Supporting Information

Reusable cobalt-copper catalyzed cross-coupling of (hetero)aryl halides with primary amides under air: investigating a new Co^0/Co^{II}-based catalytic cycle

Anay Saha,[a] Keya Roy,[a] Sampa Mondal,[a] Bijay Saha,[b] Jayabrata Sumar,[a] Sumanta Kumar Sahu,[b] and Laksmikanta Adak*[a]

[a]*Department of Chemistry, Indian Institute of Engineering Science and Technology, Shibpur, Botanic Garden, Howrah 711103, India*

[b]*Department of Chemistry and Chemical Biology, Indian Institute of Technology (ISM), Dhanbad Jharkhand 826004, India*

E-mail address: ladak@chem.iiests.ac.in / ladak.chem@faculty.iiests.ac.in

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1. General experimental

All reactions were carried out in open-air conditions in a dry reaction vessel and the reactants were transferred *via* syringes or spatulas. Analytical TLC was performed on a TLC Silica gel 60 F_{254} (Merck, #1.05554.0007) and the TLC plates were visualized by exposure to UV light (254 nm) followed by an iodine chamber. Organic parts were extracted by simple filtration using ethyl acetate which was further concentrated using rotary evaporation (BUCHI Rotavapor R-100) under reduced pressure. Column chromatography was performed on 60-120 mesh silica gel (Sprectrochem Co.) using EtOAc/hexane solvent according to the desired ratio.

Instrumentation

NMR spectroscopy

^{1}H and ^{13}C NMR spectra were obtained using Bruker Avance-400 (400 MHz) NMR spectrometer. The proton chemical shift values are reported in parts per million (ppm, δ scale) downfield from tetramethylsilane (TMS) and are referenced to TMS (δ 0.0) and $CHCl_3$ (δ 7.26). The chemical shifts of the carbon atoms are reported in parts per million (ppm, δ scale) downfield from TMS and referenced to the carbon resonance of $CDCl_3$ (δ 77.16). The data are presented as chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, quint = quintet, sext = sextet, sept = septet, m = multiplet and/or multiple resonances, and br = broad), coupling constant in hertz (Hz), and signal area integration in natural numbers.

IR analysis

IR spectra were recorded using an Agilent Cary 630 FTIR Spectorometer; characteristic IR absorptions are reported in cm^{-1}.

HRMS

High-resolution mass spectra (HRMS) were recorded using fast atom bombardment (FAB) ionization with a Q-TOF mass spectrometer (serial no. YA 263).

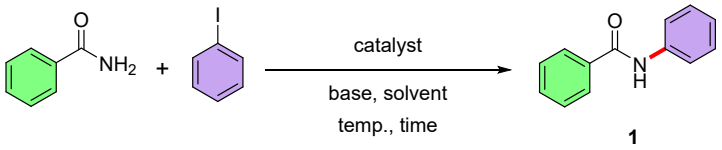
Materials

All the reactions were performed in a dry round bottom flusk of glass connecting to condenser on a magnetic stirrer in oil-bath. Used amides and halides were purchased from Sigma-AldrichCo., Tokyo Chemical Industry (India) Pvt. Ltd., Spectrochem Pvt. Ltd., Sisco Research Laboratory Pvt. Ltd., ThermoFisher Scientific, BLDpharm etc. All other chemicals were also purchased from the same. The used catalysts $Co(acac)_2$ (≥ 99.0%), and copper iodide (powder, 99.999%) were purchased from the Sigma-Aldrich Co. The solvents used for filtration and column chromatography were purchased from RANKEM Co., and other commercial suppliers, and were used after appropriate purification, unless otherwise stated.

2. Optimization of reaction conditions for the synthesis of anilides[a]

To achieve the optimized reaction conditions, a series of experiments were executed with a variation of the reaction parameters, such as catalyst, base, solvent, temperature, etc. We initiated our investigation by taking a representative reaction of benzamide with iodobenzene. The results are summarized in Table S1. The use of different solvents in the presence of $Co(acac)_2$/CuI catalyst with cesium carbonate as a base, at 110 °C temperature under an argon atmosphere, for 24 hours reaction time provided the benzanilide product **1** in moderate to excellent yields (entries 1-9). The reaction was also performed without using any solvent (neat), producing the product **1** with an 80% yield (entry 10). This yield is almost similar to that obtained using NMP as the solvent (entry 1). Based on this observation, we performed the reaction using a reduced amount of NMP (100 μL for 1.0 mmol scale of reaction) and achieved an improved yield of 88% (entry 11). By taking this condition forward, we tested $Co(OAc)_2$, $CoBr_2$ and CoI_2 instead of $Co(acac)_2$ as catalyst, but it significantly decreased the yield of the desired product (entries 12-14). Subsequently, variations of the base were tested (entries 15 and 16), and potassium carbonate stood out the best for the reaction. Lowering the reaction temperature to 90 °C and to 60 °C did not improve the yield of the desired product (entry 17 and 18). Next, to check the effect of both catalysts, we performed the reaction omitting CuI and $Co(acac)_2$ catalysts one at a time (entries 19 and 20). Each case either resulted in trace amounts of the desired product or no desired product at all. This outcome reveals the involvement of both catalysts in the reaction system. In entries 21 and 22 of the optimization process, we examined the reaction by decreasing the time and it was found that the best yield of 91% was obtained after 15 hours duration of the reaction. Finally, the reaction was carried out under a nitrogen atmosphere and in open air (entries 23 and 24). The experiment in open air furnishes the desired product with a 93% yield, indicating that open-air condition can be effectively used in the reaction and hence it has been chosen as the standard one for the protocol (entry 24). After that, to our delight, we examined the reaction altering the amounts of catalysts and reactants which did not provide better results (entry 25-29).

Table S1 Optimization of the reaction conditions[a]

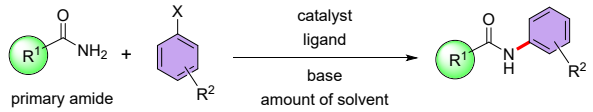


1

Entry	Catalyst	Base	Solvent	Temp.(°C)	Time	Yield(%)[b]
1	$Co(acac)_2$/CuI	Cs_2CO_3	NMP	110	24h	86
2	$Co(acac)_2$/CuI	Cs_2CO_3	DMF	110	24h	45
3	$Co(acac)_2$/CuI	Cs_2CO_3	DMSO	110	24h	76
4	$Co(acac)_2$/CuI	Cs_2CO_3	THF	90	24h	72
5	$Co(acac)_2$/CuI	Cs_2CO_3	PEG-600	110	24h	70
6	$Co(acac)_2$/CuI	Cs_2CO_3	toluene	110	24h	31
7	$Co(acac)_2$/CuI	Cs_2CO_3	PhCl	110	24h	55
8	$Co(acac)_2$/CuI	Cs_2CO_3	H_2O	110	24h	40
9	$Co(acac)_2$/CuI	Cs_2CO_3	NMP+H_2O	110	24h	60
10	$Co(acac)_2$/CuI	Cs_2CO_3	—	110	24h	80
11[c]	$Co(acac)_2$/CuI	Cs_2CO_3	NMP	110	24h	88
12[c]	$Co(OAc)_2$/CuI	Cs_2CO_3	NMP	110	24h	67
13[c]	$CoBr_2$/CuI	Cs_2CO_3	NMP	110	24h	43
14[c]	CoI_2/CuI	Cs_2CO_3	NMP	110	24h	51
15[c]	$Co(acac)_2$/CuI	K_2CO_3	NMP	110	24h	90
16[c]	$Co(acac)_2$/CuI	Na_2CO_3	NMP	110	24h	70
17[c]	$Co(acac)_2$/CuI	K_2CO_3	NMP	90	24h	58
18[c]	$Co(acac)_2$/CuI	K_2CO_3	NMP	60	24h	0
19[c]	$Co(acac)_2$/-	K_2CO_3	NMP	110	24h	0
20[c]	-/CuI	K_2CO_3	NMP	110	24h	11
21[c]	$Co(acac)_2$/CuI	K_2CO_3	NMP	110	15h	91
22[c]	$Co(acac)_2$/CuI	K_2CO_3	NMP	110	12h	81
23[c,d]	$Co(acac)_2$/CuI	K_2CO_3	NMP	110	15h	90
24[c,e]	**$Co(acac)_2$/CuI**	**K_2CO_3**	**NMP**	**110**	**15h**	**93**
25[c,f]	$Co(acac)_2$/CuI	K_2CO_3	NMP	110	15h	74
26[c,g]	$Co(acac)_2$/CuI	K_2CO_3	NMP	110	15h	87
27[c,h]	$Co(acac)_2$/CuI	K_2CO_3	NMP	110	15h	81
28[c,i]	$Co(acac)_2$/CuI	K_2CO_3	NMP	110	15h	72
29[c,j]	$Co(acac)_2$/CuI	K_2CO_3	NMP	110	15h	93

[a] Reaction conditions: amide (0.5 mmol), aryl halide (0.5 mmol), Co-catalyst (10 mol%), CuI (10 mol%), base (0.75 mmol), solvent (1 mL) under argon atmosphere. [b] Isolated yields. [c]NMP was used 100 μL for 1.0 mmol scale of reaction. [d] Reaction was carried out under nitrogen atmosphere. [e]Reaction was carried out in open air. [f]$Co(acac)_2$ (5 mol%) and CuI (5 mol%) were used. [g]$Co(acac)_2$ (5 mol%) and CuI (10 mol%) were used. [h]$Co(acac)_2$ (10 mol%) and CuI (5 mol%) were used. [i]amide (0.75 mmol), aryl halide (0.5 mmol) were used. [j]amide (0.5 mmol), aryl halide (0.75 mmol) were used.

Table S2a. Comparison of the results of the present work with those of the previously reported cross-coupling reactions of primary amides with aryl halides employing cobalt catalysis.



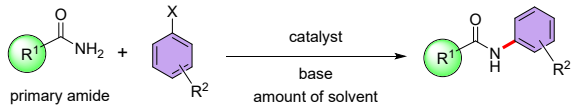
Entry	R^1	X	Catalyst	Ligand	Base	Amount of solvent for 1.0 mmol scale of reaction	Yield (%)	Mechanistic study	Mechanistic cycle	Reusebility of catalyst	Substrate scope	Gram-scale synthesis	Conventional work-up required	Ref
1	R^1 = Ph ✖ Aliphatic ✖ Heteroaryl	X = I ✖ X = Br, Cl ✖ Heteroaryl	$CoCl_2.6H_2O$ (20 mol%)	DMEDA	$K_3PO_4.H_2O$	0.7 mL	24-28	No	not provided	No	2	No	Yes	14a
2	R^1 = Aryl ✖ Aliphatic ✖ Heteroaryl	X = I ✖ X = Br, Cl ✖ Heteroaryl	$Co(C_2O_4).2H_2O$ (10-20 mol%)	DMEDA	Cs_2CO_3	0.2 mL	18-92	No	Co(II)/Co(IV)	No	29	No	Yes	14b
3	R^1 = Aiphatic ✖ Aryl ✖ Heteroaryl	X = I ✖ X = Br, Cl ✖ Heteroaryl	$Co(C_2O_4).2H_2O$ (20 mol%)	DMEDA	Cs_2CO_3	0.2 mL	trace-75	No	not provided	No	16	No	Yes	14c
4	$R^1 = C_3H_7$ ✖ Aryl ✖ Heteroaryl	X = I ✖ X = Br, Cl ✖ Heteroaryl	$Co(acac)_2$ (10 mol%) CuI (10 mol%)	—	Cs_2CO_3	4.0 mL	82 (for R^2 = 4-Cl) 90 (for R^2 = 1-naphthyl)	No	Co(I)/Co(III)	No	2	No	Yes	13e
5	**R^1 = Aliphatic, Aryl, Heteroaryl**	**X = Br, I, Cl Aryl and Heteroaryl halides**	**$Co(acac)_2$ (10 mol%) CuI (10 mol%)**	**—**	**K_2CO_3**	**0.1 mL or Solvent-free**	**43-94 (for X = I, Br) 10-80 (for X = Cl)**	**Yes**	**Co(0)/Co(II)**	**Yes**	**51**	**Yes**	**No**	**Our Work**

"✖" indicates "not applicable", which are significant disadvantages with respect to our present method.

Red colour indicates significant disadvantage with respect to our present method.

Blue colour indicates minor disadvantage with respect to our present method.

Table S2b. Comparison of the results of the present work with those of the previously reported ligand-free copper-catalyzed cross-coupling reactions of primary amides with aryl halides.



primary amide

Entry	R^1	X	Catalyst	Base	Amount of solvent for 1.0 mmol scale of reaction	Yield (%)	Mechanistic study	Mechanistic cycle	Reusebility of catalyst	Substrate scope	Gram-scale synthesis	Conventional work-up required	Ref
1	R^1 = CH_3, Aryl, heteroaryl	X = I ✖ X = Br, Cl ✖ Heteroaryl	CuI	K_3PO_4 or, CsF	0.4 mL	39-97	No	not provided	No	5	Yes	Yes	8a
2	R^1 = Pentyl, Ph ✖ Heteroaryl	X = I ✖ X = Br, Cl ✖ Heteroaryl	CuO NPs	Cs_2CO_3	0.8 mL	25-88	No	provided but not mentioned the oxidation state of Cu spesies either in the text or in the catlytic cycle	Yes	6	No	Yes	8b
3	R^1 = CH_3, Pentyl, Ph ✖ Heteroaryl	X = I ✖ X = Br, Cl ✖ Heteroaryl	Cu_2O NPs	KOH	0.7 mL	70-80	No	provided but not mentioned the oxidation state of Cu spesies either in the text or in the catlytic cycle	Yes	9	No	Yes	8c
4	R^1 = 4-BrPh, Ph ✖ Aliphaticl ✖ Heteroaryl	X = I ✖ X = Br, Cl ✖ Heteroaryl	Cu/Al_2O_3	KOH	2.0 mL	78-81	No	not provided	Yes	2	No	Yes	8e
5	R^1 = CH_3, Ph ✖ Heteroaryl	X = I, Br ✖ X = Cl ✖ Heteroaryl	Pre-prepared biogenic CuONP	K_2CO_3	3.0 mL	85-96	Yes	provided but no redox process shown at the Cu center	Yes	13	No	Yes	7j
6	R^1 = Ph ✖ Aliphaticl ✖ Heteroaryl	X = Br (only bromobenzene) ✖ X = Cl ✖ Heteroaryl	CuI	K_3PO_4	0.5 mL	49	No	not provided	No	1	No	Yes	8g
7	**R^1 = Aliphatic, Aryl, Heteroaryl**	**X = Br, I, Cl Aryl and Heteroaryl halides**	**$Co(acac)_2$/CuI**	**K_2CO_3**	**0.1 mL or Solvent-free**	**43-94 (for X = I, Br) 10-80 (for X = Cl)**	**Yes**	**Co(0)/Co(II)**	**Yes**	**51**	**Yes**	**No**	**Our Work**

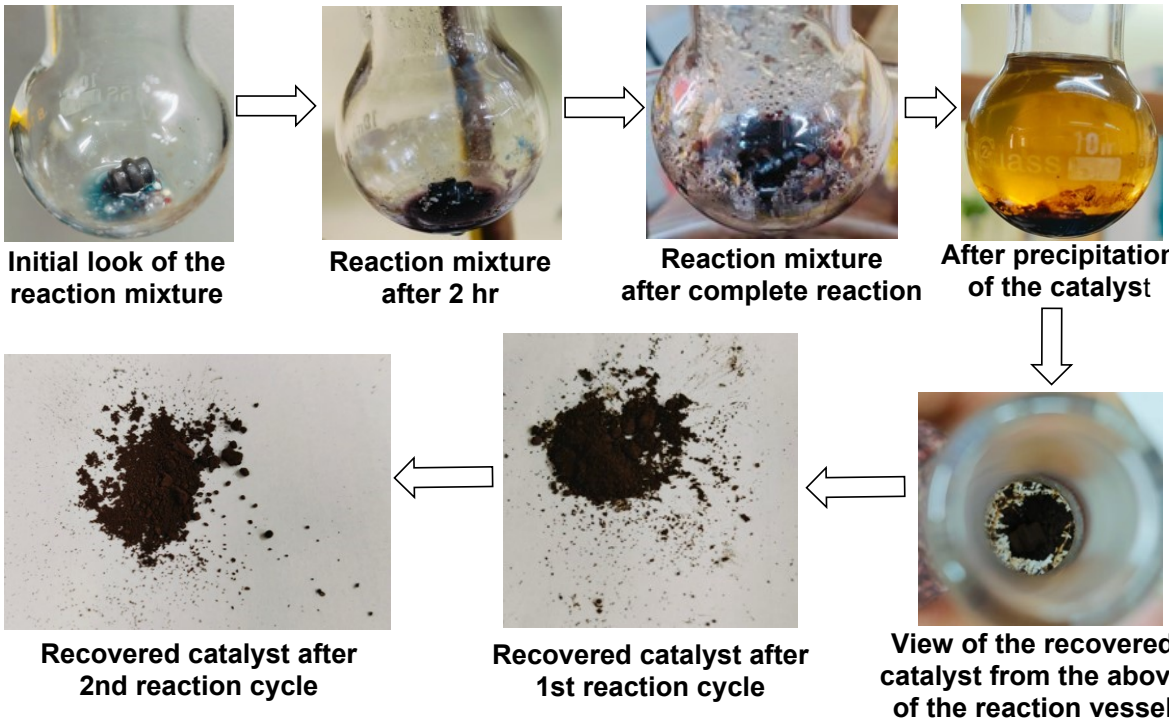
"✖" indicates "not applicable", which are significant disadvantages with respect to our present method.

