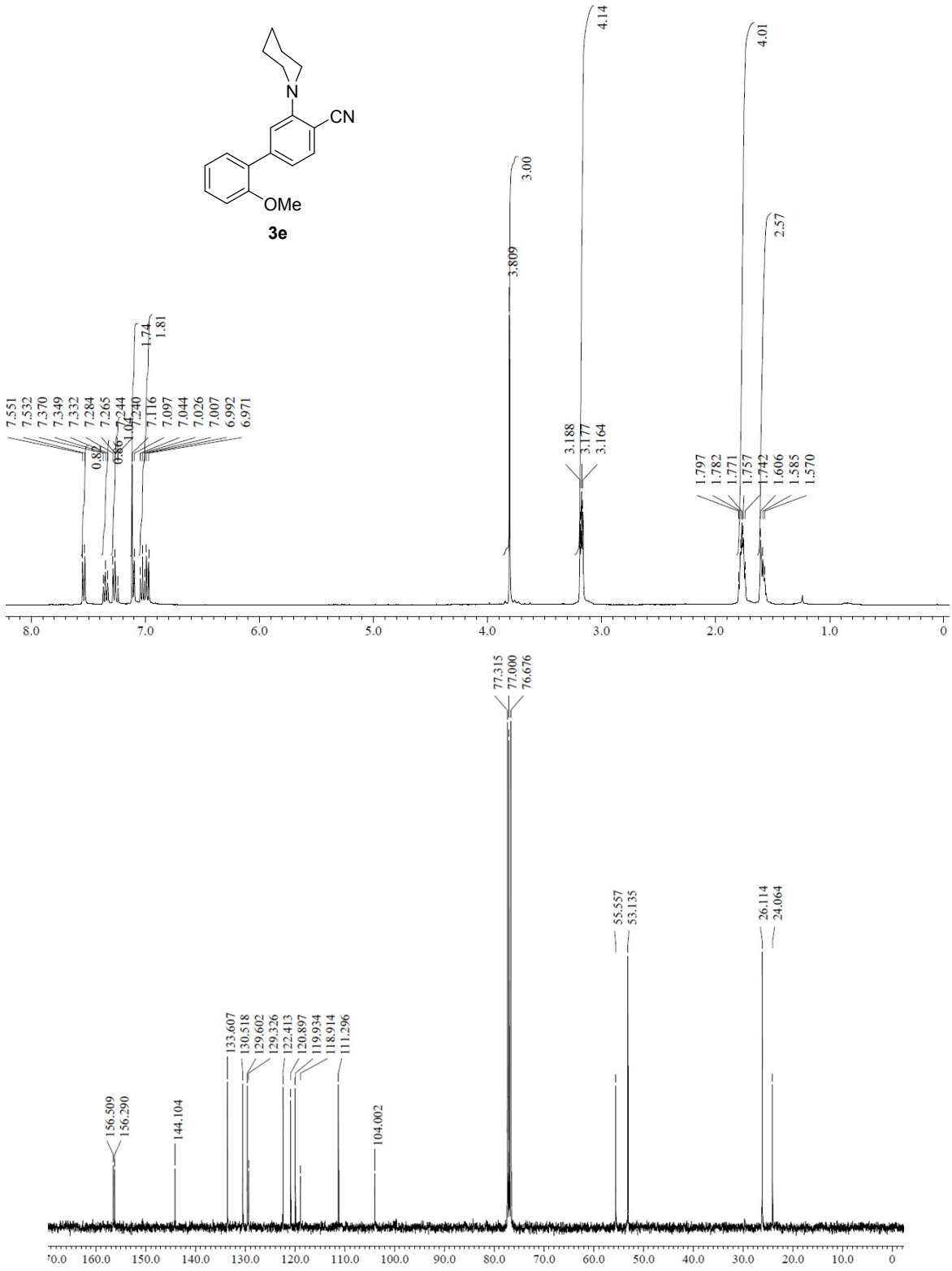
^{1}H and **^{13}C** spectra of **3b**



^{1}H and **^{13}C** spectra of **3c**



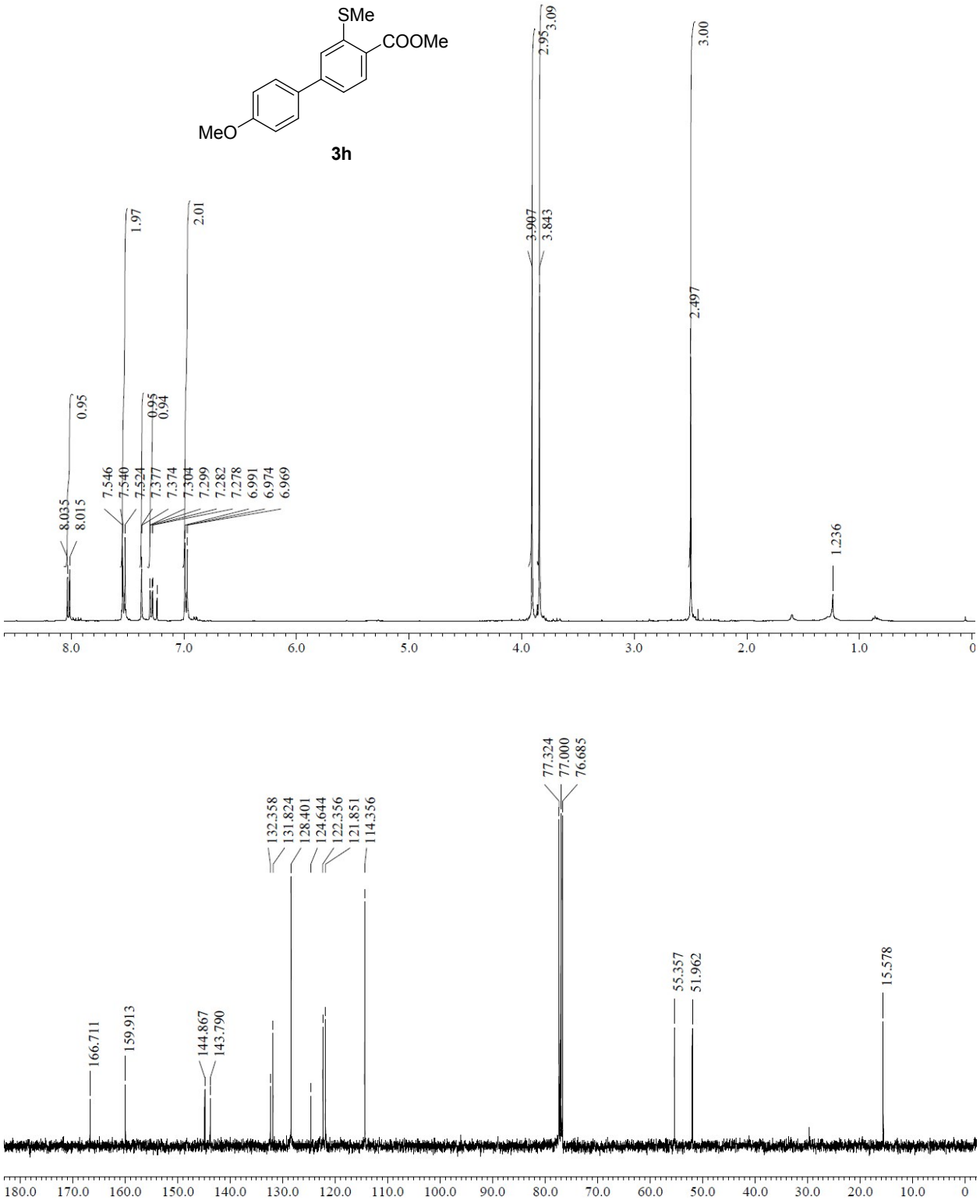
^{1}H and **^{13}C** spectra of **3d**



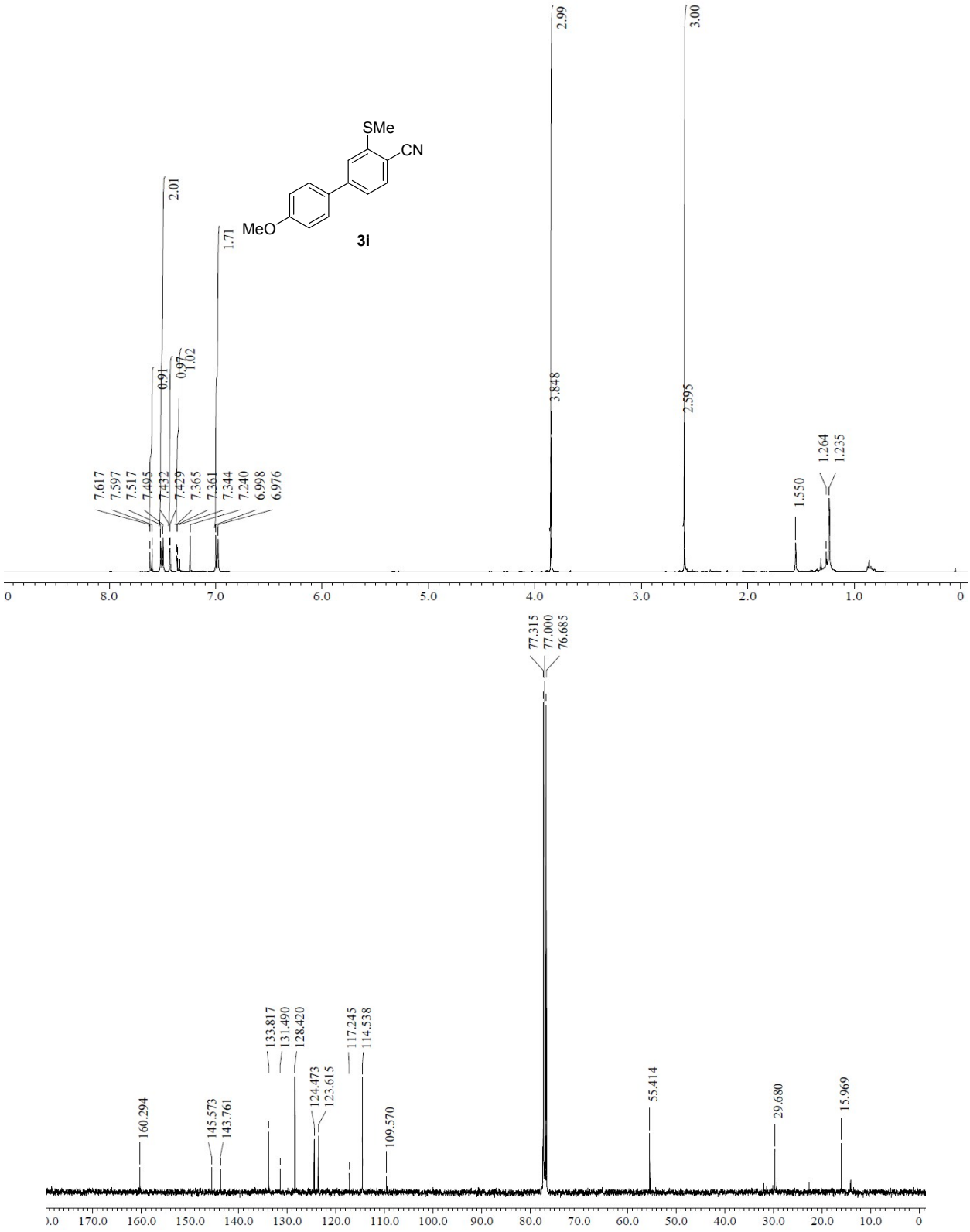
^{1}H and **^{13}C** spectra of **3e**

^{1}H and **^{13}C** spectra of **3f**

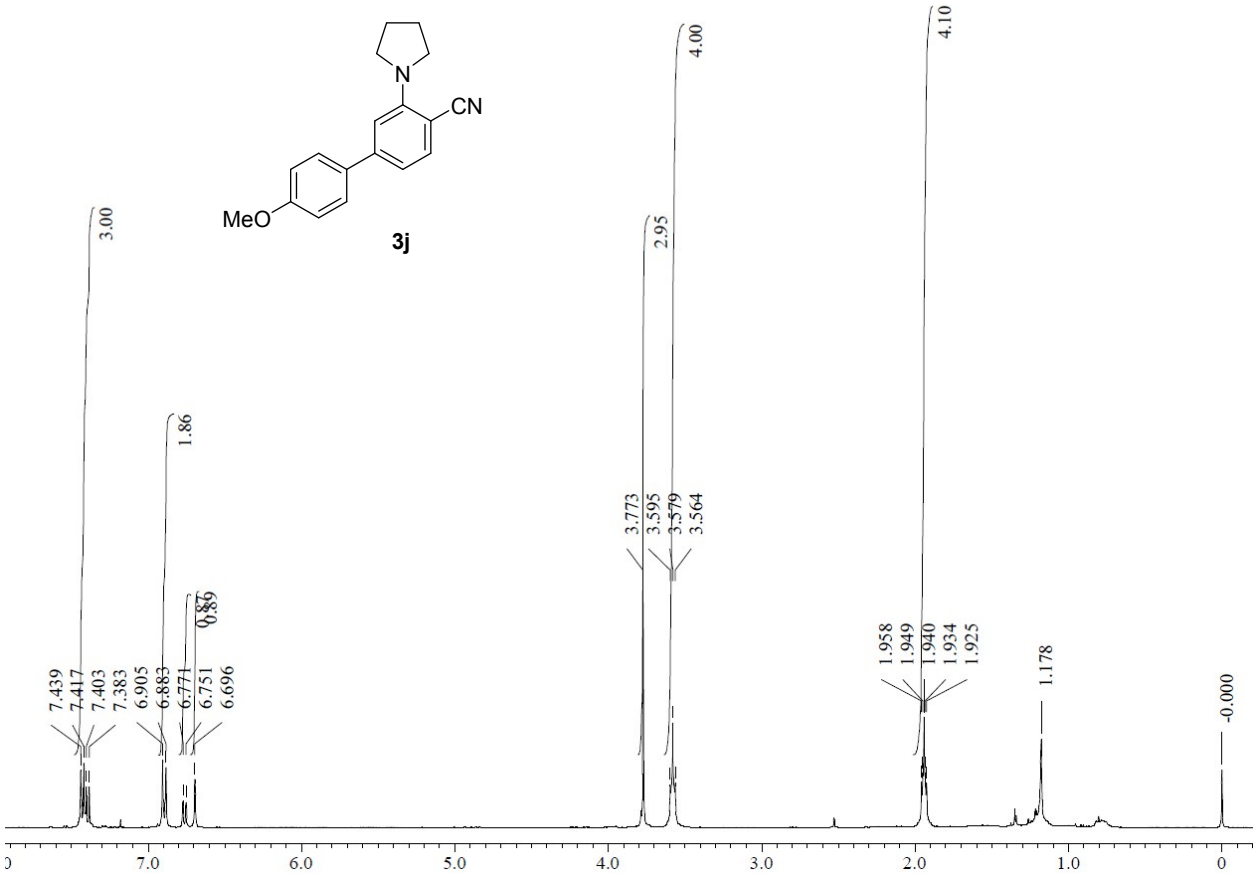
^{1}H and **^{13}C** spectra of **3g**

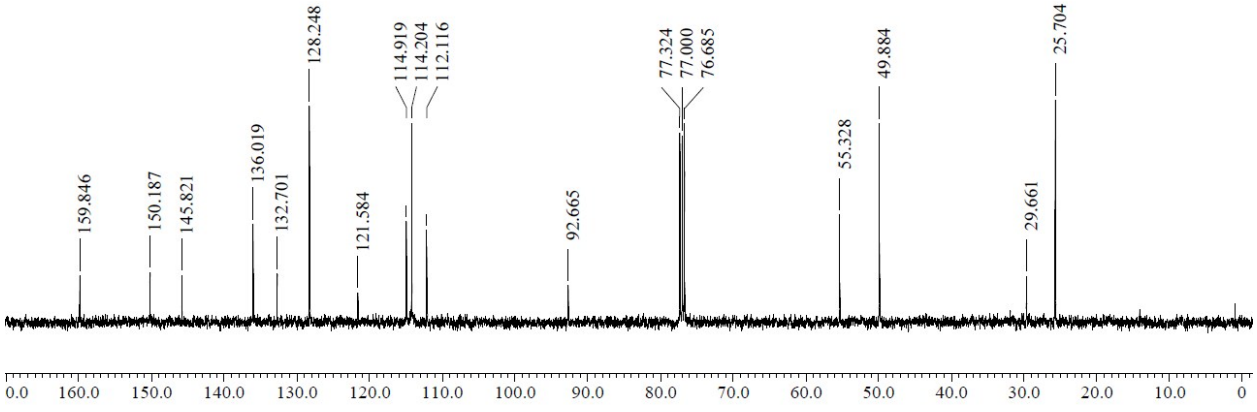


^{1}H and **^{13}C** spectra of **3h**

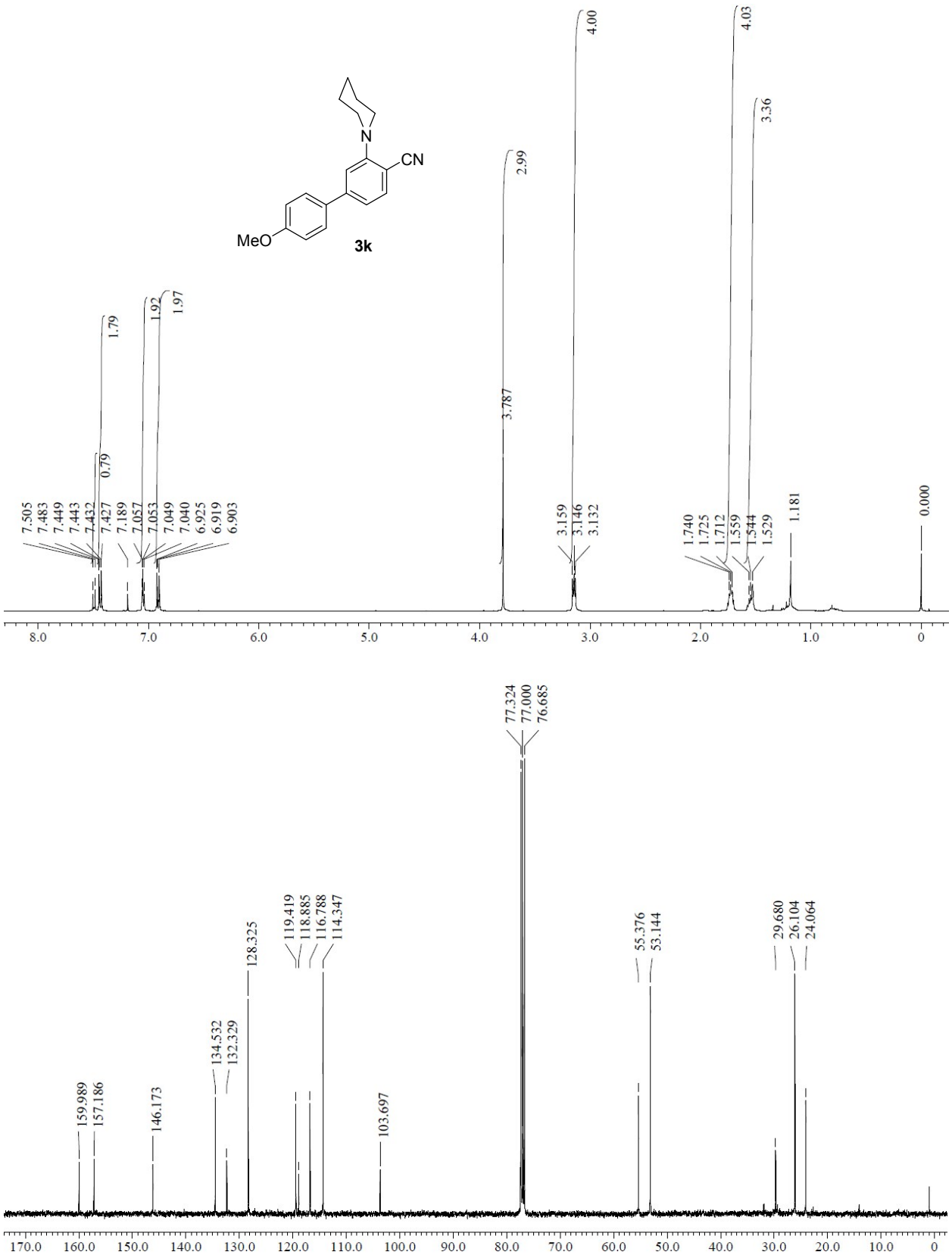


^{1}H and **^{13}C** spectra of **3i**