Red colour indicates significant disadvantage with respect to our present method.

Blue colour indicates minor disadvantage with respect to our present method.

3. Experimental procedure for catalyst recovery:

After completion of the reaction, the reaction mixture was allowed to cool to room temperature. Then ethyl acetate (10 mL) was added to the mixture and stirred for 10 min to ensure product removal from the catalyst. Next, the catalyst was allowed to precipitate and the above-layered ethyl acetate containing the organic part was poured in a separate round-bottom flask. The same procedure was followed at least three times to ensure the complete removal of the organic part (monitored by TLC). After that, the reaction vessel containing the catalyst was properly dried under a high vacuum to obtain the powdered catalyst (Scheme 1) which was used further for consecutive reactions (Figure 2).



Scheme S1 Photographs at different stages of the experimental procedure for catalyst recovery.

4. EDS (energy dispersive X-ray spectroscopy) and CV study:

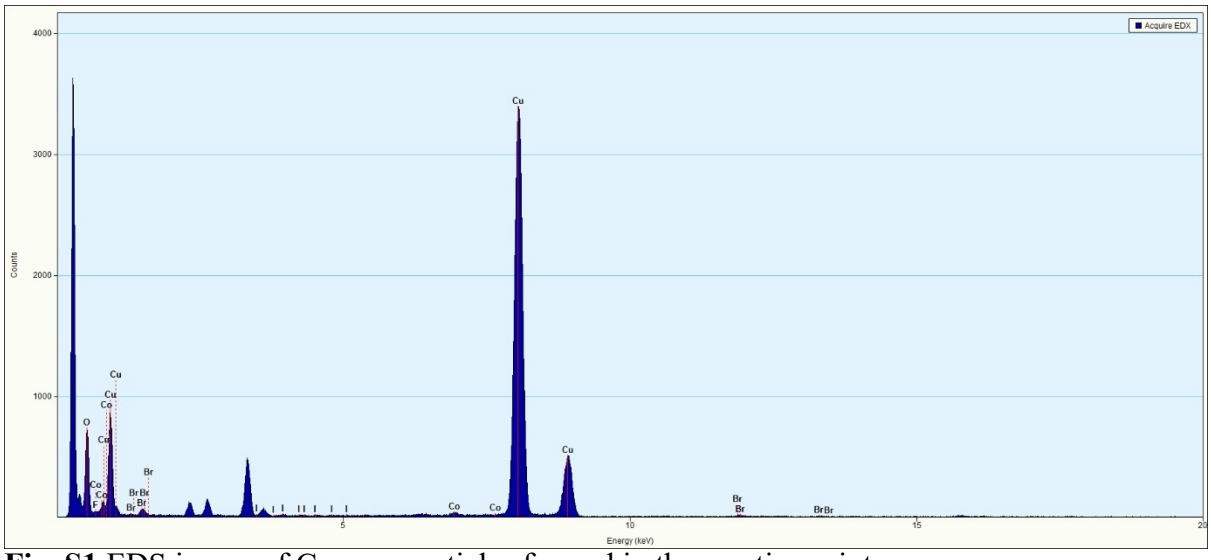
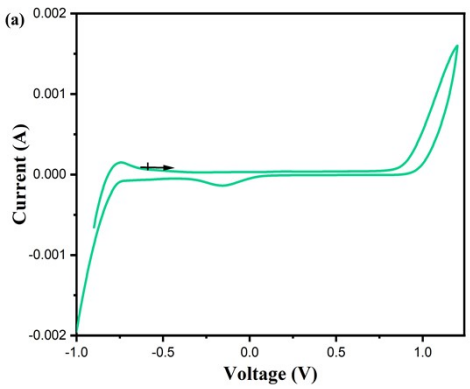


Fig. S1 EDS image of Co-nanoparticles formed in the reaction mixture.


(a)
0.002
0.001
0.000
-0.001
-0.002
Current (A)
-1.0
-0.5
0.0
0.5
1.0
Voltage (V)

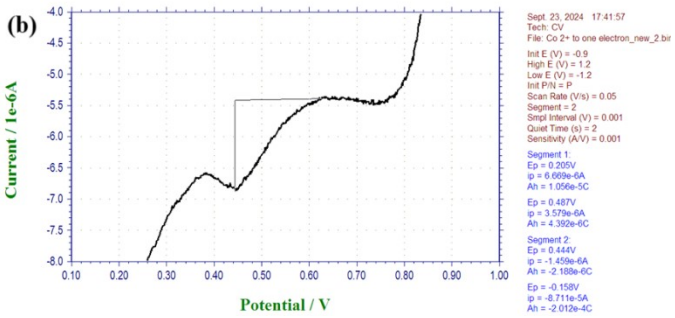
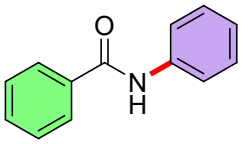

(b)
-4.0
-4.5
-5.0
-5.5
-6.0
-6.5
-7.0
-7.5
-8.0
Current / 1e-6A
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
Potential / V
Sept. 23, 2024 17:41:57
Tech: CV
File: Co 2+ to one electron_new_2.bi
Init E (V) = -0.9
High E (V) = 1.2
Low E (V) = -1.2
Init P/N = P
Scan Rate (V/s) = 0.05
Segment = 2
Smpl Interval (V) = 0.001
Quiet Time (s) = 2
Sensitivity (A/V) = 0.001
Segment 1:
Ep = 0.205V
ip = 6.669e-6A
Ah = 1.056e-5C
Ep = 0.487V
ip = 3.579e-6A
Ah = 4.392e-6C
Segment 2:
Ep = 0.444V
ip = -1.459e-6A
Ah = -2.188e-6C
Ep = -0.158V
ip = -8.711e-5A
Ah = -2.012e-4C

Fig. S2 (a) Cyclic voltammogram of $Co(acac)_2$ in H_2O/0.1 M K_2CO_3 with a Pt working electrode and a saturated Ag/AgCl reference electrode, (b) A zoomed-in picture of a Cyclic voltammogram of $Co(acac)_2$ in H_2O/0.1 M K_2CO_3 with a Pt working electrode and a saturated Ag/AgCl reference electrode.

5. Experimental procedures and characterization data of products

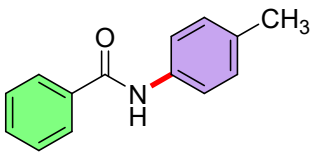
General Procedure A: synthesis of synthesis of *N*-arylamides: Representative Experimental Procedure for the synthesis of *N*-phenylbenzamide (1):



A mixture of benzamide **1i** (122 mg, 1.0 mmol), bromobenzene **2i'** (157 mg, 1.0 mmol) or iodobenzene **2i** (204 mg, 1.0 mmol), K_2CO_3 (208 mg, 1.5 mmol), $Co(acac)_2$ (26 mg, 10 mol%), CuI (19 mg, 10 mol%) and NMP (100 µL per 1.0 mmol scale of reaction) was heated at 130°C (for bromobenzene) or 110°C (for iodobenzene) in open air for 15 h. Then the reaction mixture was allowed to cool and filtration was done by ethyl acetate. Then the organic part (filtrate) was evaporated under reduced pressure to give the crude product which was purified by column chromatography over silica gel (hexane/ethyl acetate 90:10) to provide the pure product as a white solid (140.0 mg, 71 % yield: for bromobenzene and 183.4 mg, 93 % yield: for iodobenzene).[1]

White solid; mp 162-164 °C; IR (neat, cm^{-1}) ν 3320, 2915, 2841, 1625, 1595, 1502; ^1H NMR (400 MHz, $CDCl_3$) δ 7.15 (t, J = 7.4 Hz, 1H), 7.36 (t, J = 7.6 Hz, 2H), 7.44-7.54 (m, 3H), 7.64 (d, J = 7.7 Hz, 2H), 7.85 (t, J = 7.0 Hz, 2H), 7.97 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 120.4 (2C), 124.7, 127.2 (2C), 128.9 (2C), 129.2 (2C), 132.0, 135.0, 138.0, 166.0; HRMS (EI^+) m/z $[M]^+$ Calcd for $C_{13}H_{11}NO$: 197.0841, Found 197.0841. All analytical data are in good accordance with those reported in the literature.[1]

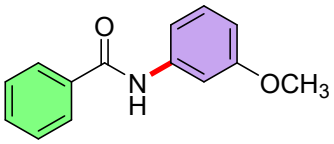
Synthesis of *N*-(p-tolyl)benzamide (2):



The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 4-Iodotoluene (218 mg, 1.0 mmol). The title compound (164.8 mg, 78% yield) was obtained as a white solid after silica gel column chromatography.[1]

White solid; mp 148°C-149 ^0C; ^1H NMR (400MHz, $CDCl_3$) δ 2.34 (s, 3H), 7.18 (d, J = 8Hz, 2H), 7.47-7.55 (m, 5H), 7.78 (s, 1H), 7.86 (d, J = 8Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.1, 120.4, 127.1(2C), 128.9 (2C), 129.8 (2C), 131.9 (2C), 134.4, 135.2, 135.4, 165.8. All analytical data are in good accordance with those reported in the literature.[1]

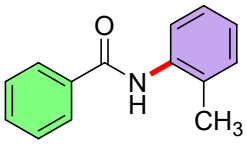
Synthesis of *N*-(3-methoxyphenyl)benzamide (3):



The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 3-Iodoanisole (234 mg, 1.0 mmol). The title compound (138.6 mg, 61% yield) was obtained as a white solid after silica gel column chromatography.[2]

White solid; mp 160-162 ºC; ^{1}H NMR (400MHz, $CDCl_3$) δ 3.79 (s, 3H), 6.69 (d, *J* = 8.4 Hz, 1H), 7.12 (d, *J* = 8.0 Hz, 1H), 7.21-7.26 (m, 1H), 7.41-7.52 (s, 4H), 7.84 (d, *J* = 7.2 Hz, 2H), 8.14 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 55.4, 106.0, 110.6, 112.5, 127.2 (2C), 128.8 (2C), 129.8, 131.9, 135.0, 139.3, 160.3, 166.1. All analytical data are in good accordance with those reported in the literature.[2]

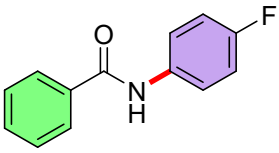
Synthesis of *N*-(o-tolyl)benzamide (4):



The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 2-Iodotoluene (218 mg, 1.0 mmol). The title compound (190.1 mg, 90% yield) was obtained as a white solid after silica gel column chromatography.[1]

White solid; mp 145-146°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 2.30 (s, 3H), 7.12 (t, *J* = 6.7 Hz, 1H), 7.21-7.26 (m, 2H), 7.45 (t, *J* = 7.2 Hz, 2H), 7.54 (t, *J* = 7.4 Hz, 1H), 7.81-7.93 (m, 4H); ^{13}C NMR (100MHz, $CDCl_3$) δ 17.9, 123.7, 125.6, 126.8, 127.2 (2C), 128.8 (2C), 130.0, 130.6, 131.9, 134.9, 135.8, 165.9. All analytical data are in good accordance with those reported in the literature.[1]

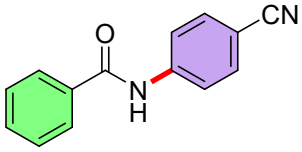
Synthesis of *N*-(4-fluorophenyl)benzamide (5):



The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 4-Fluoroiodobenzene (222 mg, 1.0 mmol). The title compound (174.3 mg, 81% yield) was obtained as a white solid after silica gel column chromatography.[3]

Light brown solid; mp 184-185 °C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.06 (t, *J* = 8.6 Hz, 3H), 7.47-7.50 (t, *J* = 7.6 Hz, 2H), 7.55 (d, *J* = 7.6 Hz, 1H), 7.58-7.62 (m, 2H), 7.86 (d, *J* = 7.4 Hz, 3H); ^{13}C NMR (100MHz, $CDCl_3$) δ 115.9 (d, *J* = 23.0 Hz, 2C), 122.2 (d, *J* = 7.0 Hz, 2C), 127.2, 129.0 (2C), 132.1 (2C), 134.0 (d, *J* = 2.0 Hz, 1C), 134.9, 159.7 (d, *J* = 243.0 Hz, 1C), 165.0. All analytical data are in good accordance with those reported in the literature.[3]

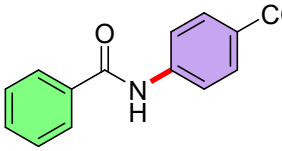
Synthesis of *N*-(4-cyanophenyl)benzamide (6):



The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 4-iodobenzonitrile (229 mg, 1.0 mmol). The title compound (166.7 mg, 75% yield) was obtained as a white solid after silica gel column chromatography.[4]

White solid; mp 165-166 ºC; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.49 (t, *J* = 7.6 Hz, 2H), 7.56 (d, *J* = 7.6 Hz, 1H), 7.62 (d, *J* = 8.4 Hz, 2H), 8.81 (d, *J* = 8.8 Hz, 2H), 8.87 (d, *J* = 7.2 Hz, 2H), 8.33 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 107.3, 116.5, 119.0, 120.2, 124.7, 127.3, 128.6, 129.1, 130.3, 132.6, 133.4, 134.2, 142.3, 166.3. All analytical data are in good accordance with those reported in the literature.[4]

Synthesis of ethyl 4-benzamidobenzoate (7):

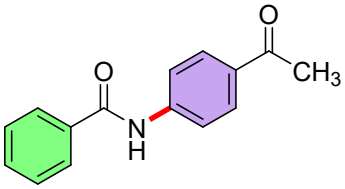


The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and ethyl

4-iodobenzoate (269.3 mg, 1.0 mmol). The title compound (193.9 mg, 72% yield) was obtained as a white solid after silica gel column chromatography.[1]

White solid; mp 149-150°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 2.71 (s, 1H), 2.99 (s, 1H), 4.31-4.40 (m, 3H), 7.48-7.59 (m, 3H), 7.74 (d, *J* = 8.6 Hz, 2H), 7.88 (d, *J* = 7.6 Hz, 2H), 8.02 (s, 1H), 8.06 (d, *J* = 8.6 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 14.5, 61.1, 115.3, 119.3, 126.4, 127.2, 129.1 (2C), 131.0 (2C), 131.9, 132.4, 134.7, 142.2, 165.9, 166.3. All analytical data are in good accordance with those reported in the literature.[1]

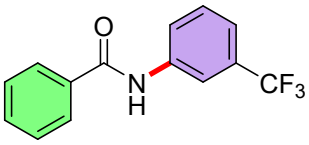
Synthesis of *N*-(4-acetylphenyl)benzamide (8):



The reaction was carried out according to the general procedure A for 15 h at 130°C using benzamide (122 mg, 1.0 mmol) and 1-(4-bromophenyl)ethan-1-one (199.0 mg, 1.0 mmol). The title compound (150.7 mg, 63% yield) was obtained as a white solid after silica gel column chromatography.[1]

White solid; mp 203-204 °C; ^{1}H NMR (400MHz, $CDCl_3$) δ 2.59 (s, 3H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.57 (d, *J* = 7.2 Hz, 1H), 7.77 (d, *J* = 8.8 Hz, 2H), 7.88 (d, *J* = 7.2 Hz, 2H), 7.97 (d, *J* = 8.4 Hz, 2H), 8.15 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 26.6, 119.4 (2C), 127.3 (2C), 129.1 (2C), 130.0 (2C), 132.4, 133.2, 134.6, 142.5, 166.0, 197.2. All analytical data are in good accordance with those reported in the literature.[1]

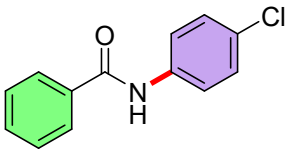
Synthesis of *N*-(4-(trifluoromethyl)phenyl)benzamide (9):



The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 1-iodo-3-(trifluoromethyl)benzene (272 mg, 1.0 mmol). The title compound (190.9 mg, 72% yield) was obtained as a white solid after silica gel column chromatography.[3]

White solid; mp 88–89 °C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.27-7.35 (m, 4H), 7.43 (t, *J* = 11.4 Hz, 1H), 7.75 (d, *J* = 7.56 Hz, 3H), 7.85 (s, 1H), 8.29 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 117.3 (d, *J* = 4.0 Hz, 1C), 121.2 (d, *J* = 4.0 Hz, 1C), 123.6, 124.5 (d, *J* = 273.0 Hz, 1C), 127.2 (2C), 128.9 (2C), 129.7, 131.5 (d, *J* = 2.0 Hz, 1C), 132.3, 134.5, 138.6, 166.4. All analytical data are in good accordance with those reported in the literature.[3]

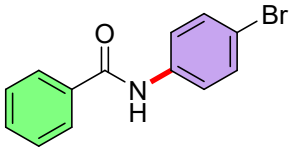
Synthesis of *N*-(4-chlorophenyl)benzamide (10):



The reaction was carried out according to the general procedure A for 15 h at 130°C using benzamide (122 mg, 1.0 mmol) and 1-bromo-4-chlorobenzene (208 mg, 1.0 mmol). The title compound (231.7 mg, 72% yield) was obtained as a white solid after silica gel column chromatography.

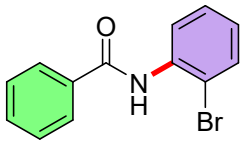
White solid; mp 198-200 ºC; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.33 (d, *J* = 8.8 Hz, 2H), 7.49 (t, *J* = 8.0 Hz, 2H), 7.55 (d, *J* = 7.2 Hz, 1H), 7.60 (d, *J* = 8.8 Hz, 2H), 7.86 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100MHz, $CDCl_3$) δ 121.6 (2C), 127.2 (2C), 129.0 (2C), 129.3 (2C), 129.7, 132.2, 134.8, 136.6, 165.8. All analytical data are in good accordance with those reported in the literature.[5]

Synthesis of *N*-(4-bromophenyl)benzamide (11):



The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 1-Bromo-4-iodobenzene (283 mg, 1.0 mmol). The title compound (193.3 mg, 70% yield) was obtained as a white solid after silica gel column chromatography.[5]

White solid; mp 175-178 ºC; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.40-7.47 (m, 3H), 7.55 (td, J = 6.4, 0.8 Hz, 1H), 7.80-7.84 (m, 5H), 8.11 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 121.9 (2C), 123.2, 127.2 (2C), 129.0 (2C), 130.1 (2C), 132.5, 134.1, 140.1, 166.0. All analytical data are in good accordance with those reported in the literature.[5]

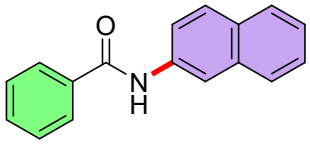


Synthesis of *N*-(2-bromophenyl)benzamide (12):

The reaction was carried out according to the general procedure A for 15 h at 130°C using benzamide (122 mg, 1.0 mmol) and 1,2-dibromobenzene (236 mg, 1.0 mmol). The title compound (168.4 mg, 61% yield) was obtained as a white solid after silica gel column chromatography.[6]

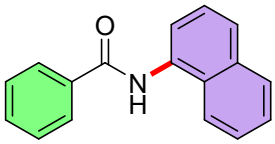
White solid; mp 168-170 ºC; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.38 (t, J = 7.2 Hz, 1H), 7.37 (t, J = 7.6 Hz, 2H), 7.48 (t, J = 6.8 Hz, 2H), 7.54 (d, J = 7.2 Hz, 1H), 7.64 (d, J = 8.0 Hz, 2H), 7.87 (d, J = 6.8 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 120.3, 124.8, 127.2 (2C), 127.8, 128.9 (2C), 129.1, 129.3, 132.0, 135.1, 138.1, 165.9; All analytical data are in good accordance with those reported in the literature.[6]

Synthesis of *N*-(naphthalen-2-yl)benzamide (13):



The reaction was carried out according to the general procedure A for 15 h at 130°C using benzamide (122 mg, 1.0 mmol) and 2-bromonaphthalene (206.7 mg, 1.0 mmol). The title compound (168.2 mg, 68% yield) was obtained as a white solid after silica gel column chromatography.[1]

White solid; mp 164-165°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.41-7.52 (m, 4H), 7.55-7.61 (m, 2H), 7.81 (q, J = 8.4, 4.4 Hz, 3H), 7.92 (d, J = 7.2 Hz, 2H), 8.06 (s, 1H), 8.35 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 117.2, 120.2, 125.5, 126.7, 127.2 (2C), 127.7, 127.9, 128.9 (2C), 129.0, 130.9, 132.1, 134.0, 135.1, 135.5, 166.1. All analytical data are in good accordance with those reported in the literature.[1]



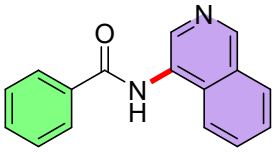
Synthesis of *N*-(naphthalen-1-yl)benzamide (14):

The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 1-iodonaphthalene (254.1 mg, 1.0 mmol). The title compound (168.2 mg, 68% yield) was obtained as a white solid after silica gel column chromatography.[1]

White solid; mp 158-160 ^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.43-7.51 (m, 5H), 7.56 (t, J = 7.2 Hz, 1H), 7.72 (d, J = 8.0 Hz, 1H), 7.86-7.95 (m, 5H), 8.39 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 121.1, 121.7, 125.8, 126.1, 126.3, 126.4, 127.3 (2C), 127.8, 128.8, 128.9 (2C), 132.0, 132.5,

134.2, 134.8, 166.6. All analytical data are in good accordance with those reported in the literature.[1]

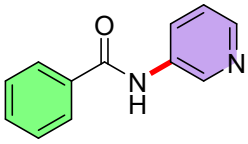
Synthesis of *N*-(quinolin-3-yl)benzamide (15):



The reaction was carried out according to the general procedure A for 15 h at 130°C using benzamide (122 mg, 1.0 mmol) and 4-bromoisoquinoline (184.9 mg, 1.0 mmol). The title compound (186.2 mg, 75% yield) was obtained as a white solid after silica gel column chromatography. [7]

Yellow solid; mp 123-125 ^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.64 (s, 1H), 7.33-7.38 (m, 3H), 7.46 (t, *J* = 8.0 Hz, 2H), 7.55 (t, *J* = 7.2 Hz, 1H), 7.60 (d, *J* = 8.0 Hz, 1H), 7.76 (d, *J* = 7.6 Hz, 2H), 7.94 (d, *J* = 8.0 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 125.2, 127.4 (2C), 127.6, 127.9, 128.1, 128.6 (2C), 128.7, 132.1, 132.4, 133.2, 134.2, 144.3, 144.5, 167.0. All analytical data are in good accordance with those reported in the literature.[7]

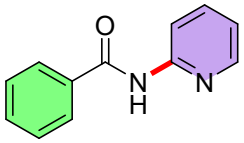
Synthesis of *N*-(pyridin-3-yl)benzamide (16):



The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 3-iodopyridine (205 mg, 1.0 mmol). The title compound (154.6 mg, 78% yield) was obtained as a white solid after silica gel column chromatography.[1]

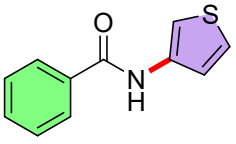
White solid; mp 116-118°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 6.58 (s, *J* = 7.4 Hz, 1H), 7.16 (q, *J* = 4.8 Hz, 1H), 7.39 (t, *J* = 7.6 Hz, 2H), 7.48 (t, *J* = 7.6 Hz, 1H), 7.77-7.81 (m, 3H), 8.49 (d, *J* = 4.8 Hz, 1H), 8.64 (d, *J* = 4.8 Hz, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 119.9, 123.8, 126.4 (2C), 127.5 (2C), 130.9, 132.5, 137.7, 146.8, 149.9, 169.0; All analytical data are in good accordance with those reported in the literature.[1]

Synthesis of *N*-(pyridin-2-yl)benzamide (17):



The reaction was carried out according to the general procedure A for 15 h at 130°C using benzamide (122 mg, 1.0 mmol) and 2-bromopyridine (105.3 mg, 1.0 mmol). The title compound (99.1 mg, 50% yield) was obtained as a light yellow solid after silica gel column chromatography. [8]

Light yellow solid; mp 114-116°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.11 (t, *J* = 6.0 Hz, 1H), 7.51 (t, *J* = 7.2 Hz, 2H), 7.58 (t, *J* = 7.6 Hz, 1H), 7.81 (t, *J* = 7.2 Hz, 1H), 7.98 (d, *J* = 7.2 Hz, 2H), 8.27 (s, 1H), 8.46 (d, *J* = 8.4 Hz, 1H), 9.20 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 114.8, 120.1, 127.5 (2C), 129.0 (2C), 132.5, 134.1, 139.4, 147.0, 151.6, 166.0. All analytical data are in good accordance with those reported in the literature.[8]



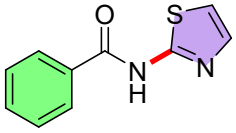
Synthesis of *N*-(thiophen-3-yl)benzamide (18):

The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and 3-iodothiophene (210 mg, 1.0 mmol). The title compound (111.7 mg, 55% yield) was obtained as a light yellow solid after silica gel column chromatography.

Light yellow solid; mp 118-120°C; IR (neat, cm^{-1}) *ν* 3108, 2918, 1710, 1602, 1563, 1460, 1246, 1024,. ^{1}H NMR (400MHz, $CDCl_3$) δ 7.12 (d, *J* = 5.2 Hz, 1H), 7.27-7.30 (m, 1H), 7.47-7.56(m, 4H), 7.74 (d, *J* = 2.0 Hz, 1H), 7.86 (d, *J* = 7.2 Hz, 1H), 8.15 (brs, 1H); ^{13}C NMR

(100MHz, $CDCl_3$) δ 110.9, 121.3, 124.9, 127.1 (2C), 129.0 (2C), 132.1, 134.5, 152.2, 171.4; HRMS (FAB$^+$) m/z $[M]^+$ Calcd for $C_{11}H_9NOS$: 203.0405, Found 203.0405.

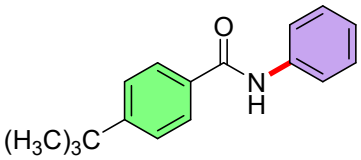
Synthesis of *N-(*thiazol-2-yl)benzamide (19):



The reaction was carried out according to the general procedure A for 15 h at 130°C using benzamide (122 mg, 1.0 mmol) and 2-bromothiazole (164 mg, 1.0 mmol). The title compound (106.2 mg, 52% yield) was obtained as a yellow solid after silica gel column chromatography.

Yellow solid; mp 120-122 ^{0}C; IR (neat, cm^{-1}) *v* 3103, 2925, 2851, 1707, 1599, 1564, 1461, 1290, 1244, 1021, 1027. ^{1}H NMR (400MHz, $CDCl_3$) δ 6.80 (d, *J* = 5.2 Hz, 1H), 7.40 (d, *J* = 3.6 Hz, 1H), 7.51-7.57 (m, 2H), 7.67 (d, *J* = 3.6 Hz, 1H), 8.30 (d, *J* = 4.8 Hz, 1H), 8.45 (q, *J* = 8.0, 1.6 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 110.1, 118.7, 123.3, 128.5, 130.0, 132.5, 138.4, 144.0, 156.2, 165.2; HRMS (FAB$^+$) m/z $[M+Na]^+$ Calcd for $C_{10}H_8N_2OSNa$: 227.0249, Found 227.0247.

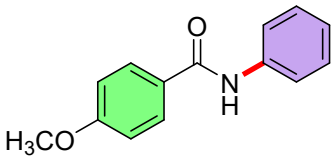
Synthesis of 4-(tert-butyl)-*N*-phenylbenzamide (20):



The reaction was carried out according to the general procedure A for 15 h at 130°C using 4-(tert-butyl)benzamide (177.2 mg, 1.0 mmol) and bromobenzene (157 mg, 1.0 mmol). The title compound (202.7 mg, 80% yield) was obtained as a yellow solid after silica gel column chromatography.

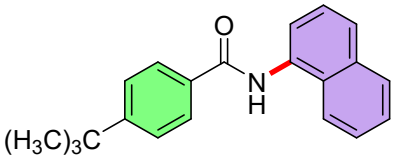
Yellow solid; mp 123-125 ^{0}C; IR (neat, cm^{-1}) *v* 3099, 2926, 1707, 1601, 1563, 1460, 1245, 1021, 1024. ^{1}H NMR (400MHz, $CDCl_3$) δ 1.35 (s, 9H), 7.14 (t, *J* = 7.2 Hz, 1H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.50 (d, *J* = 8.4 Hz, 2H), 7.64 (d, *J* = 8.0 Hz, 2H), 7.81 (d, *J* = 8.4 Hz, 2H), 7.88 (brs, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 31.3 (3C), 35.1, 120.3 (2C), 124.6, 125.9 (2C), 127.0 (2C), 129.2 (2C), 132.2, 138.2, 155.6, 165.9; HRMS (FAB$^+$) m/z $[M]^+$ Calcd for $C_{17}H_{19}NO$: 253.1467, Found 253.1467.