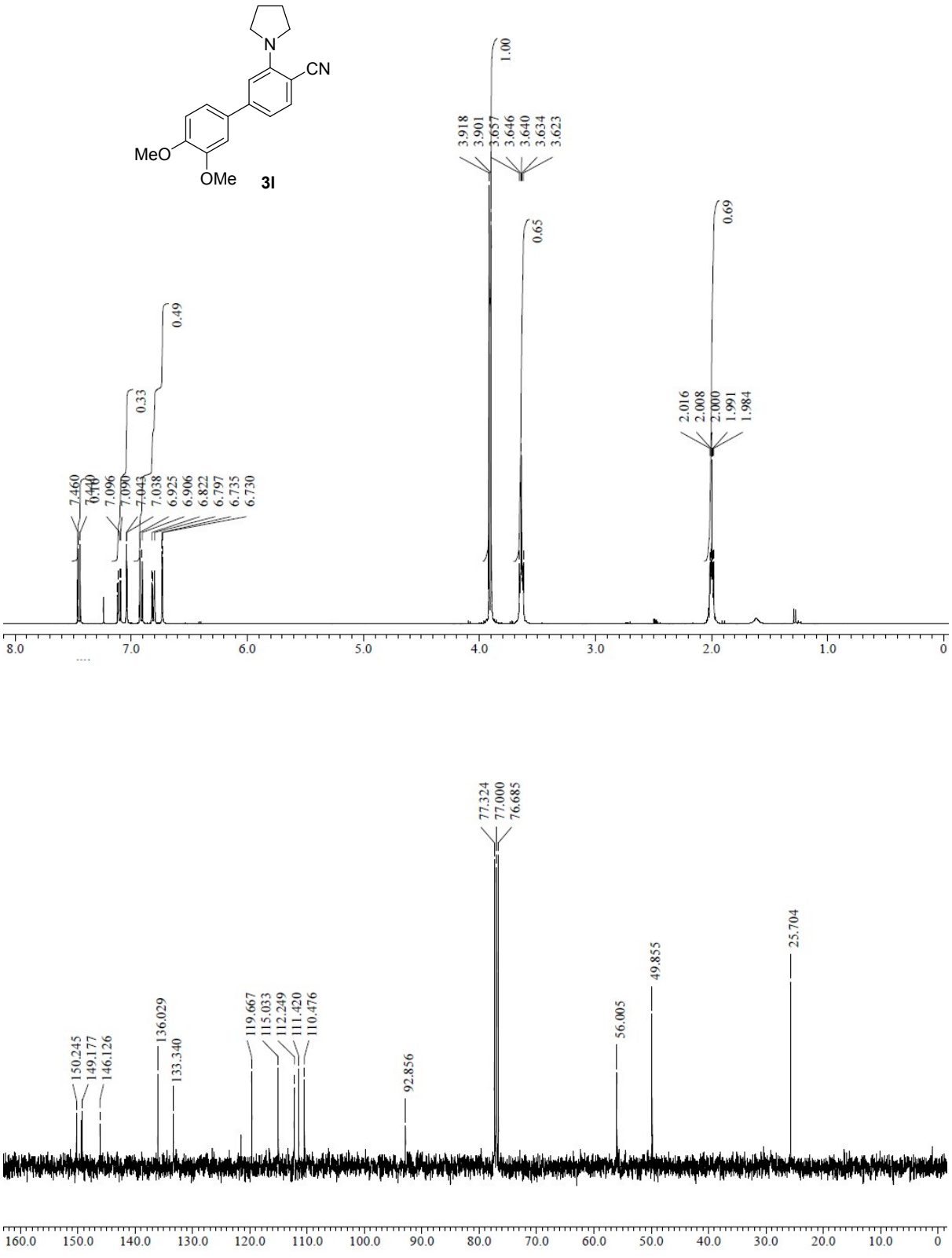




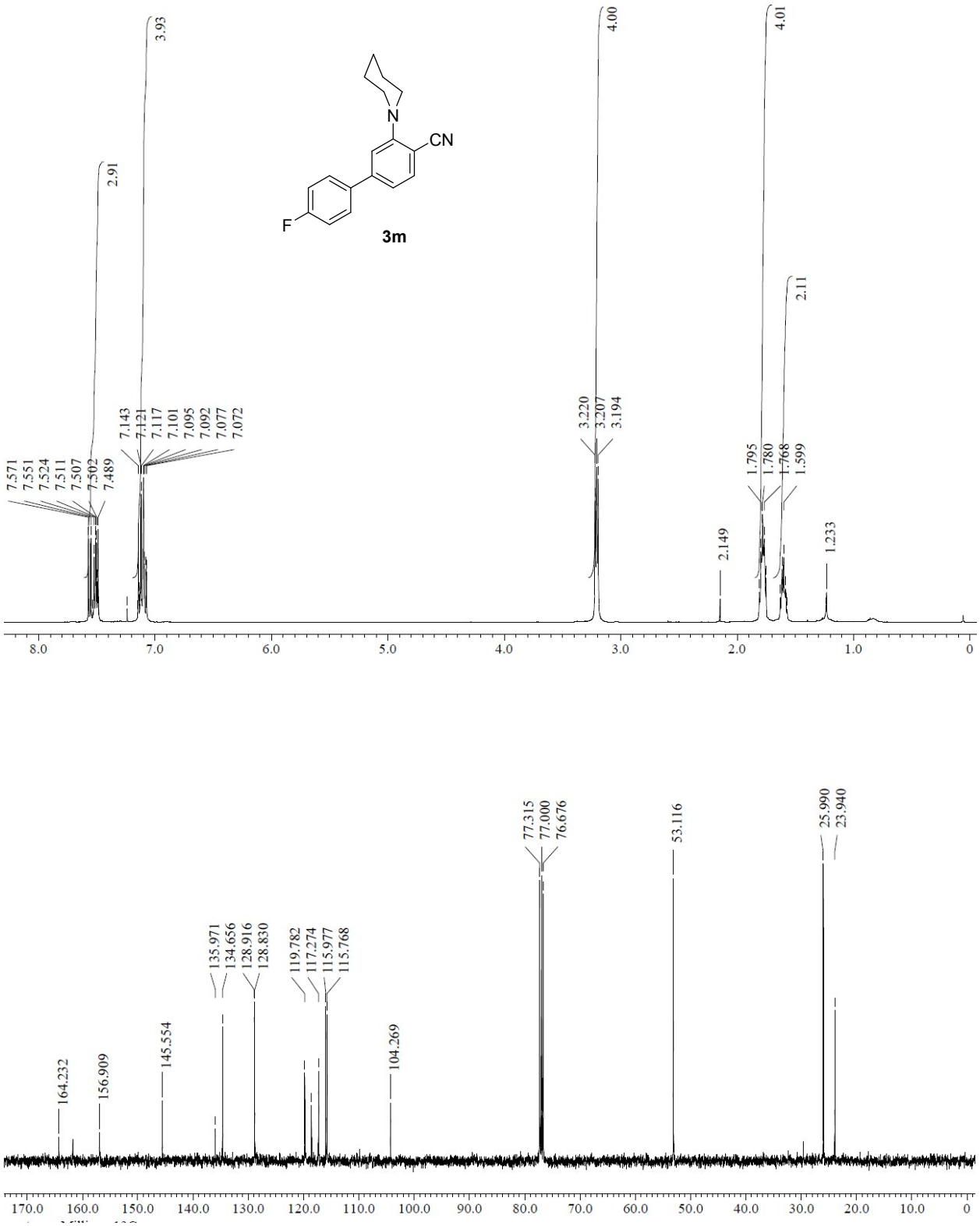
^{1}H and **^{13}C** spectra of **3j**



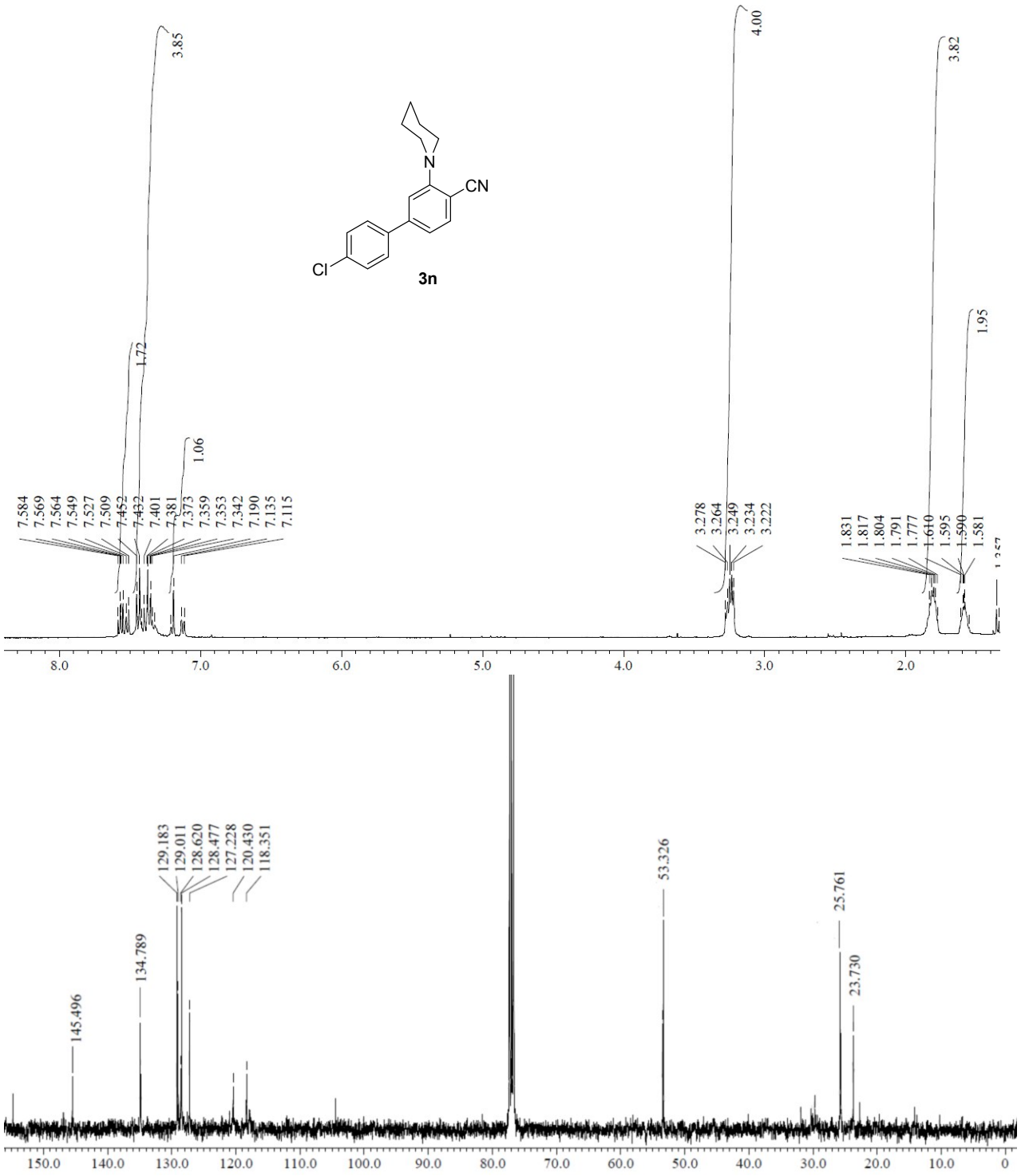
^{1}H and **^{13}C** spectra of **3k**



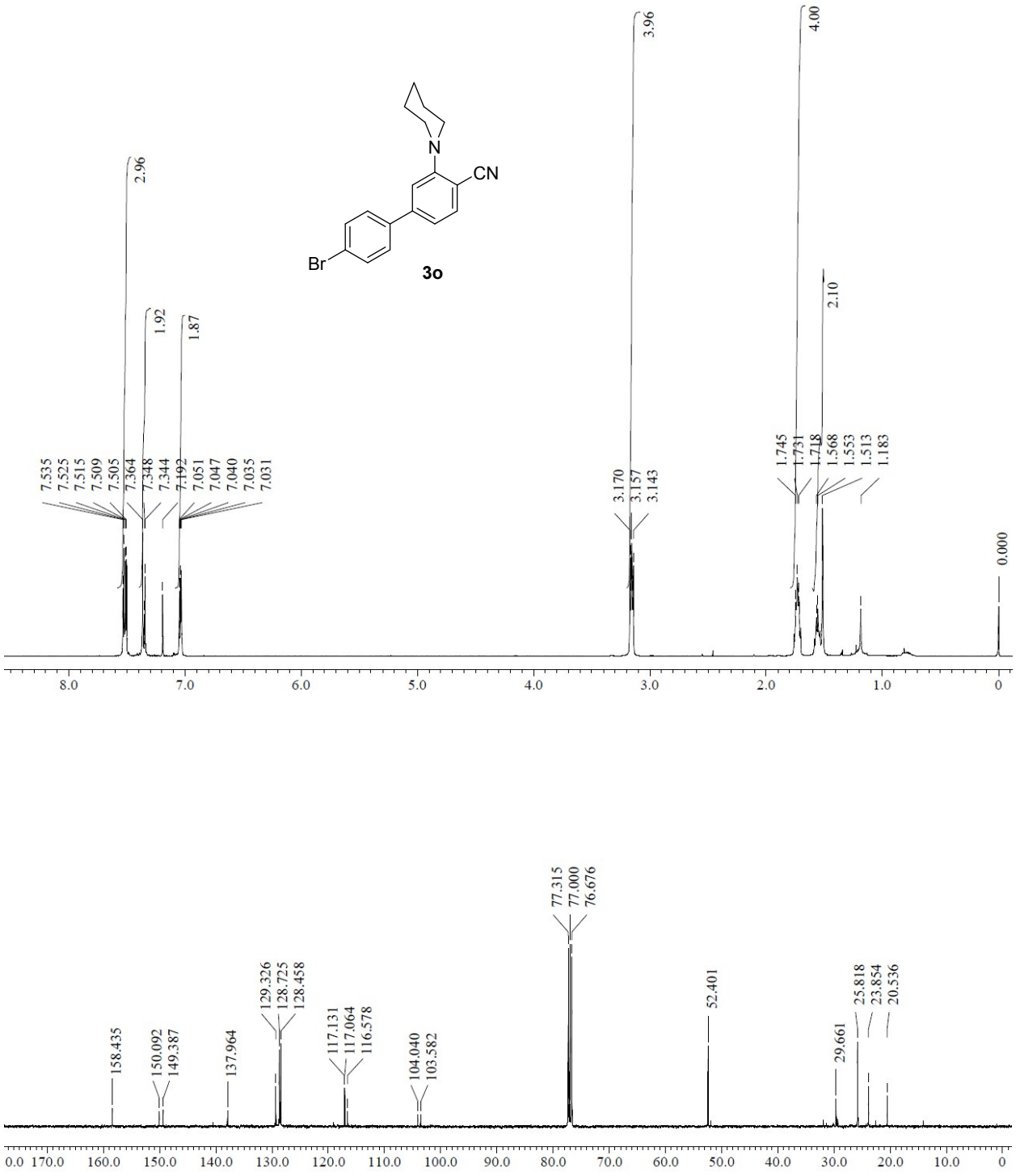
^{1}H and **^{13}C** spectra of **3l**