Synthesis of 4-methoxy-*N*-phenylbenzamide (21):



The reaction was carried out according to the general procedure A for 15 h at 110°C using benzamide (122 mg, 1.0 mmol) and iodobenzene (204.0 mg, 1.0 mmol). The title compound (154.5 mg, 68% yield) was obtained as a white solid after silica gel column chromatography.[5]

White solid; mp 160-162 ºC; ^{1}H NMR (400MHz, $CDCl_3$) δ 3.87 (s, 3H), 6.96 (d, *J* = 8.8 Hz, 2H), 7.14 (t, *J* = 7.2 Hz, 1H), 7.36 (t, *J* = 8.4 Hz, 2H), 7.62 (d, *J* = 8.0 Hz, 2H), 7.83 (d, *J* = 8.8 Hz, 3H); ^{13}C NMR (100MHz, $CDCl_3$) δ 55.6, 114.1 (2C), 120.3 (2C), 124.5, 127.2, 129.1 (2C), 129.2 (2C), 138.2, 162.6, 165.4. All analytical data are in good accordance with those reported in the literature.[5]

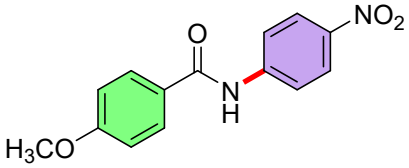


Synthesis of 4-(tert-butyl)-*N*-(naphthalen-1-yl)benzamide (22):

The reaction was carried out according to the general procedure A for 15 h at 130°C using 4-(tert-butyl)benzamide (177.2 mg, 1.0 mmol) and 1-bromonaphthalene (207 mg, 1.0 mmol). The title compound (218.5 mg, 72% yield) was obtained as a yellow solid after silica gel column chromatography.[9]

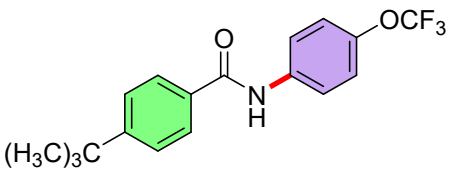
White solid; mp 110-112 ^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 1.38 (s, 9H), 7.50-7.56 (m, 5H), 7.74 (d, J = 8.0 Hz, 1H), 7.89-7.94 (m, 4H), 8.03 (d, J = 6.8 Hz, 1H), 8.25 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 31.3, 35.2 (3C), 120.8, 121.3, 126.0 (2C), 126.1, 126.2, 126.5, 127.2 (2C), 127.6, 129.0, 130.0, 132.1, 132.6, 134.3, 155.7, 166.3. All analytical data are in good accordance with those reported in the literature.[9]

Synthesis of 4-methoxy-*N*-(4-nitrophenyl)benzamide (23):



The reaction was carried out according to the general procedure A for 15 h at 130°C using 4-methoxybenzamide (151.2 mg, 1.0 mmol), 1-bromo-4-nitrobenzene (202 mg, 1.0 mmol). The title compound (136.1 mg, 50% yield) was obtained as a yellow solid after silica gel column chromatography.[10]

Yellow solid; mp 210-212 ^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 3.79 (s, 3H), 6.69 (d, J = 8.4 Hz, 1H), 7.12 (d, J = 8.0 Hz, 1H), 7.21-7.26 (m, 1H), 7.41-7.52 (m, 3H), 7.84 (d, J = 7.2 Hz, 2H), 8.07-8.14 (m, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 55.7, 114.4 (2C), 119.5 (2C), 125.3 (2C), 126.2, 129.3 (2C), 143.6, 144.2, 163.2, 165.5. All analytical data are in good accordance with those reported in the literature.[10]

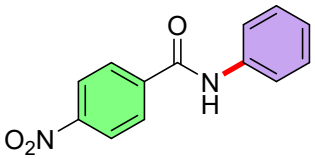


Synthesis of 4-(tert-butyl)-*N*-(4-(trifluoromethoxy)phenyl)benzamide (24):

The reaction was carried out according to the general procedure A for 15 h at 110°C using 4-(tert-butyl)benzamide (177.2 mg, 1.0 mmol), 1-iodo-4-(trifluoromethoxy)benzene (288.0 mg, 1.0 mmol). The title compound (263.1 mg, 78% yield) was obtained as a white solid after silica gel column chromatography.

White solid; mp 122-124ºC; IR (neat, cm^{-1}) ν3308, 2965, 2868, 1644, 1541, 1507, 1416, 1215, 1152, 1021; ^{1}H NMR (400MHz, $CDCl_3$) δ 1.30 (s, 9H), 7.15 (d, J = 8.6 Hz, 2H), 7.43 (d, J = 8.4 Hz, 2H), 7.66 (d, J = 8.9 Hz, 2H), 7.78 (d, J = 8.4 Hz, 2H), 8.28 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 31.2, 35.1, 119.3, 121.6 (2C), 121.8 (2C), 125.8 (2C), 127.1 (2C), 131.7, 136.9, 145.5, 155.8, 166.2; HRMS (FAB$^+$) m/z $[M+H]^+$ Calcd for $C_{18}H_{19}F_3NO_2$: 338.1363, Found 338.1363.

Synthesis of 4-nitro-*N*-phenylbenzamide (25):

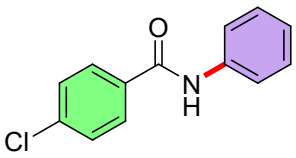


The reaction was carried out according to the general procedure A for 15 h at 110°C using 4-nitrobenzamide (166.1 mg, 1.0 mmol) and iodobenzene (204.0 mg, 1.0 mmol). The title compound (169.6 mg, 70% yield) was obtained as a yellow solid after silica gel column chromatography.[11]

Yellow solid; mp 200-202 ^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 6.52 (d, J = 9.2 Hz, 1H), 6.90 (d, J = 8.8 Hz, 1H), 7.21 (t, J = 7.6 Hz, 1H), 7.41 (t, J = 7.6 Hz, 1H), 7.64 (d, J = 7.6 Hz, 1H), 7.90 (s, 1H), 8.04-8.16 (m, 3H), 8.35 (d, J = 8.8 Hz, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 116.5,

120.6, 124.2 (2C), 125.5 (2C), 128.4 (2C), 129.4 (2C), 137.3, 140.7, 163.8. All analytical data are in good accordance with those reported in the literature.[11]

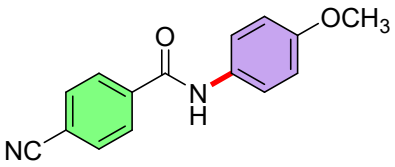
Synthesis of 4-chloro-*N*-phenylbenzamide (26):



The reaction was carried out according to the general procedure A for 15 h at 110°C using 4-chlorobenzamide (155.6 mg, 1.0 mmol) and iodobenzene (204.0 mg, 1.0 mmol). The title compound (185.3 mg, 80% yield) was obtained as a white solid after silica gel column chromatography.[1]

White solid; mp 187-188°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.17 (t, *J* = 7.4 Hz, 1H), 7.38 (t, *J* = 7.7 Hz, 2H), 7.46 (d, *J* = 8.0 Hz, 2H), 7.62 (d, *J* = 7.9 Hz, 2H), 7.81 (d, *J* = 8.0 Hz, 3H); ^{13}C NMR (100MHz, $CDCl_3$) δ 120.4 (2C), 125.0 (2C), 128.6 (2C), 129.3 (2C), 132.8, 133.5, 137.8, 138.3, 164.8. All analytical data are in good accordance with those reported in the literature.[1]

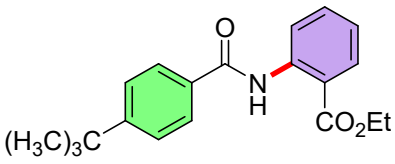
Synthesis of 4-cyano-*N*-*(*4-methoxyphenyl)benzamide (27):



The reaction was carried out according to the general procedure A for 15 h at 130°C using 4-cyanobenzamide (155.6 mg, 1.0 mmol), 1-bromo-4-methoxybenzene (187.0 mg, 1.0 mmol). The title compound (206.9 mg, 82% yield) was obtained as a red solid after silica gel column chromatography.[12]

Red solid; mp 186-188ºC; ^{1}H NMR (400MHz, $CDCl_3$) δ 3.81 (s, 3H), 6.89 (d, *J* = 8.9 Hz, 2H), 7.51 (d, *J* = 8.8 Hz, 2H), 7.74 (d, *J* = 8.2 Hz, 2H), 7.95 (d, *J* = 8.0 Hz, 3H); ^{13}C NMR (100MHz, $CDCl_3$) δ 55.7, 114.5, 115.4, 118.1, 122.5, 127.9, 130.4, 132.7, 139.1, 157.2, 164.0. All analytical data are in good accordance with those reported in the literature.[12]

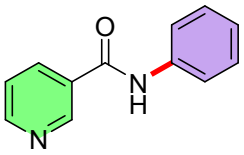
Synthesis of ethyl 2-(4-(tert-butyl)benzamido)benzoate (28):



The reaction was carried out according to the general procedure A for 15 h at 130°C using 4-(tert-butyl)benzamide (177.2 mg, 1.0 mmol), ethyl 2-bromobenzoate (229.1 mg, 1.0 mmol). The title compound (175.7 mg, 54% yield) was obtained as a yellow solid after silica gel column chromatography.

Yellow solid; mp 176-178 ^{0}C; IR (neat, cm^{-1}) *v* 3125, 3068, 2959, 2857, 1702, 1655, 1604, 1582, 1541, 1507, 1450, 1387, 1330, 1307, 1227, 1130, 1073; ^{1}H NMR (400MHz, $CDCl_3$) δ 1.27-1.31 (m, 2H), 1.34 (s, 12H), 7.14 (d, *J* = 7.6 Hz, 1H), 7.51 (d, *J* = 8.4 Hz, 2H), 7.64 (td, *J* = 7.6, 0.8 Hz, 1H), 7.96 (d, *J* = 8.4 Hz, 2H), 8.17 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.95 (d, *J* = 8.4 Hz, 1H), 11.96 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) δ 29.8, 31.3 (3C), 35.1, 60.7, 100.0, 114.7, 120.7, 122.9, 125.9 (2C), 127.4 (2C), 132.0, 135.7, 142.4, 155.9, 166.3, 172.1; HRMS (FAB$^+$) m/z $[M+NH_4]^+$ Calcd for $C_{20}H_{27}N_2O_3$: 343.2016, Found 343.2014.

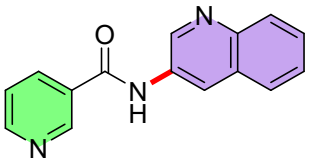
Synthesis of *N*-phenylnicotinamide (29):



The reaction was carried out according to the general procedure A for 15 h at 130°C using nicotinamide (122.1 mg, 1.0 mmol), bromobenzene (157.1 mg, 1.0 mmol). The title compound (101.1 mg, 51% yield) was obtained as a yellow solid after silica gel column chromatography.[13]

Yellow solid; mp 130–132^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.50 (t, *J* = 7.2 Hz, 1H), 7.33 (t, *J* = 8.0 Hz, 3H), 7.62 (t, *J* = 8.0 Hz, 2H), 8.18 (d, *J* = 7.6 Hz, 1H), 8.67 (s, 1H), 8.71 (s, 1H), 9.06 (s, 1H) ; ^{13}C NMR (100MHz, $CDCl_3$) δ 120.8, 123.9, 125.1 (2C), 129.2 (2C), 131.1, 135.9, 137.7, 147.9, 152.1, 164.2. All analytical data are in good accordance with those reported in the literature.[13]

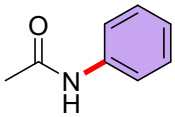
Synthesis of *N*-(quinolin-3-yl)nicotinamide (30):



The reaction was carried out according to the general procedure A for 15 h at 130°C using nicotinamide (122.1 mg, 1.0 mmol), 3-bromoquinoline (208.1 mg, 1.0 mmol). The title compound (107.2 mg, 43% yield) was obtained as a yellow solid after silica gel column chromatography.[14]

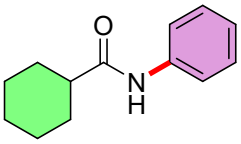
White solid; mp 141-143^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.51 (t, *J* = 7.2 Hz, 1H), 7.60-7.67 (m, 2H), 7.77-7.85 (m, 2H), 7.93-8.03 (m, 1H), 8.10 (d, *J* = 2.4 Hz, 1H), 8.37 (t, *J* = 8.4 Hz, 1H), 8.86 (d, *J* = 2.4 Hz, 1H), 9.19-9.27 (m, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 127.1, 127.6, 127.8, 128.5, 128.6, 128.8, 129.3, 129.8, 133.1, 137.4, 140.1, 145.2, 146.7, 148.3, 149.8. All analytical data are in good accordance with those reported in the literature.[14]

Synthesis of *N*-phenylacetamide (31):



The reaction was carried out according to the general procedure A for 15 h at 130°C using acetamide (59.1 mg, 1.0 mmol), bromobenzene (157.1 mg, 1.0 mmol). The title compound (118.9 mg, 88% yield) was obtained as a white solid after silica gel column chromatography.[15]

White solid, mp 112-114 °C; ^{1}H NMR (400MHz, $CDCl_3$) δ 2.72 (s, 3H), 7.10 (t, *J* = 7.2 Hz, 1H), 7.29-7.35 (m, 3H), 7.49 (d, *J* = 7.6 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 24.6, 120.0 (2C), 124.5, 129.1 (2C), 138.0, 168.5. All analytical data are in good accordance with those reported in the literature.[15]

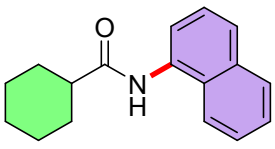


Synthesis of *N*-phenylcyclohexanecarboxamide (32):

The reaction was carried out according to the general procedure A for 15 h at 130°C using cyclohexanecarboxamide (127.2 mg, 1.0 mmol), bromobenzene (157.1 mg, 1.0 mmol). The title compound (162.6 mg, 80% yield) was obtained as a white solid after silica gel column chromatography.[16]

White solid; mp 120-122 ^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 1.43-1.58 (m, 3H), 1.65-1.75 (m, 2H), 1.82 (d, *J* = 11.6 Hz, 2H), 1.95 (d, *J* = 12.4 Hz, 2H), 2.18-2.26 (m, 2H), 7.09 (t, *J* = 7.6 Hz, 1H), 7.24 (s, 1H), 7.31 (t, *J* = 7.6 Hz, 2H), 7.52 (d, *J* = 8.0 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 25.8 (2C), 29.7 (2C), 29.8, 46.7, 119.9 (2C), 124.2, 129.1 (2C), 138.2, 174.6. All analytical data are in good accordance with those reported in the literature.[16]

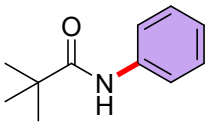
Synthesis of *N*-(naphthalen-1-yl)cyclohexanecarboxamide (33):



The reaction was carried out according to the general procedure A for 15 h at 110°C using cyclohexanecarboxamide (127.2 mg, 1.0 mmol), 1-iodonaphthalene (254.1 mg, 1.0 mmol). The title compound (192.5 mg, 76% yield) was obtained as a white solid after silica gel column chromatography.[17]

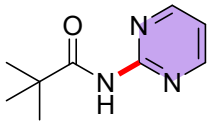
White solid; mp 130-132ºC; ^{1}H NMR (400MHz, $CDCl_3$) δ 1.26-1.39 (m, 4H), 1.60 (q, *J* = 12.0 Hz, 2H), 1.85 (d, *J* = 10.8 Hz, 2H), 2.05 (d, *J* = 7.6 Hz, 2H), 2.38 (t, *J* = 11.6 Hz, 1H), 7.40-7.49 (m, 3H), 7.67 (d, *J* = 8.4 Hz, 2H), 7.80-7.88 (m, 3H); ^{13}C NMR (100MHz, $CDCl_3$) δ 25.8 (2C), 29.8, 30.0 (2C), 46.4, 120.8, 121.3, 125.7, 125.8, 126.0, 126.3, 127.4, 128.8, 132.4, 134.2, 175.1. All analytical data are in good accordance with those reported in the literature.[17]

Synthesis of *N*-phenylpivalamide (34):



The reaction was carried out according to the general procedure A for 15 h at 130°C using pivalamide (101.2 mg, 1.0 mmol), bromobenzene (157.1 mg, 1.0 mmol). The title compound (152.4 mg, 86% yield) was obtained as a white solid after silica gel column chromatography.[18]

White solid; mp 126-128 ^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 1.32 (s, 9H), 7.10 (t, *J* = 7.2 Hz, 1H), 7.32 (t, *J* = 8.4 Hz, 3H), 7.52 (d, *J* = 8.0 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 27.8, 39.7 (3C), 120.1 (2C), 124.3, 129.0 (2C), 138.1, 176.7. All analytical data are in good accordance with those reported in the literature.[18]

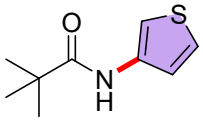


Synthesis of *N*-(pyrimidin-2-yl)pivalamide (35):

The reaction was carried out according to the general procedure A for 15 h at 130°C using pivalamide (101.2 mg, 1.0 mmol), 2-bromopyrimidine (159.0 mg, 1.0 mmol). The title compound (168.5 mg, 94% yield) was obtained as a white solid after silica gel column chromatography.[19]

White solid; mp 132-134 ^{0}C; ^{1}H NMR (400MHz, $CDCl_3$) δ 1.31 (s, 9H), 7.00 (dd, *J* = 4.9, 1.6 Hz, 1H), 7.22 (q, *J* = 3.8 Hz, 1H), 7.61 (dd, *J* = 3.3, 1.1 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) δ 21.3 (3C), 42.7, 110.9, 158.0 (2C), 162.8, 175.9. All analytical data are in good accordance with those reported in the literature.[19]

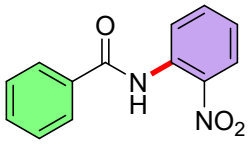
Synthesis of *N*-(thiophen-3-yl)pivalamide (36):



The reaction was carried out according to the general procedure A for 15 h at 110°C using 4-chlorobenzamide (155.6 mg, 1.0 mmol) and 3-iodothiophene (210.0 mg, 1.0 mmol). The title compound (155.8 mg, 85% yield) was obtained as a white solid after silica gel column chromatography.

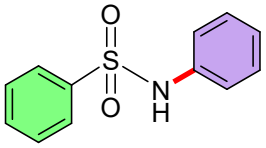
White solid; mp 152-154ºC; IR (neat, cm^{-1}) *ν* 3343, 2954, 2919, 2868, 1650, 1519,1485, 1364, 1198, 1141; ^{1}H NMR (400MHz, $CDCl_3$) δ 1.30 (s, 9H), 6.99 (dd, *J* = 4.8, 1.6 Hz, 1H), 7.22 (q, *J* = 3.6 Hz, 1H), 7.61 (dd, *J* = 3.2, 1.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 27.8 (3C), 39.4, 110.2, 121.2, 124.5, 135.8, 176.1; HRMS (FAB$^+$) m/z [M+H]$^+$ Calcd for $C_9H_{14}NOS$: 184.0791, Found 184.0791.

Synthesis of *N*-(2-nitrophenyl)benzamide (37):



The reaction was carried out according to the general procedure A for 15 h at 130°C using benzamide (122 mg, 1.0 mmol), 1-chloro-2-nitrobenzene (236.4 mg, 1.5 mmol). The title compound (193.8 mg, 80% yield) was obtained as a yellow solid after silica gel column chromatography.[20]

Yellow solid; mp 182-184 ^{0}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.07 (d, *J* = 8.4 Hz, 2H), 7.33 (td, *J* = 8.0, 0.8 Hz, 3H), 7.61 (td, *J* = 7.2, 0.8 Hz, 3H), 8.05 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR (100



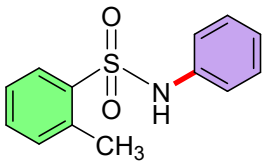
MHz, $CDCl_3$) δ 123.7, 125.6, 126.8, 127.2 (2C), 128.8 (2C), 130.0, 130.6, 131.9, 134.9, 135.8, 165.9. All analytical data are in good accordance with those reported in the literature.[20]

Synthesis of *N*-phenylbenzenesulfonamide (38):

The reaction was carried out according to the general procedure A for 15 h at 130°C using benzenesulfonamide (157 mg, 1.0 mmol), bromobenzene (236 mg, 1.5 mmol). The title compound (142.3 mg, 61% yield) was obtained as a yellow solid after silica gel column chromatography.[21]

Yellow solid; mp 110-112 ^{0}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.0-7.05 (m, 3H), 7.08 (s, 1H), 7.14-7.19 (m, 2H), 7.35 (t, J = 7.9 Hz, 2H), 7.44-7.97 (m, 1H), 7.71 (d, J = 7.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 122.0 (2C), 125.7, 127.3 (2C), 129.2 (2C), 129.5 (2C), 133.2, 136.4, 139.1. All analytical data are in good accordance with those reported in the literature.[21]

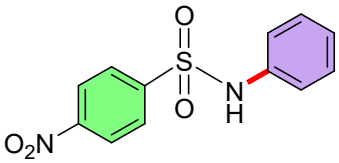
Synthesis of 2-methyl-*N*-phenylbenzenesulfonamide (39):



The reaction was carried out according to the general procedure A for 15 h at 130°C using 2-methylbenzenesulfonamide (171 mg, 1.0 mmol), bromobenzene (236 mg, 1.5 mmol). The title compound (103.9 mg, 42% yield) was obtained as a yellow solid after silica gel column chromatography.[21]

Yellow solid; mp 116-118 ^{0}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.58 (s, 3H), 6.94-6.99 (m, 4H), 7.12-7.14 (m, 2H), 7.18 (q, J = 3.6 Hz, 2H), 7.34-7.36 (m, 1H), 7.90 (d, J = 4.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 20.5, 120.7, 125.1, 126.4, 129.5 (2C), 130.1, 132.7 (2C), 133.3, 136.6, 137.3, 137.5. All analytical data are in good accordance with those reported in the literature.[21]

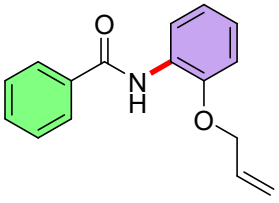
Synthesis of 4-nitro-*N*-phenylbenzenesulfonamide (40):



The reaction was carried out according to the general procedure A for 15 h at 130°C using 4-nitrobenzenesulfonamide (202 mg, 1.0 mmol), bromobenzene (236 mg, 1.5 mmol). The title compound (136.4 mg, 49% yield) was obtained as a yellow solid after silica gel column chromatography.[22]

Yellow solid; mp 132-134 ^{0}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.14 (d, J = 8.4 Hz, 2H), 7.36 (q, J = 1.2 Hz, 4H), 7.46 (t, J = 7.6 Hz, 1H), 7.80 (d, J = 7.6 Hz, 2H), 8.06 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 113.8 (2C), 122.1 (2C), 124.8, 126.4 (2C), 129.9 (2C), 139.6, 139.9, 150.3. All analytical data are in good accordance with those reported in the literature.[22]

Synthesis of *N*-(2-(allyloxy)phenyl)benzamide (41):

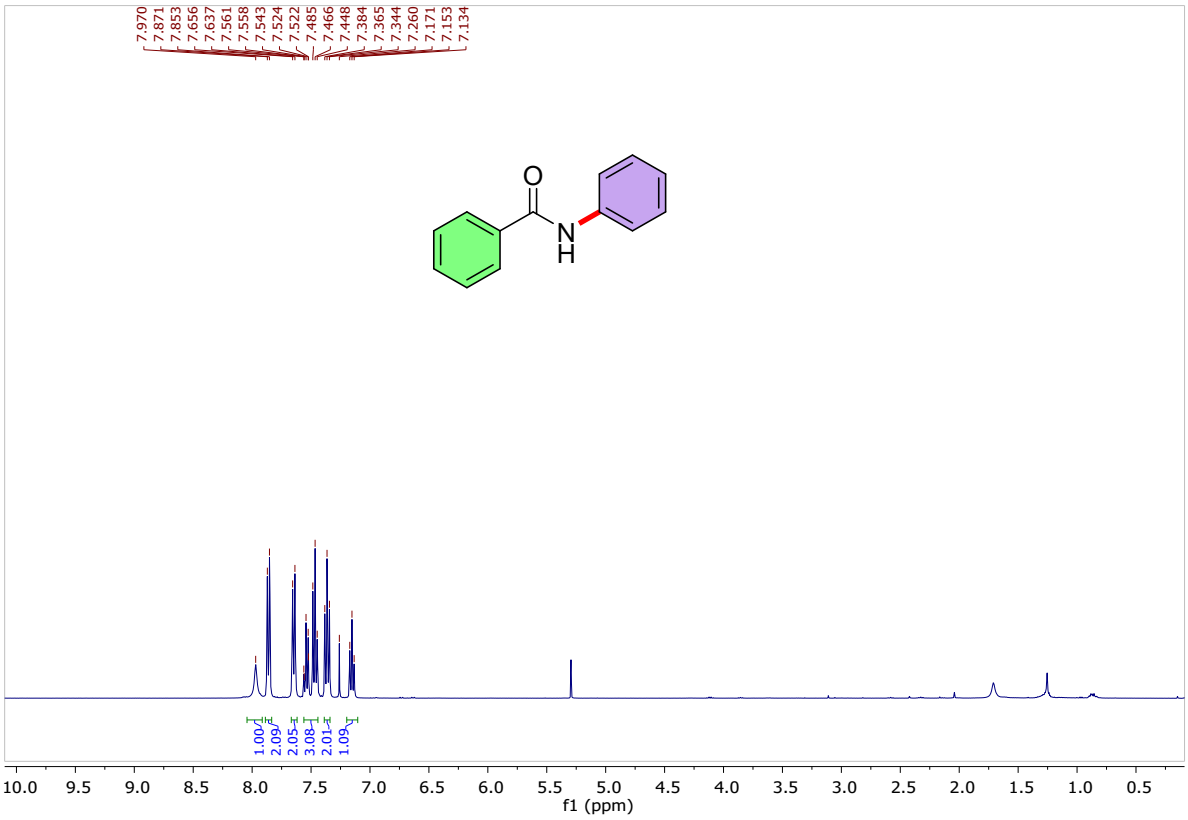


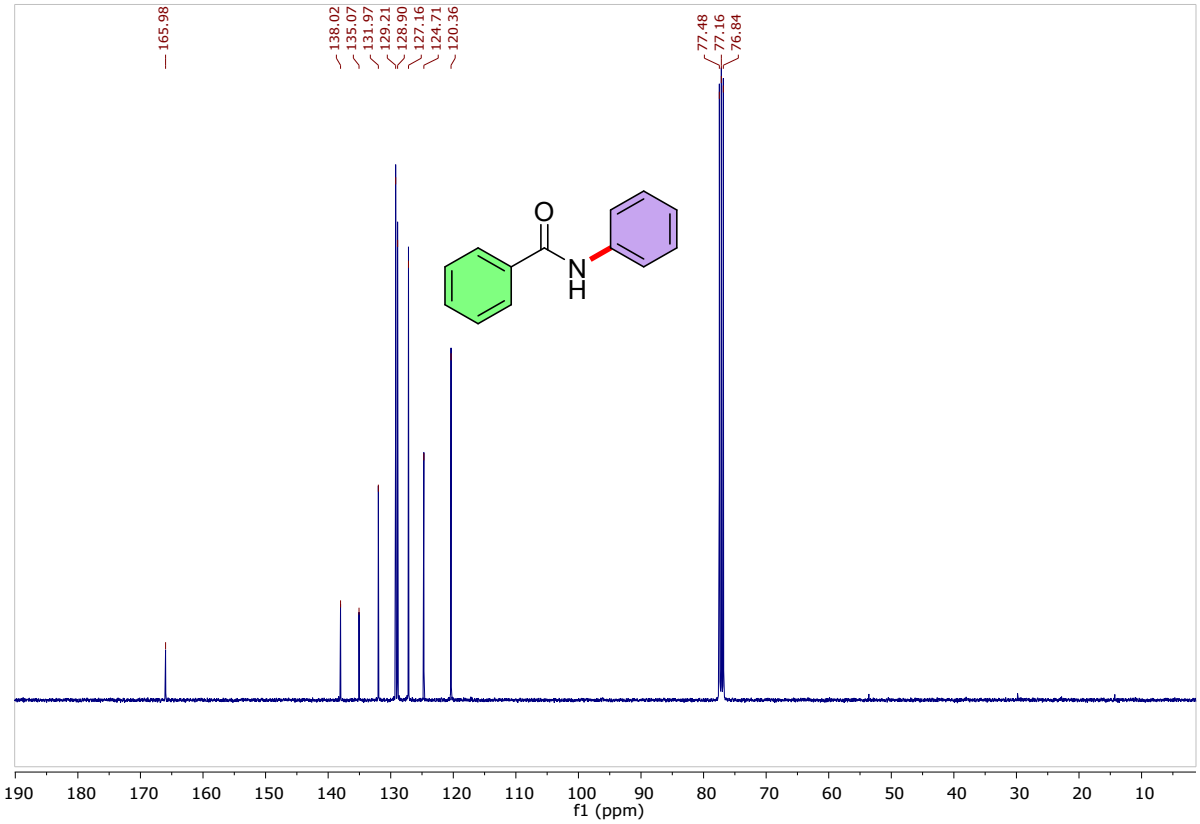
The reaction was carried out according to the general procedure A for 15 h at 130°C using benzamide (122 mg, 1.0 mmol), 1-(allyloxy)-2-bromobenzene (213.1 mg, 1.0 mmol). The title compound (164.6 mg, 65% yield) was obtained as a yellow liquid after silica gel column chromatography.

Yellow liquid; ^{1}H NMR (400MHz, $CDCl_3$) δ 4.65 (t, J = 3.4 Hz, 2H), 5.34 (dd, J = 10.4, 1.2 Hz, 1H), 5.43 (dd, J = 17.2, 1.6 Hz, 1H), 6.05-6.14 (m, 1H), 6.93 (dd, J = 7.6, 1.6 Hz, 1H), 7.05 (td, J = 7.6, 2.0 Hz, 1H), 7.48-7.56 (m, 4H), 7.86-7.91 (m, 2H), 8.55 (dd, J = 7.6, 2.0 Hz,

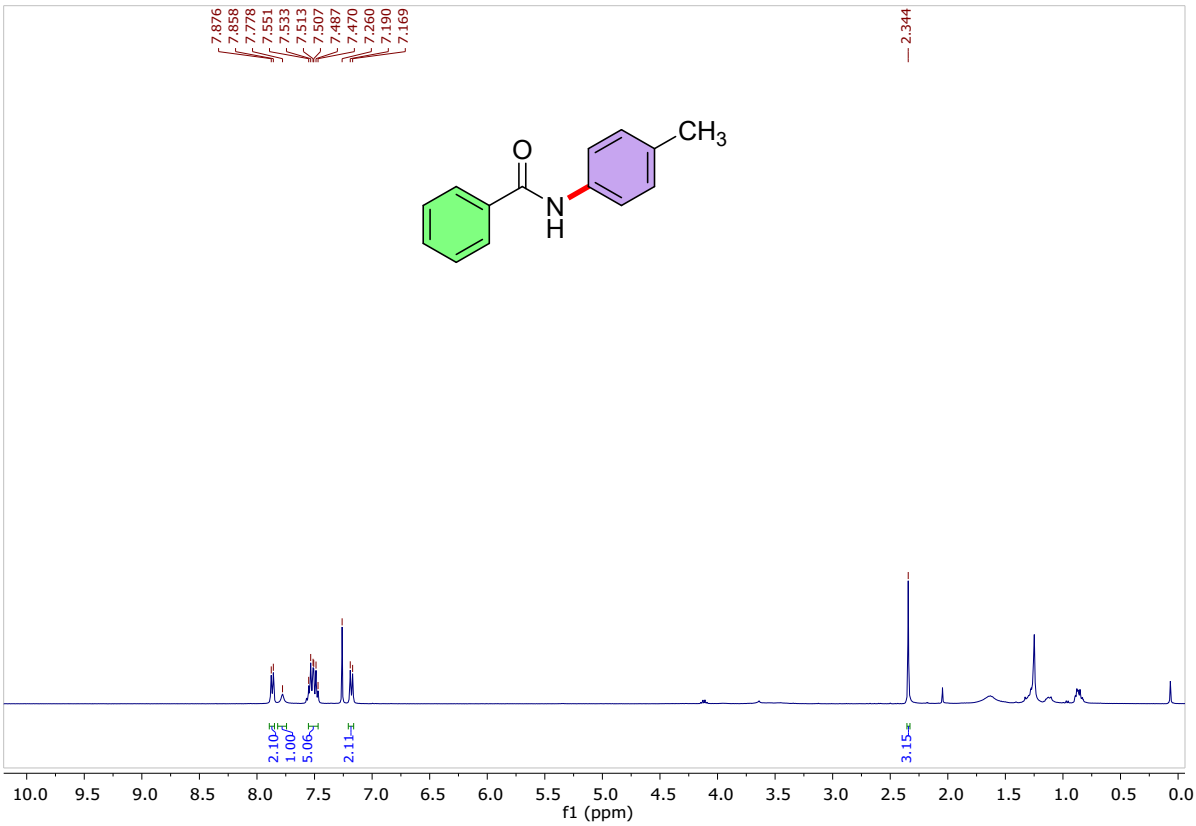
1H), 8.63 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 69.7, 111.6, 118.3, 120.1, 121.7, 123.9, 125.7, 127.1 (2C), 128.9 (2C), 131.9, 132.9, 135.4, 147.3, 165.3; HRMS (FAB^+) m/z $[M]^+$ Calcd for $C_{16}H_{15}NO_2$: 253.1103, Found 253.1103.