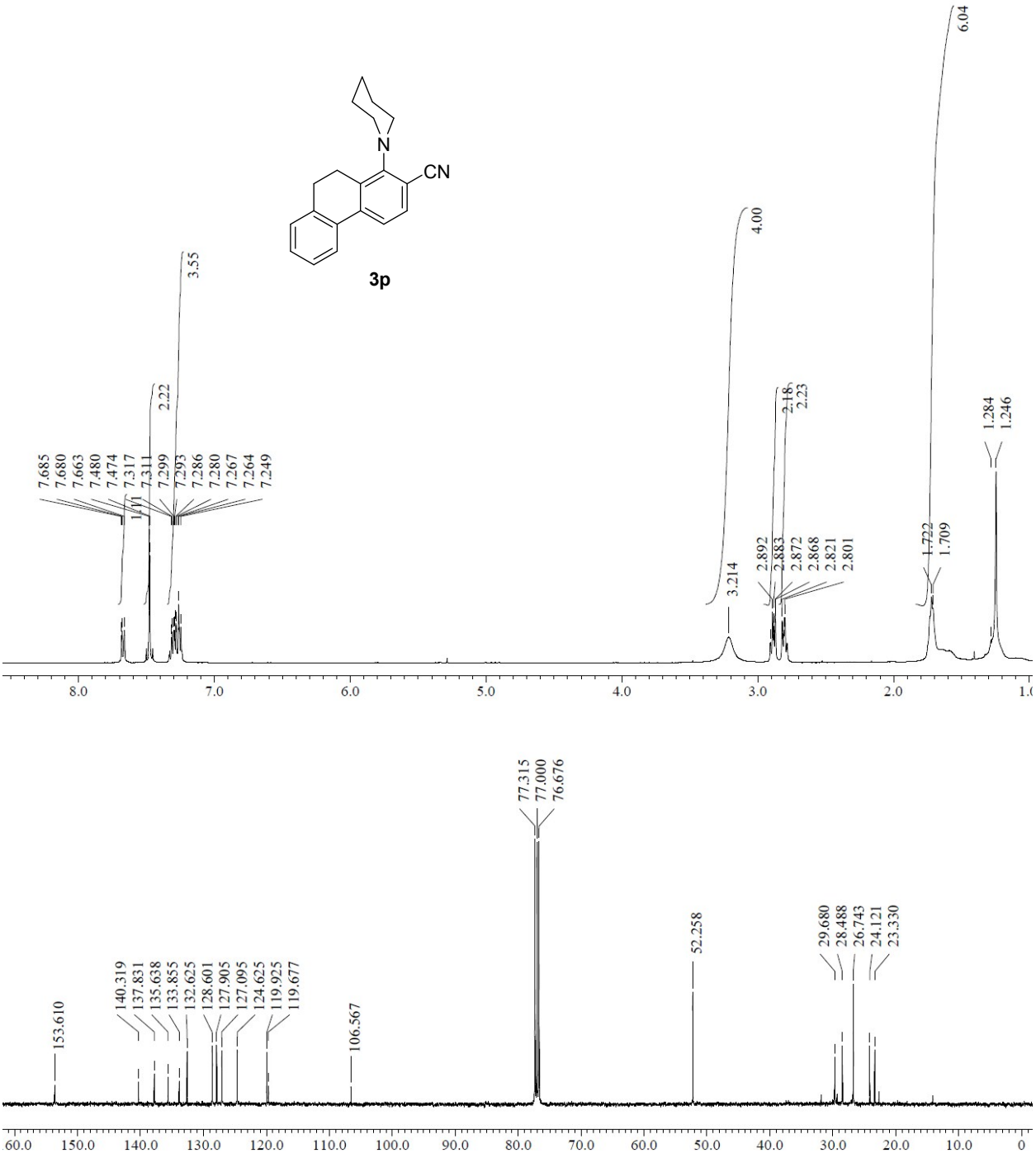
^{1}H and **^{13}C** spectra of **3m**



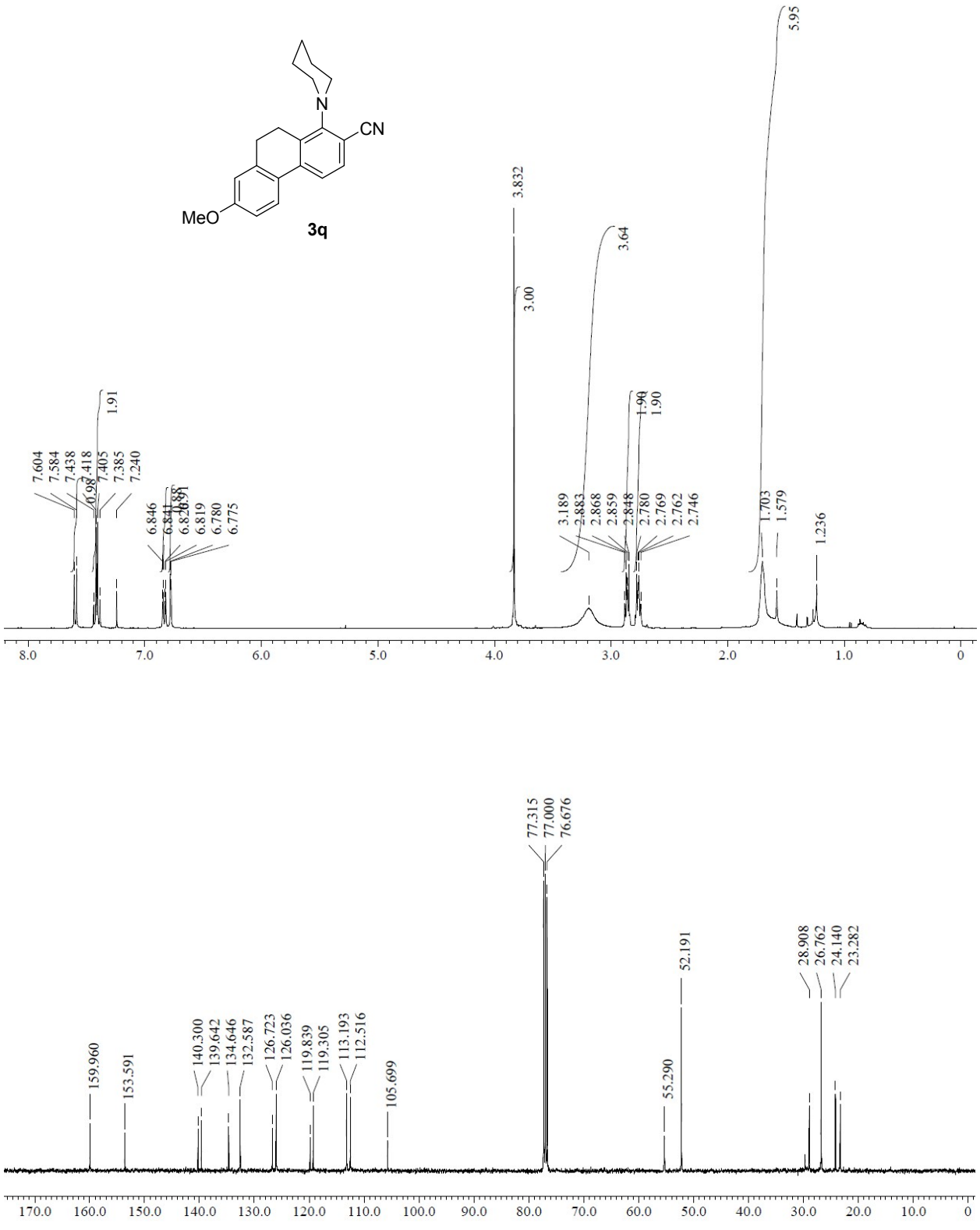
^{1}H and **^{13}C** spectra of **3n**



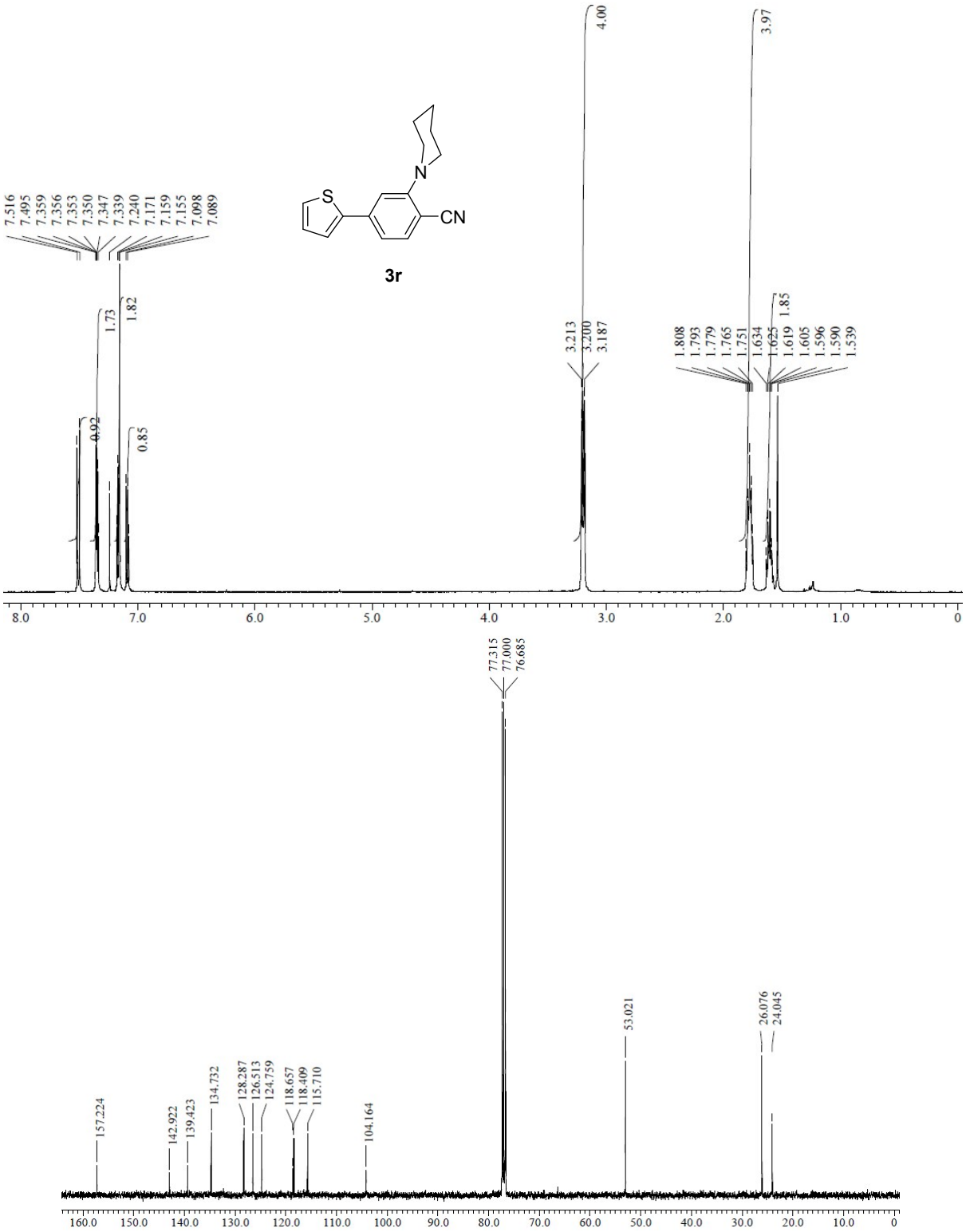
^{1}H and **^{13}C** spectra of **3o**