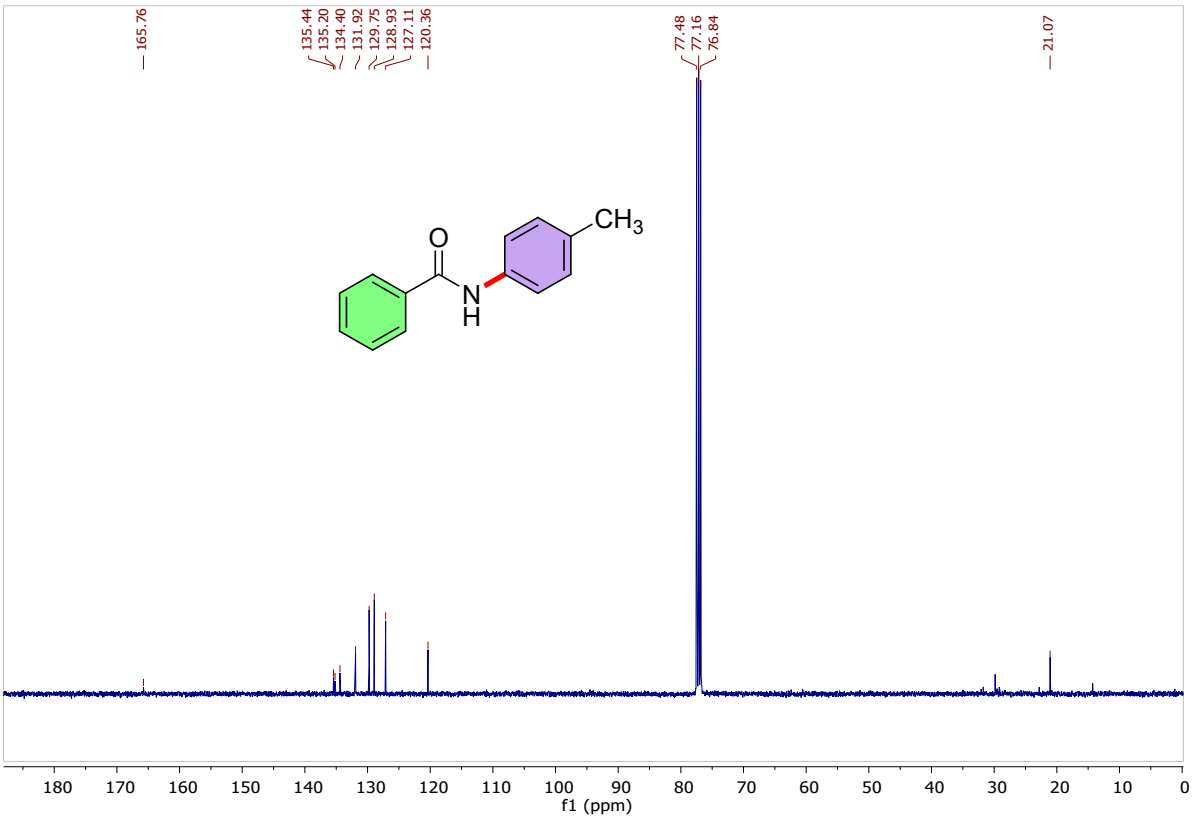
6. ^{1}H and ^{13}C NMR Spectra
***N*-phenylbenzamide (1)**



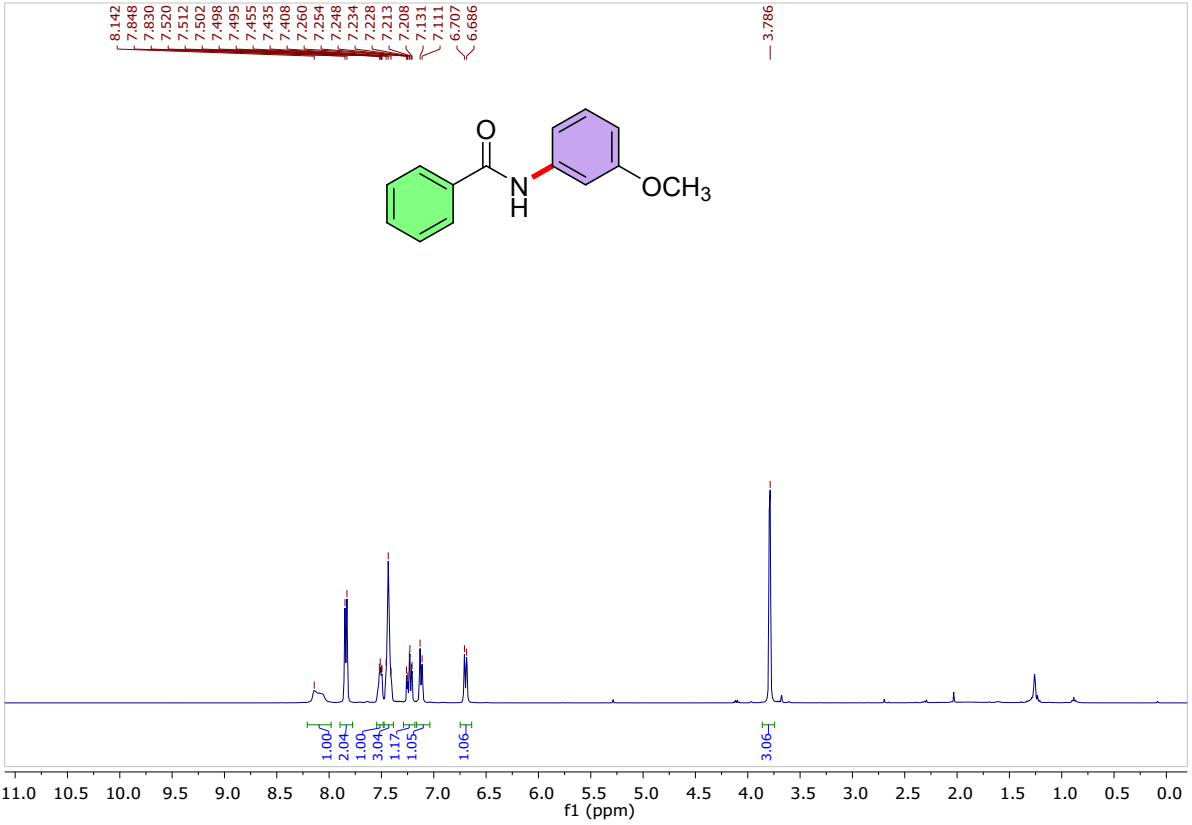


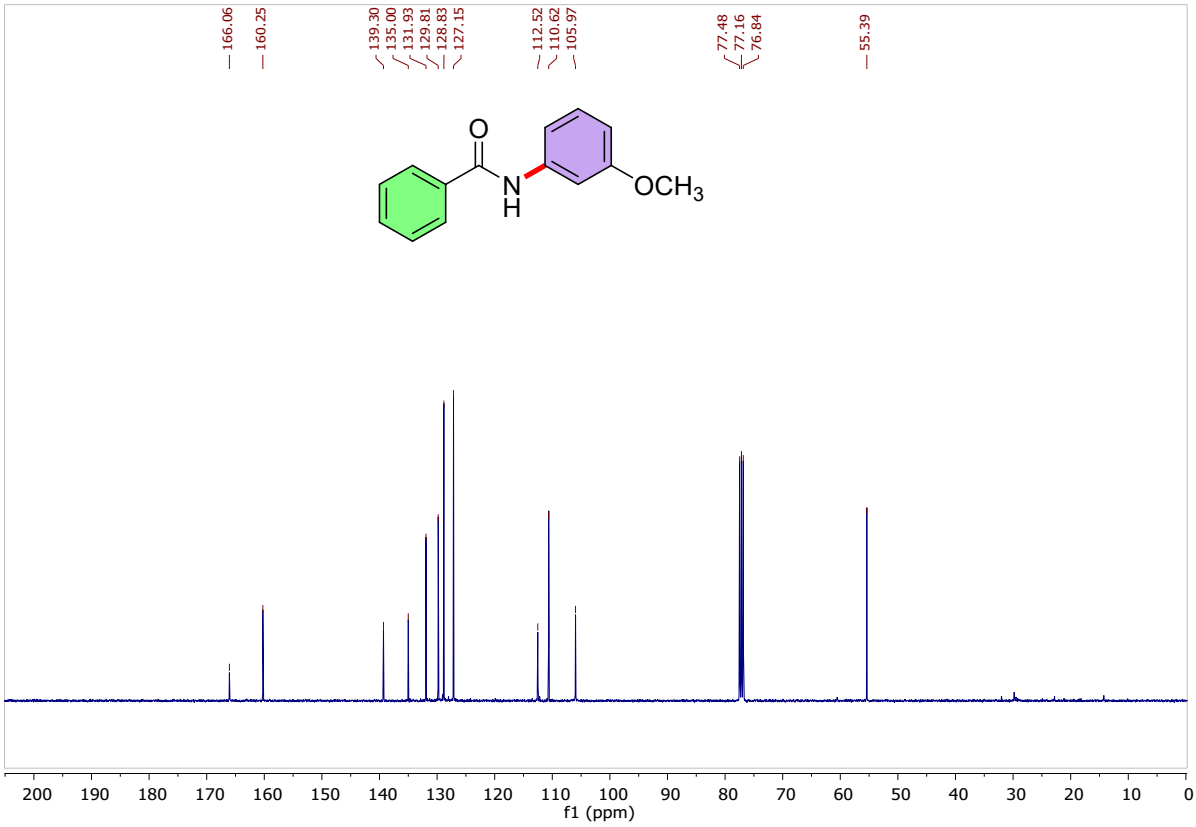
_N_-(p-tolyl)benzamide (2)


7.876
7.858
7.778
7.551
7.533
7.513
7.507
7.487
7.470
7.260
7.190
7.169
2.344
O
N
H
CH3
2.10
1.00
5.06
2.11
3.15
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

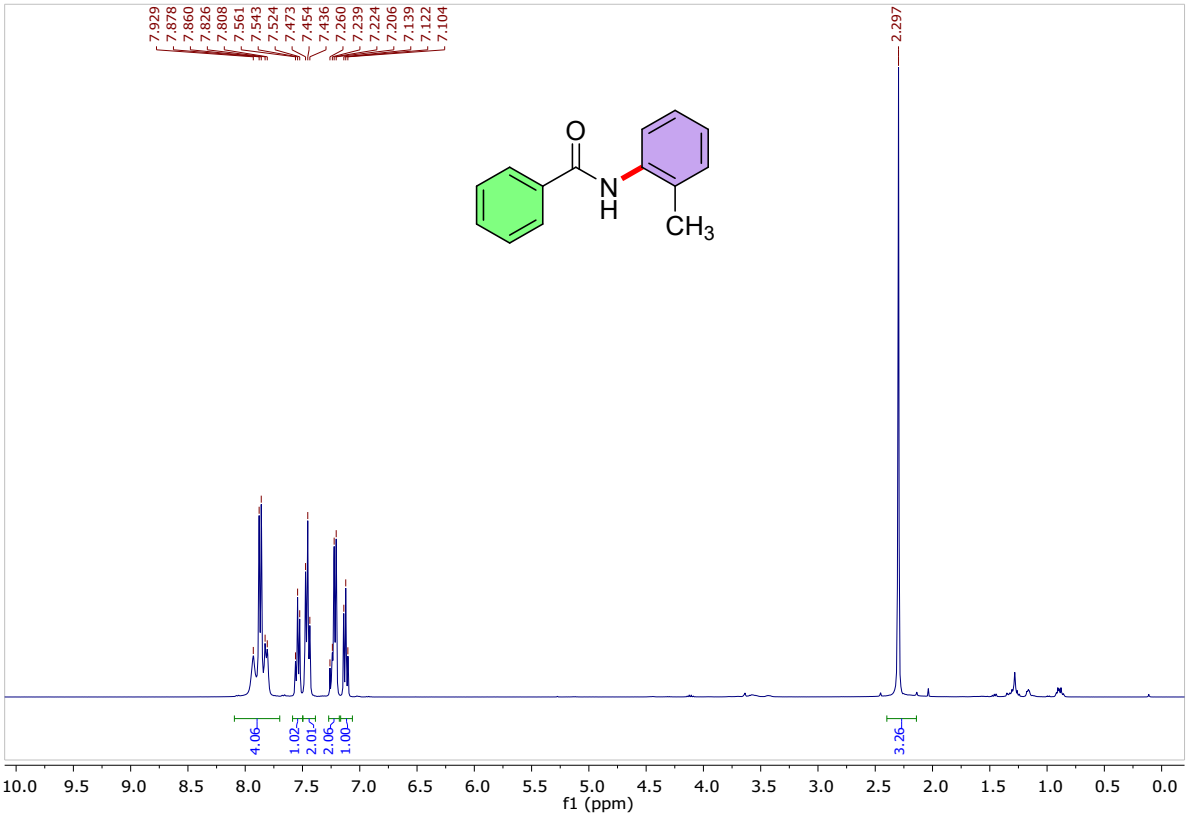

165.76
135.44
135.20
134.40
131.92
129.75
128.93
127.11
120.36
77.48
77.16
76.84
21.07
O
N
H
CH3
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

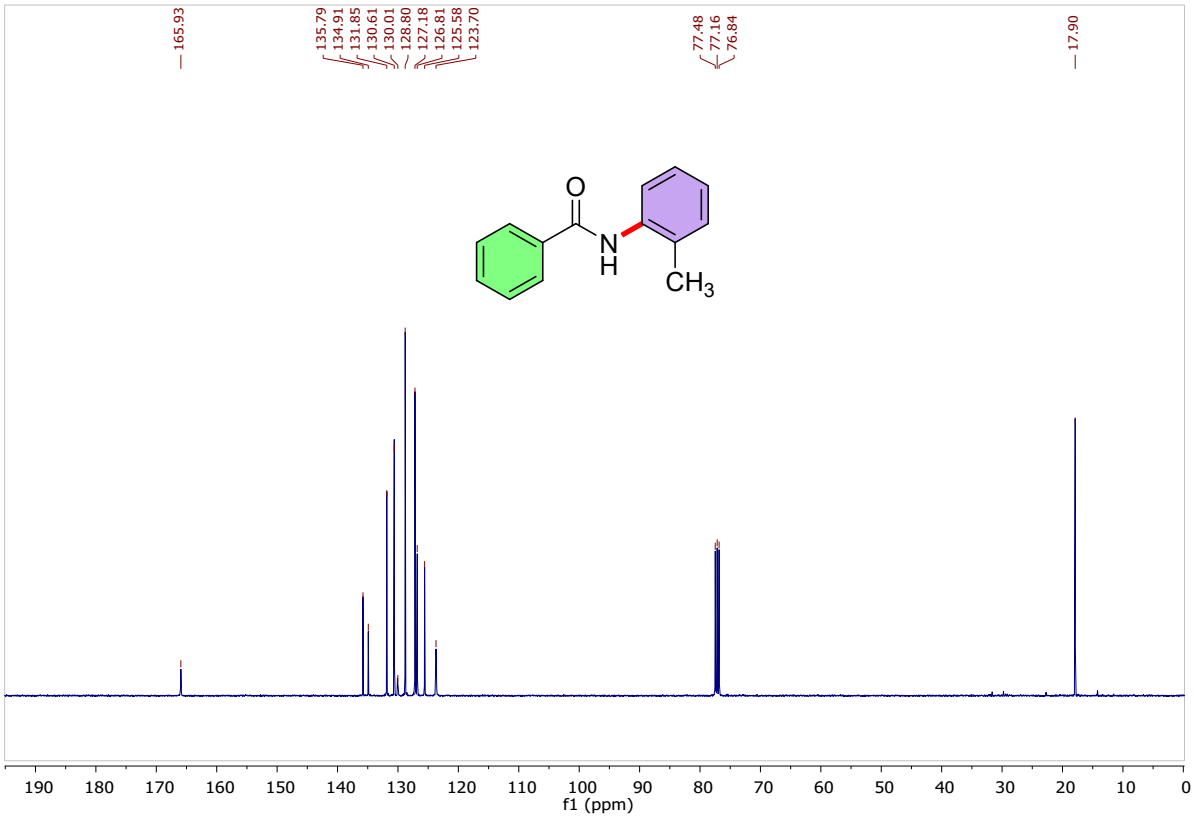
N-(3-methoxyphenyl)benzamide (3)



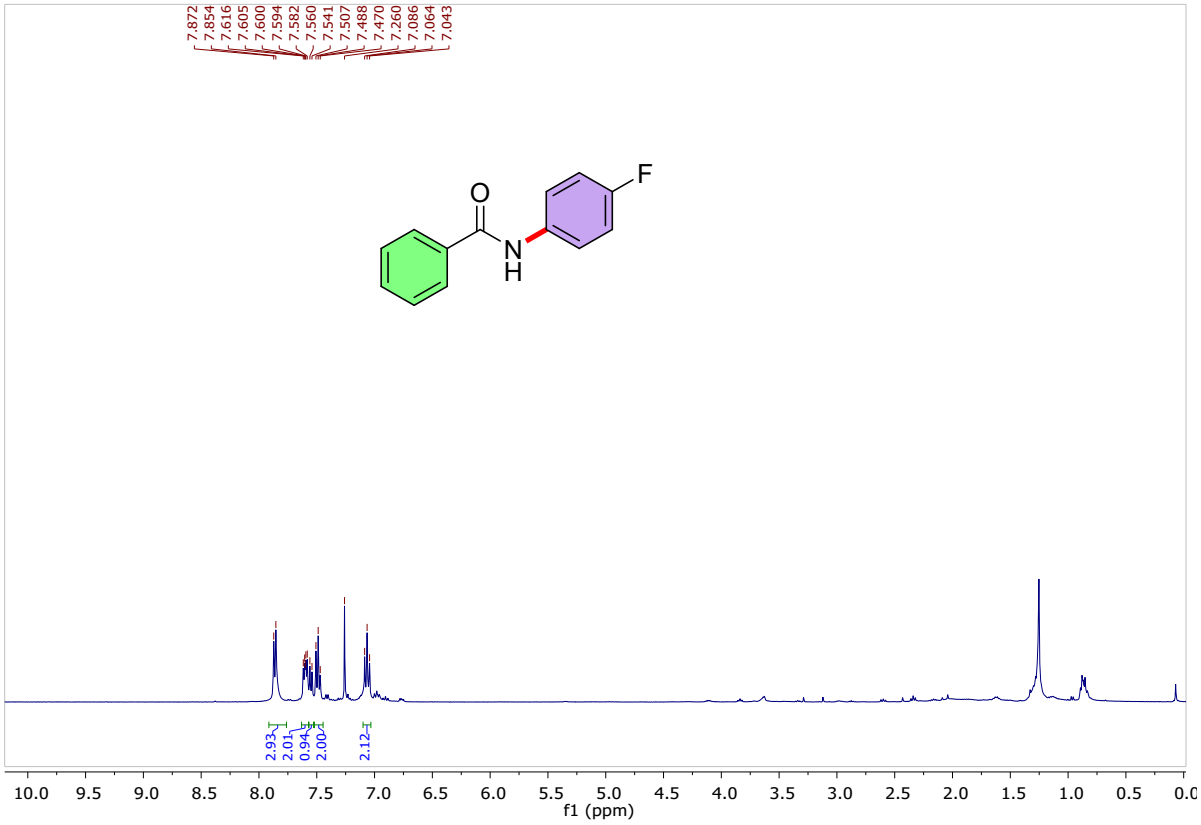


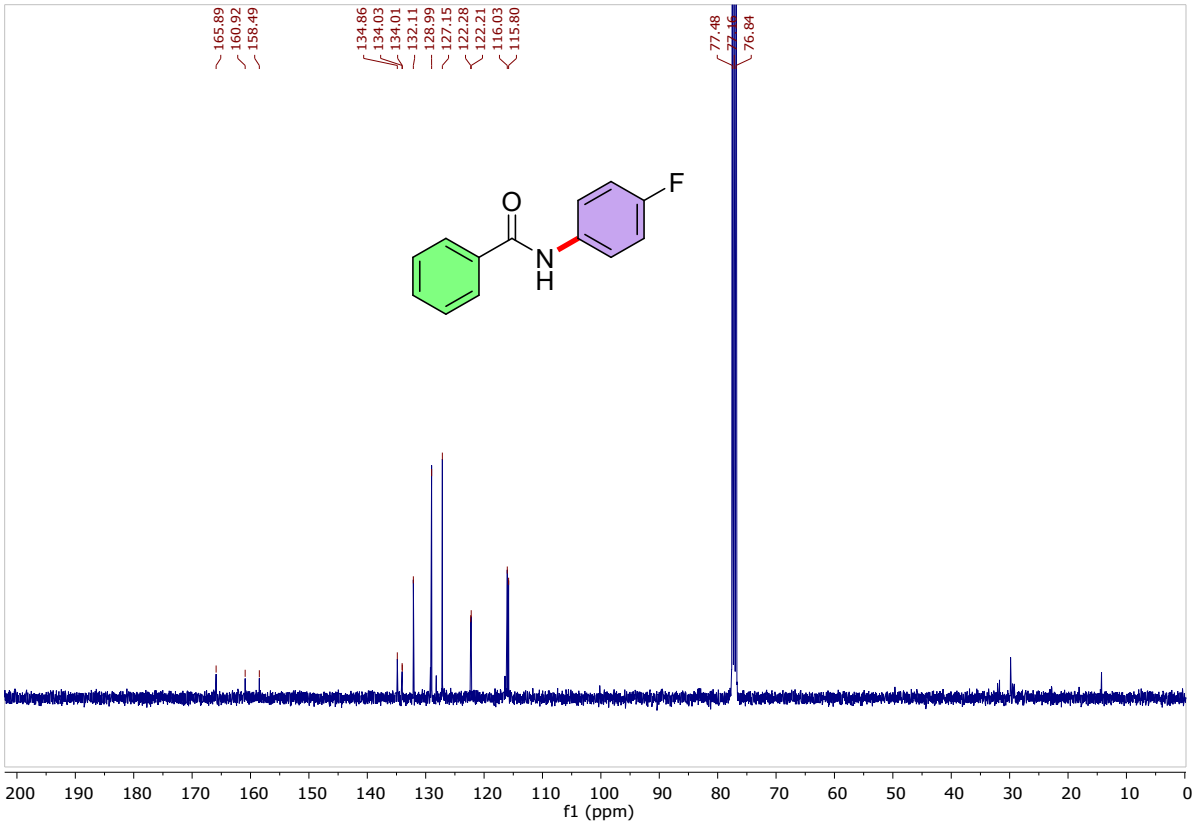
N-(o-tolyl)benzamide (4)



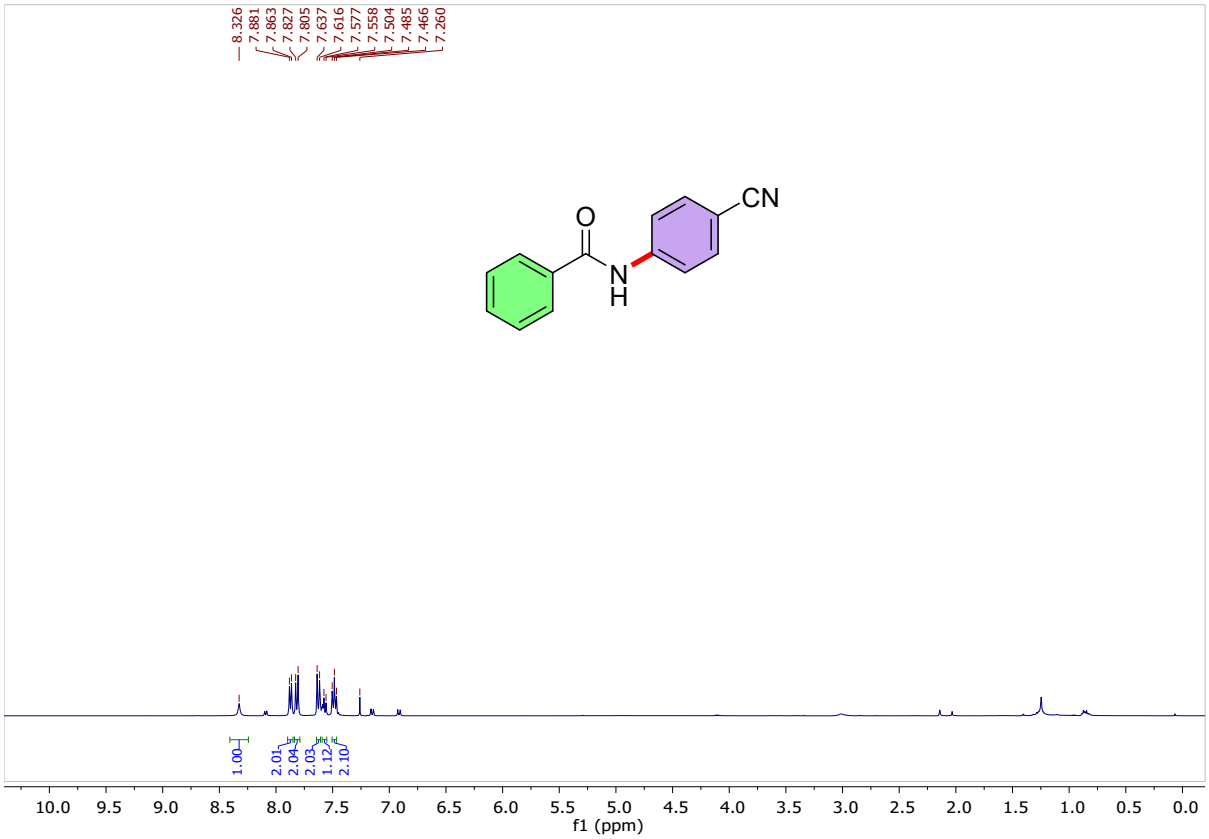


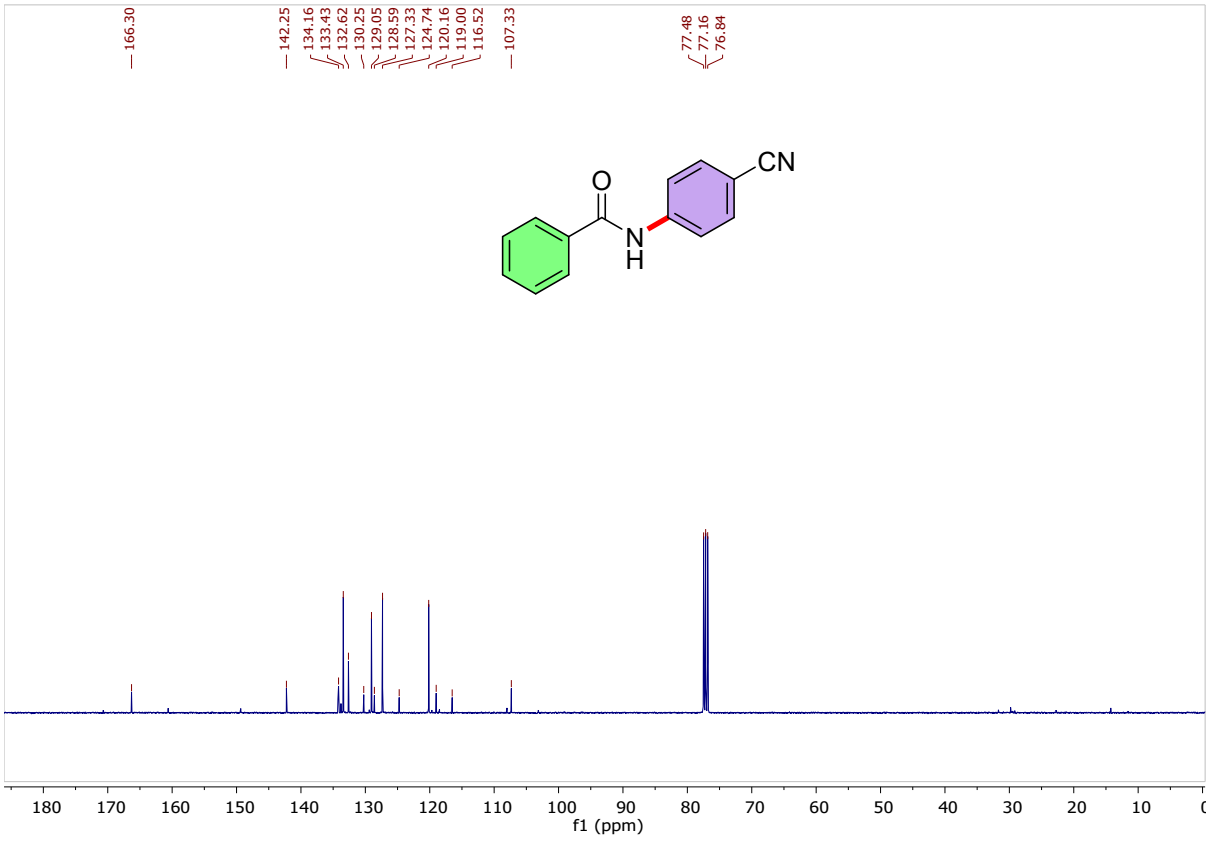
N-(4-fluorophenyl)benzamide (5)