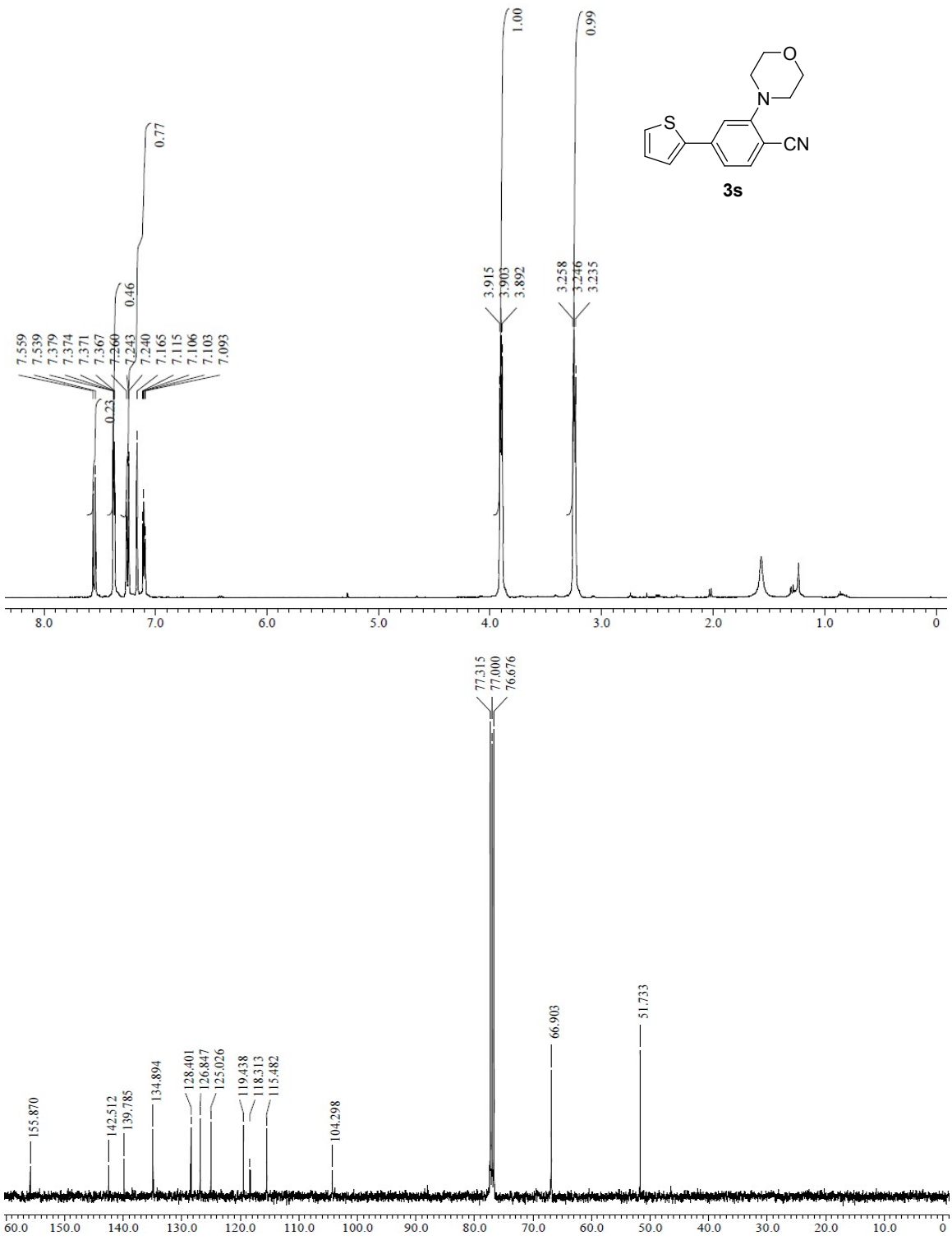
^{1}H and **^{13}C** spectra of **3p**



^{1}H and **^{13}C** spectra of **3q**



^{1}H and **^{13}C** spectra of **3r**



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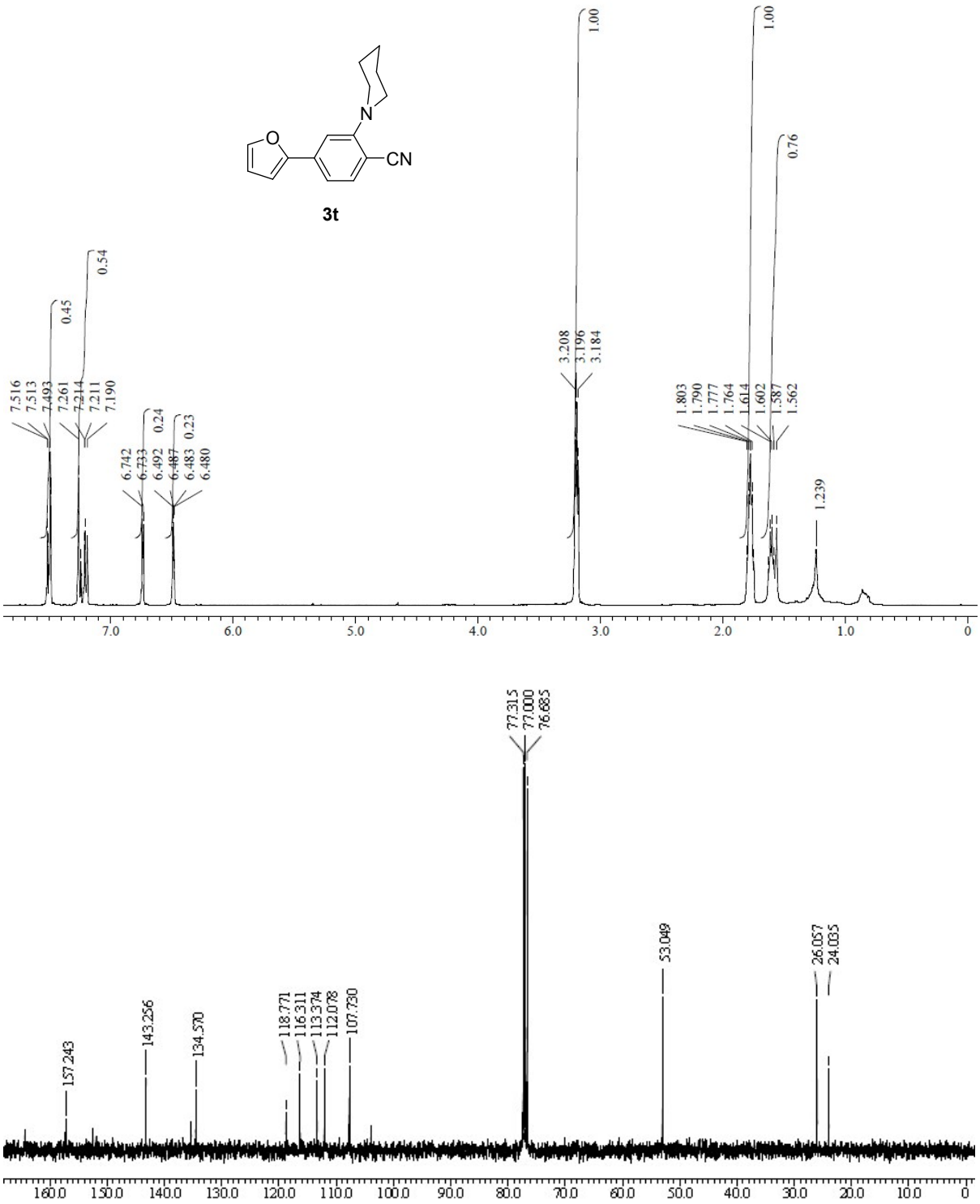
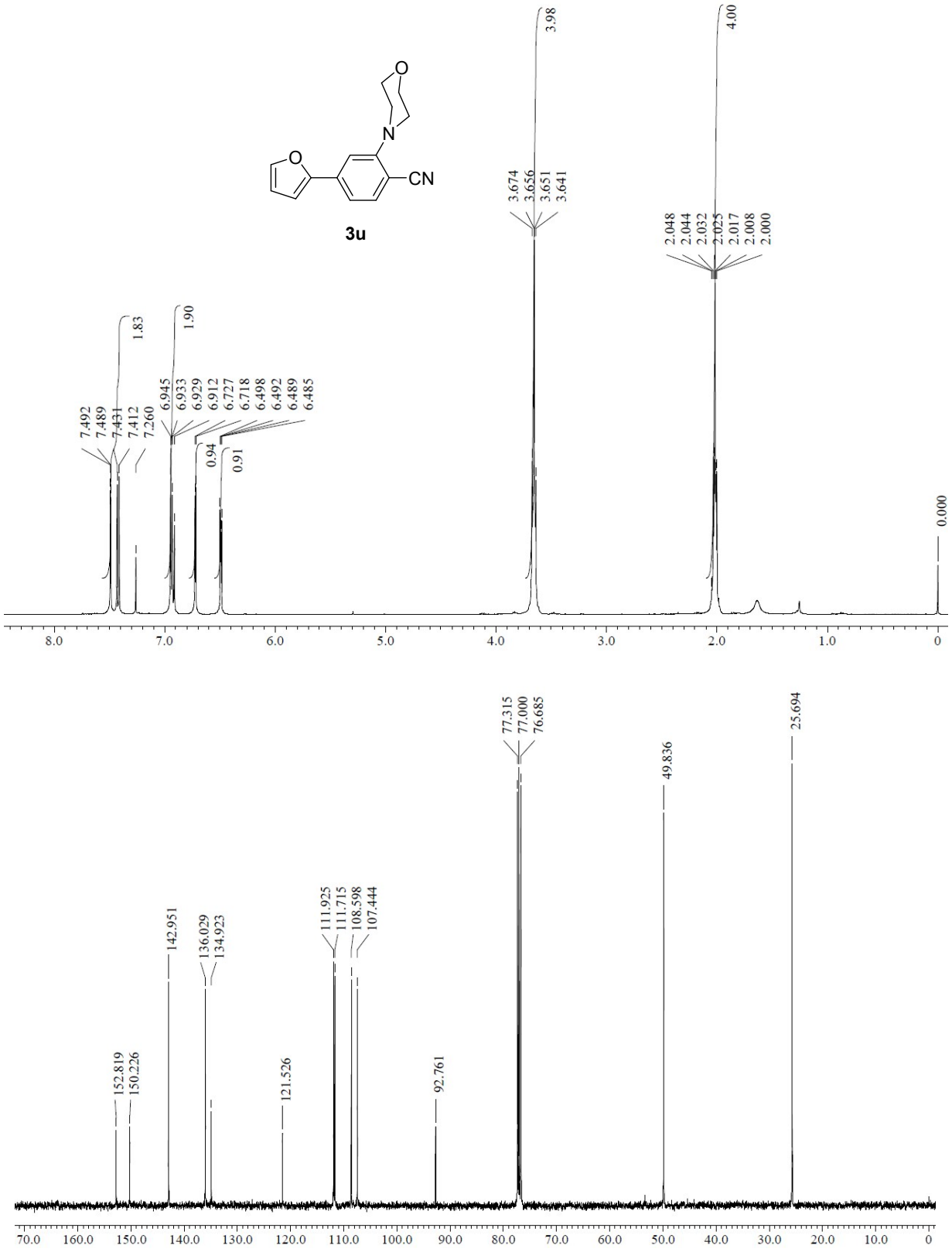


^{1}H and **^{13}C** spectra of **3t**



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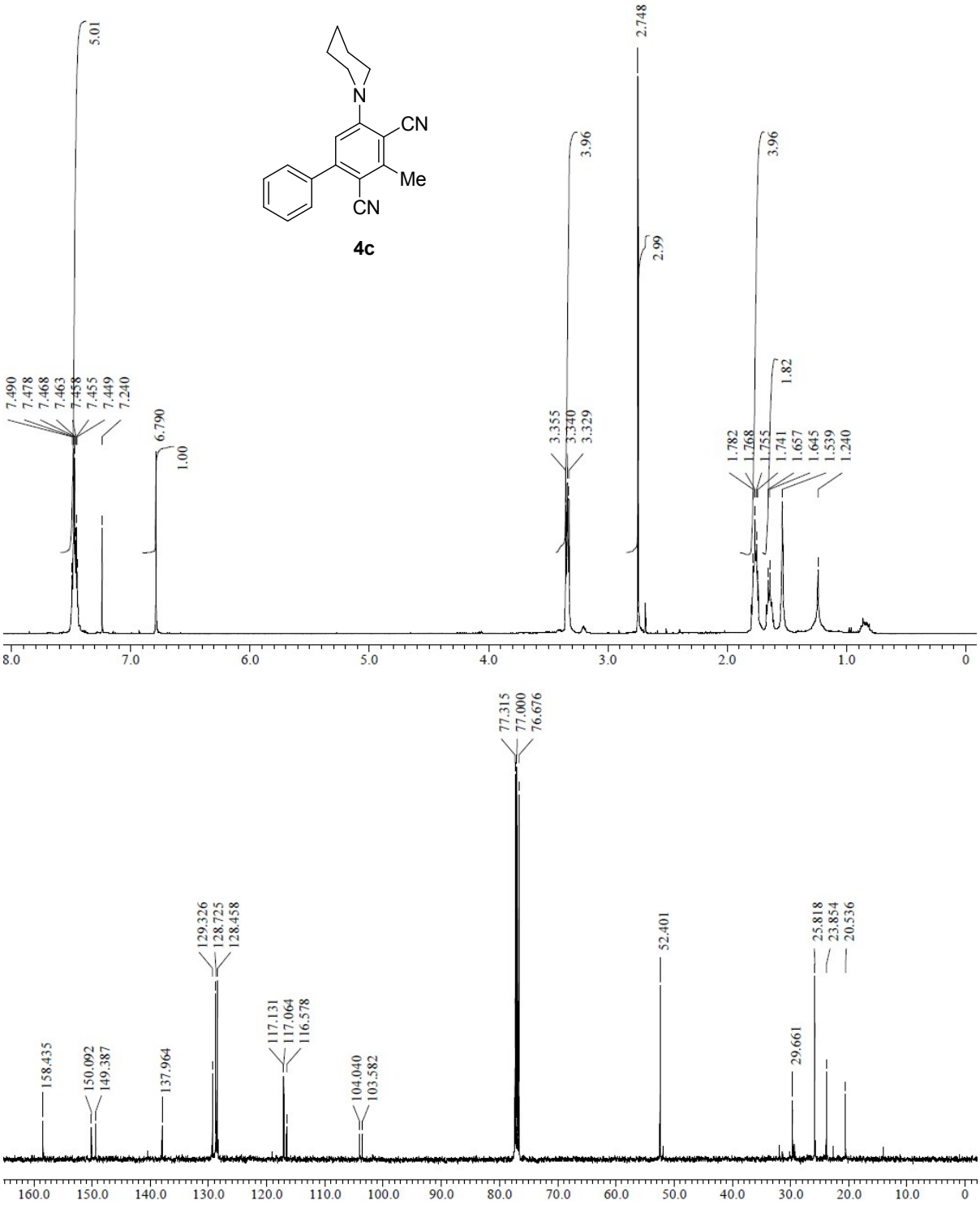
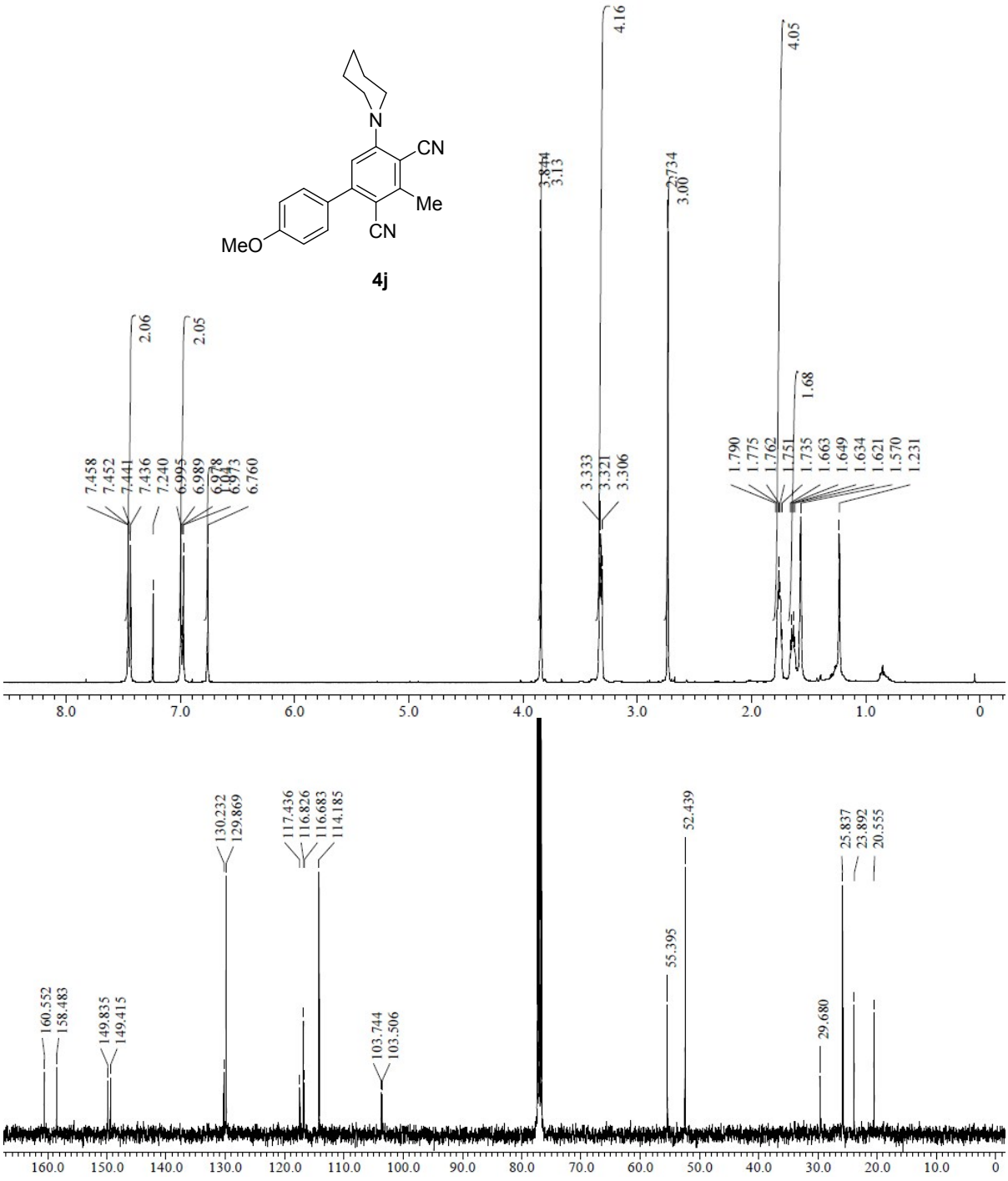
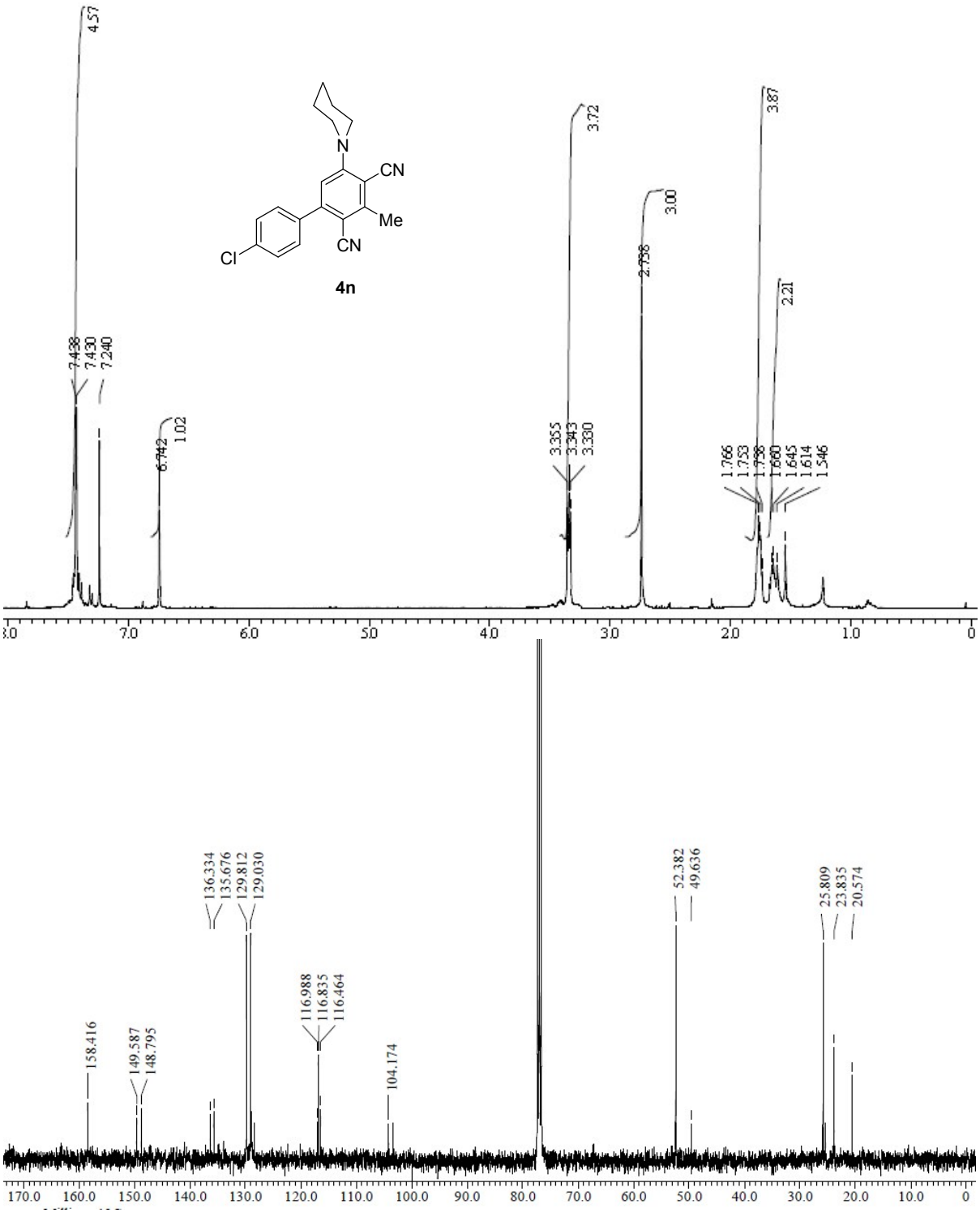


^{1}H and **^{13}C** spectra of **4c**



^{1}H and **^{13}C** spectra of **4j**



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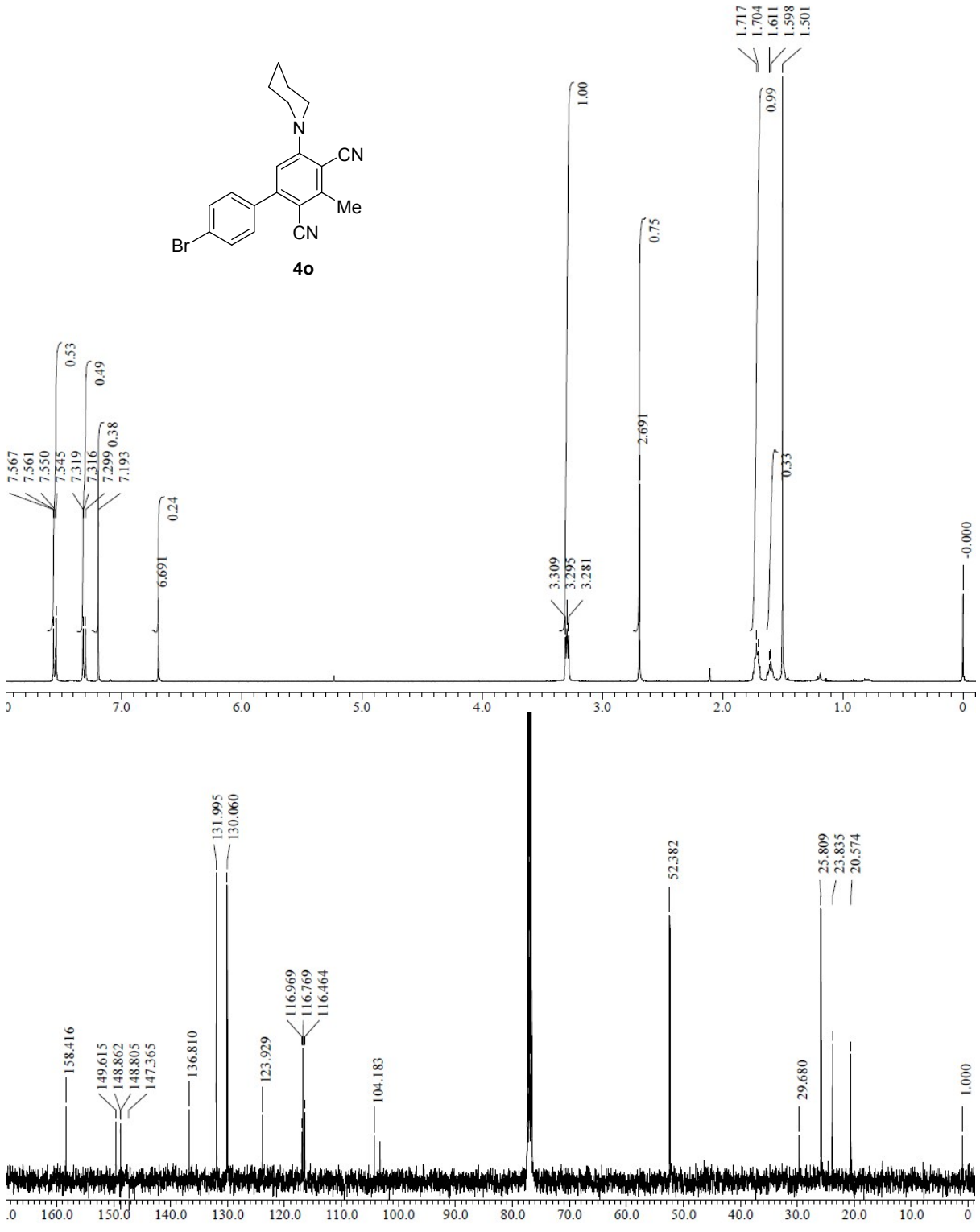

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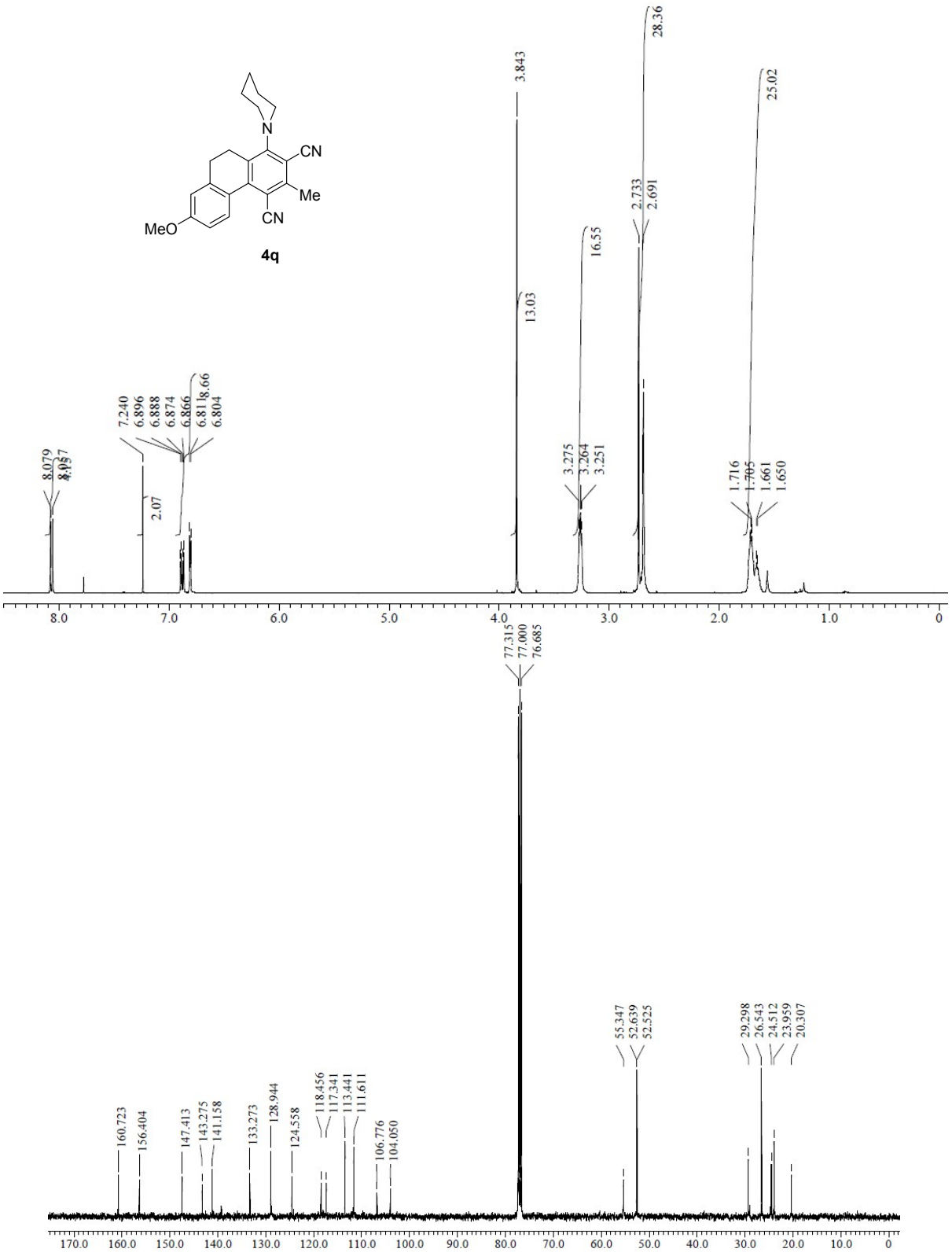

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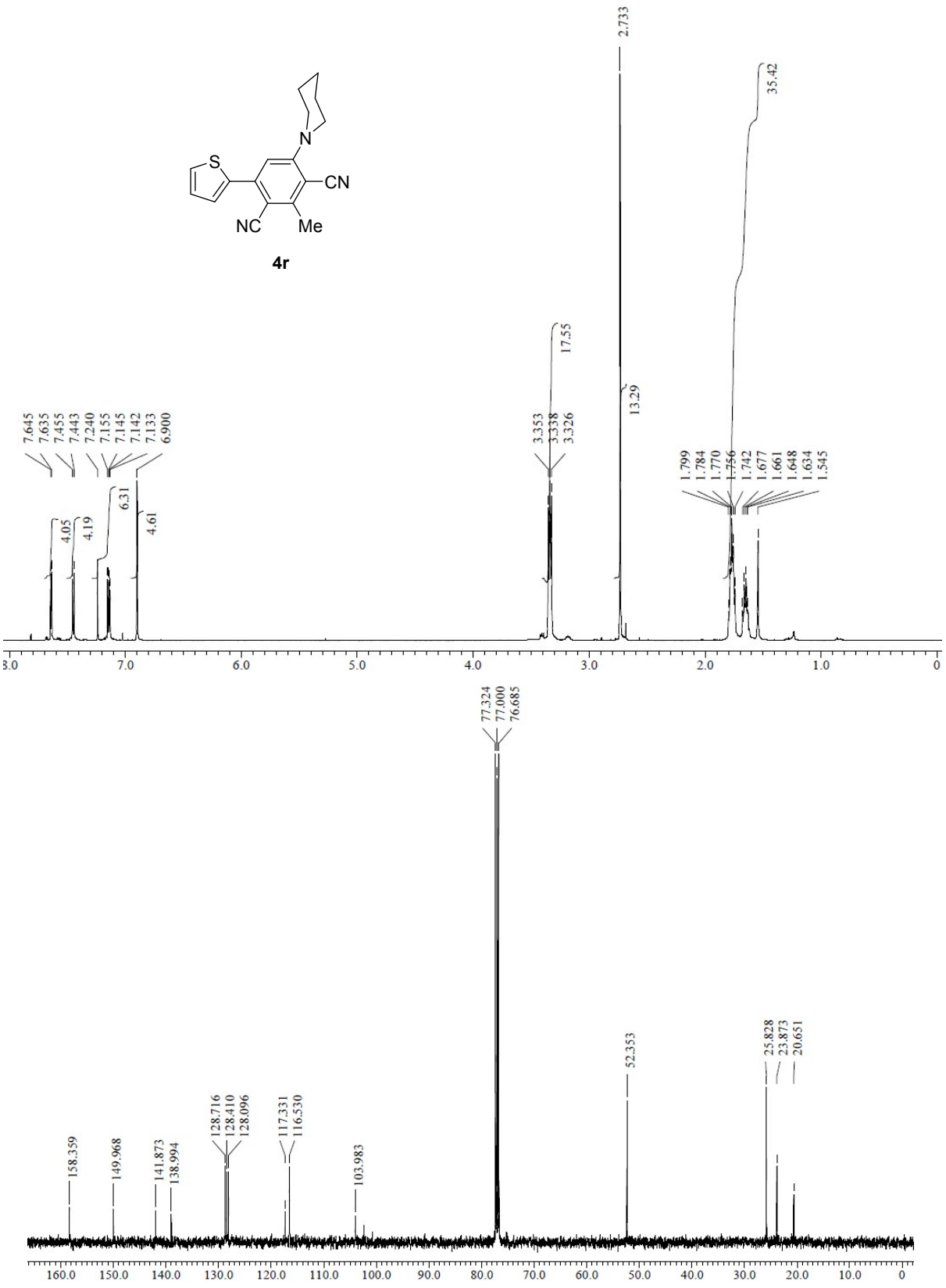
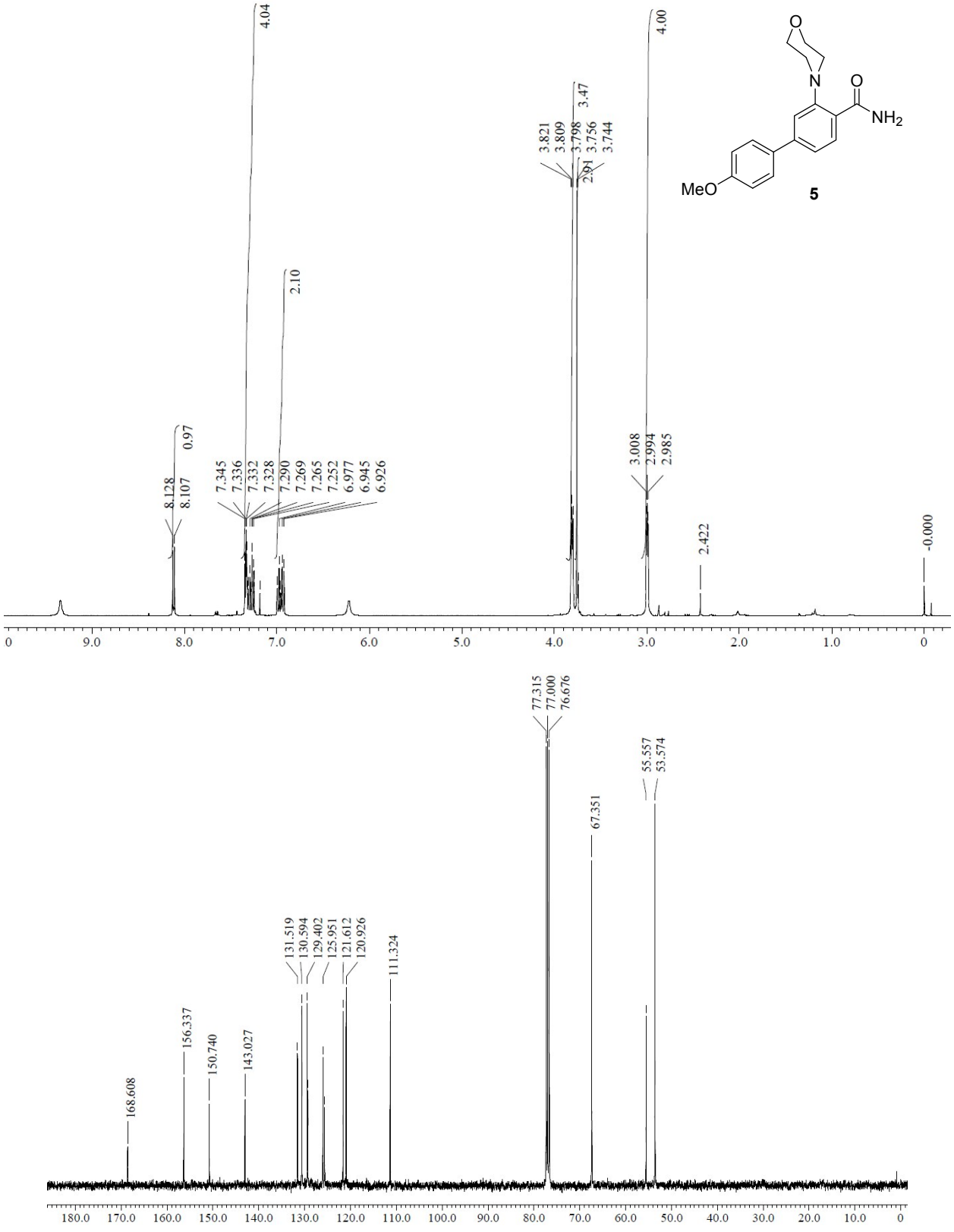
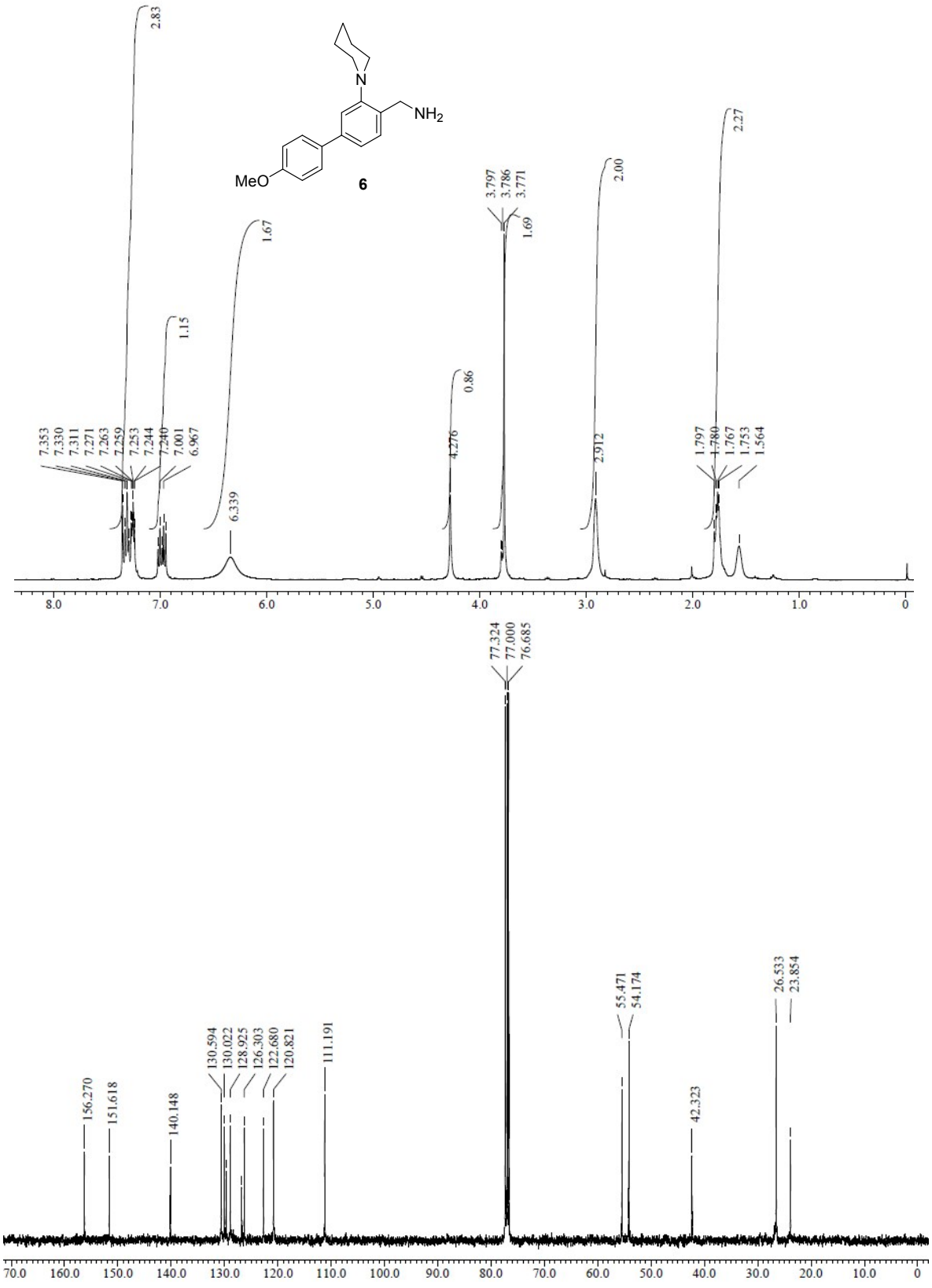


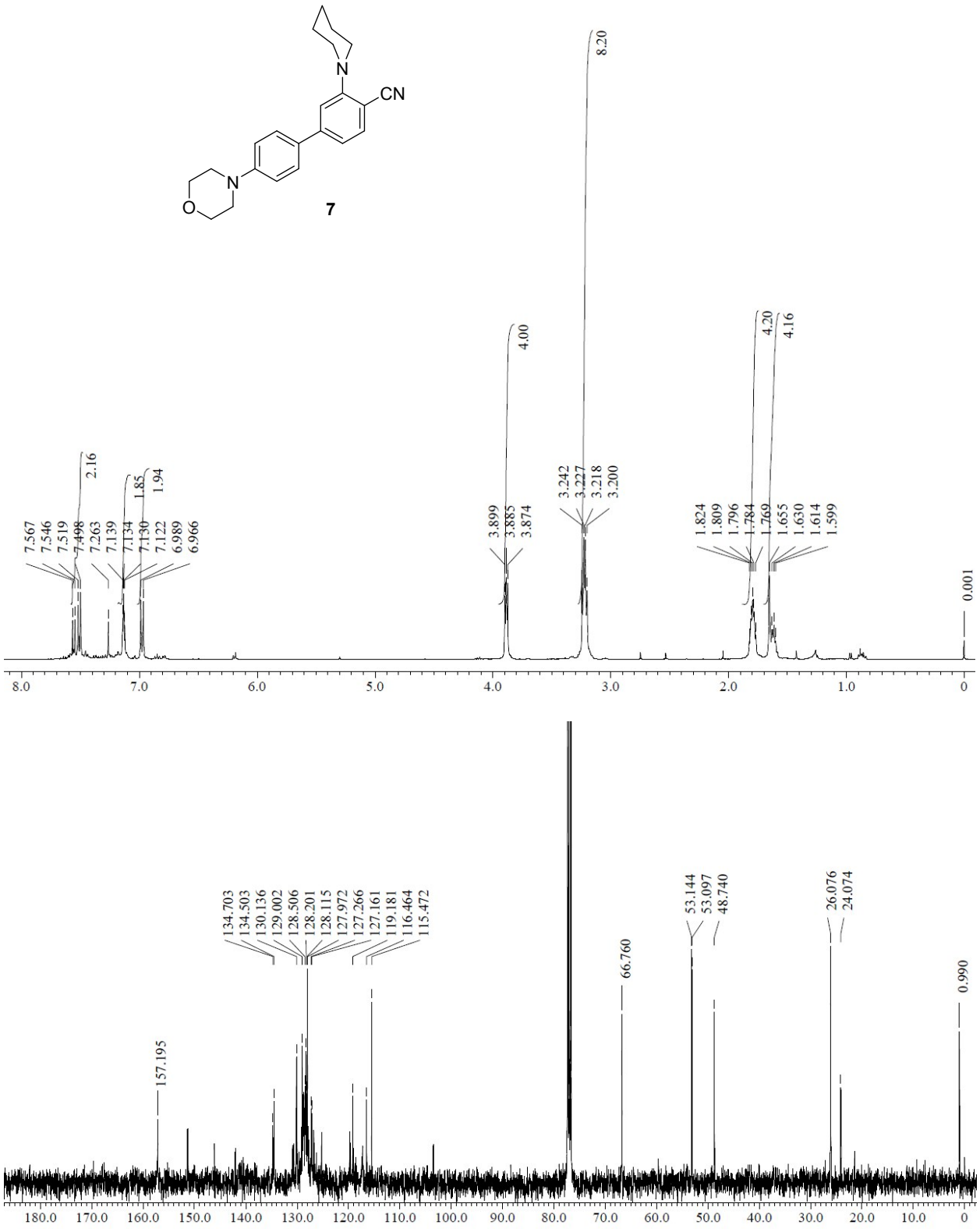
^{1}H and **^{13}C** spectra of **4r**



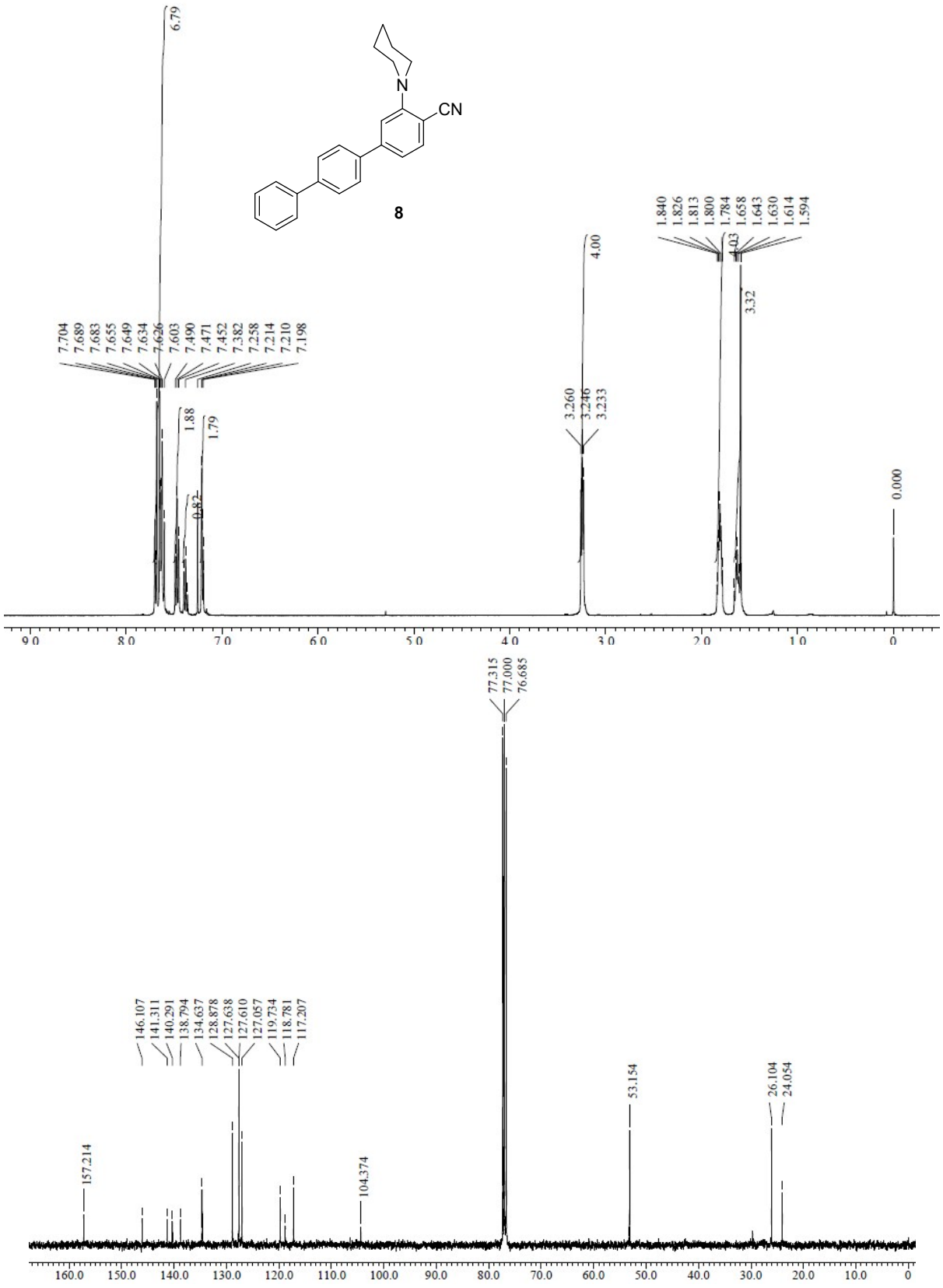
^{1}H and **^{13}C** spectra of **5**



^{1}H and **^{13}C** spectra of **6**



^{1}H and **^{13}C** spectra of **7**



^{1}H and **^{13}C** spectra of **8**