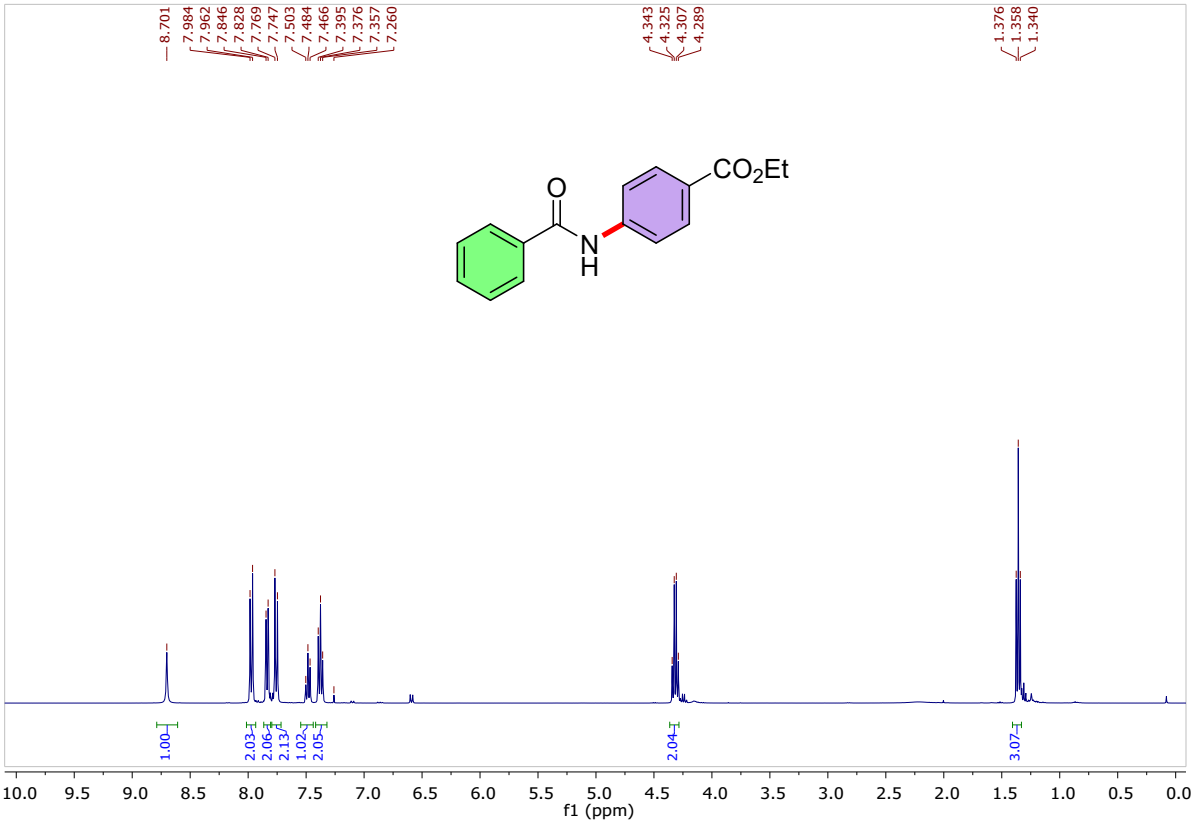


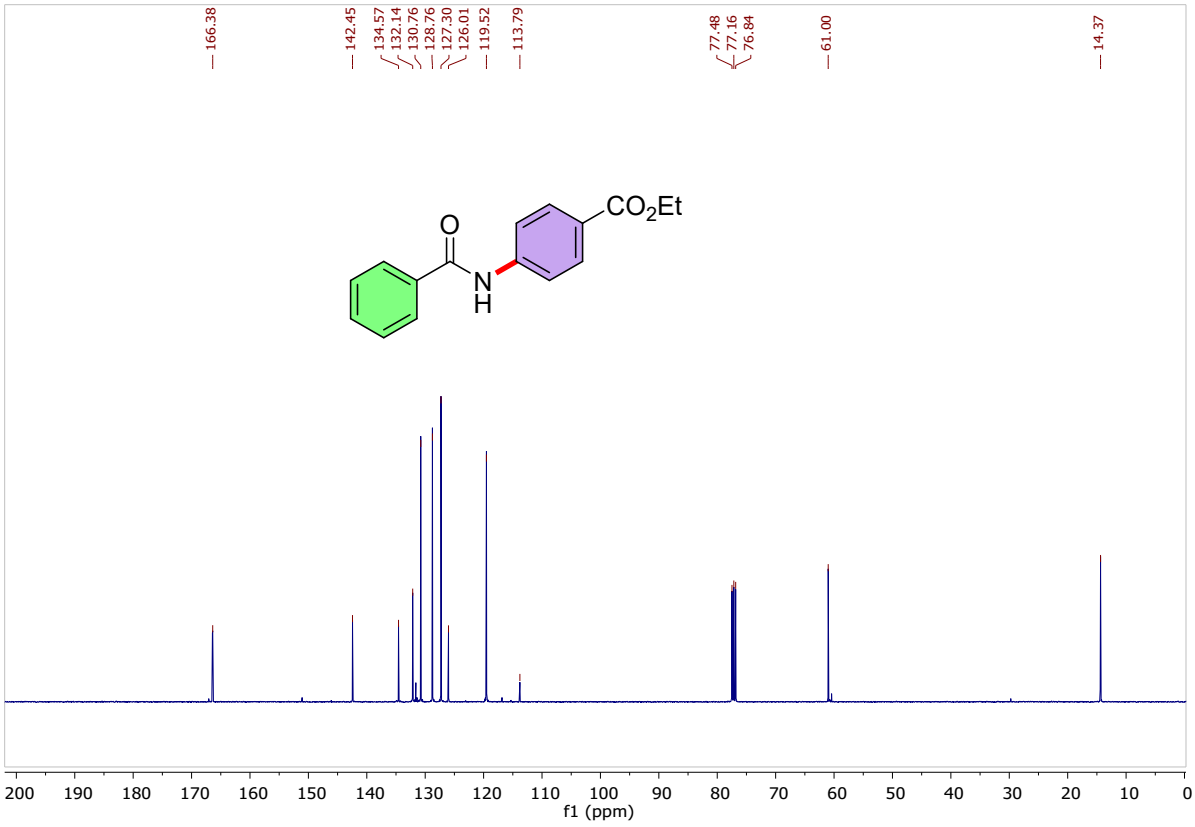
N-(4-cyanophenyl)benzamide (6)



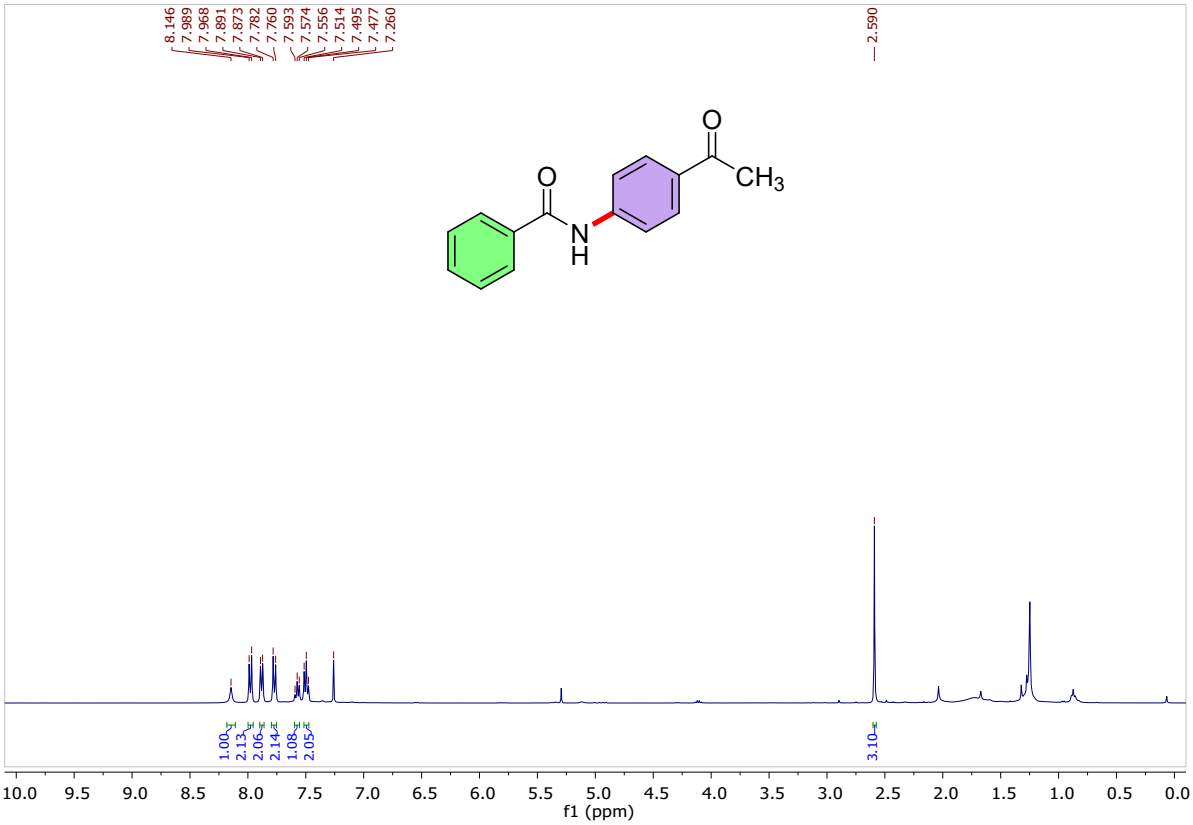


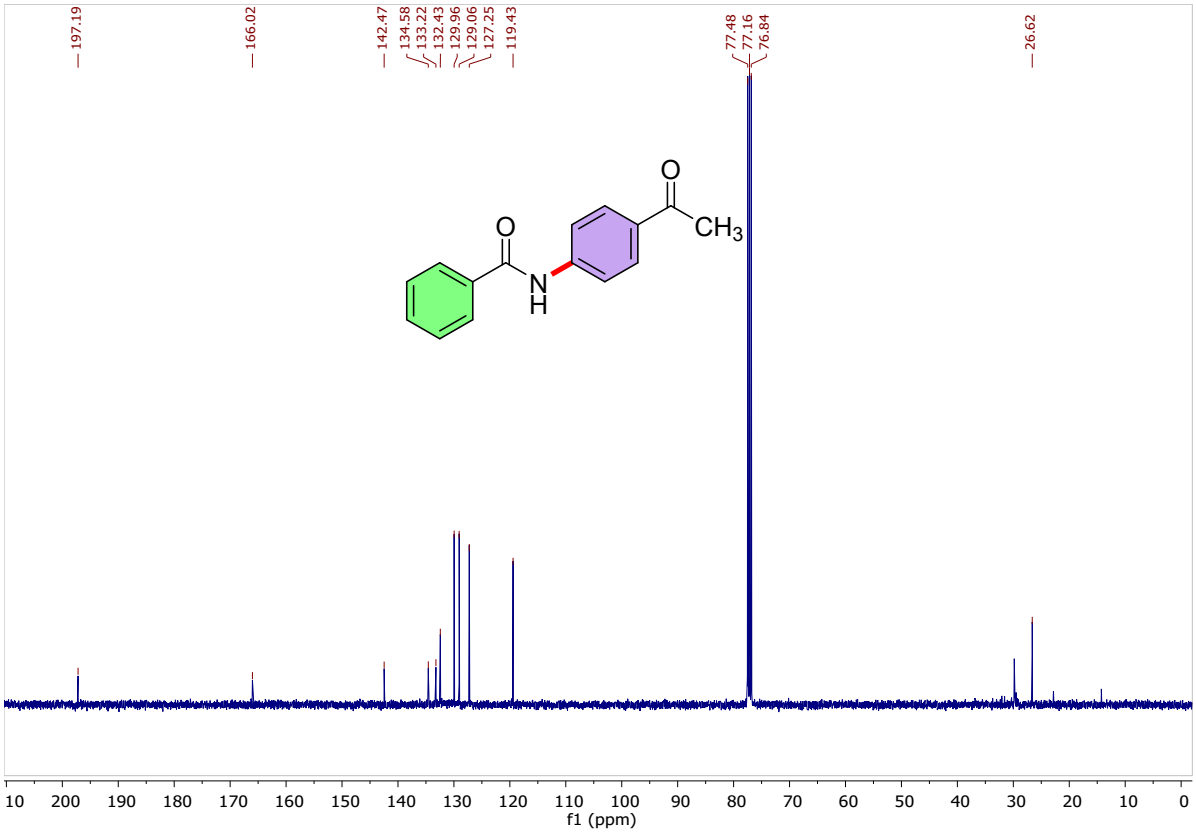
ethyl 4-benzamidobenzoate (7)



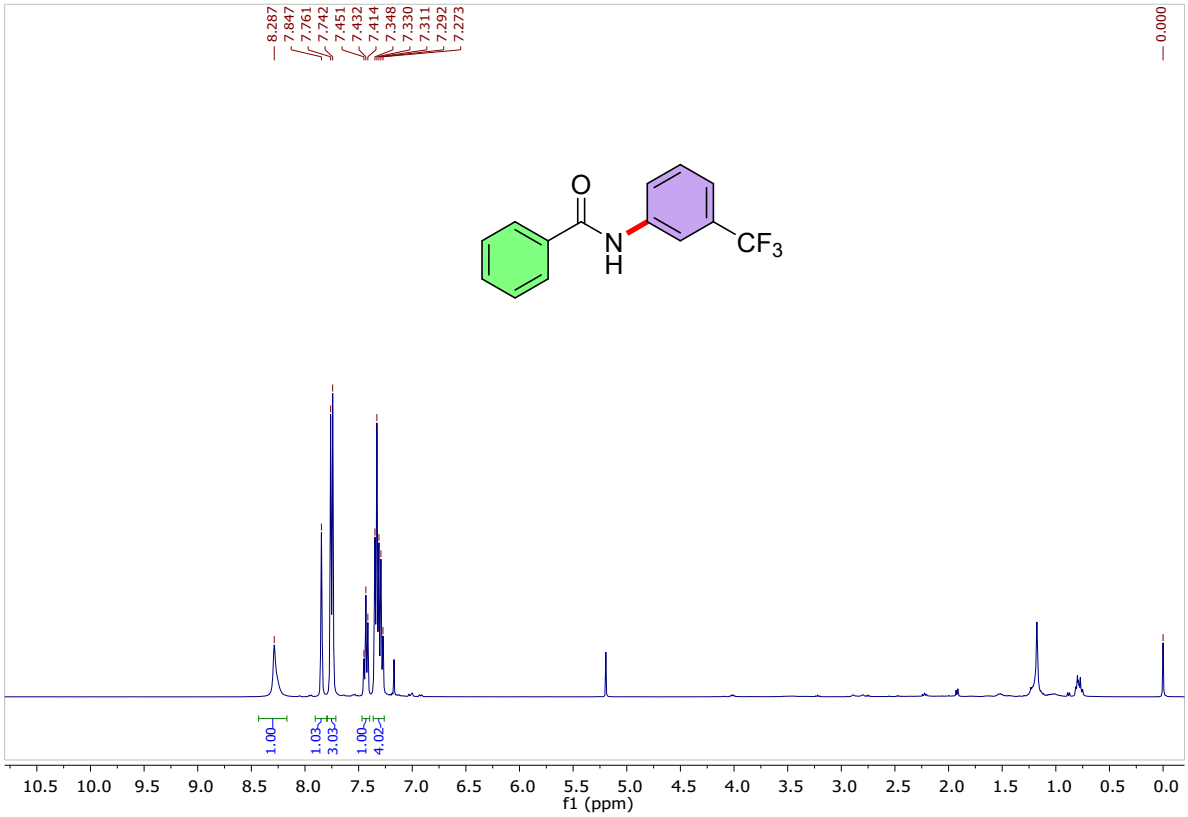


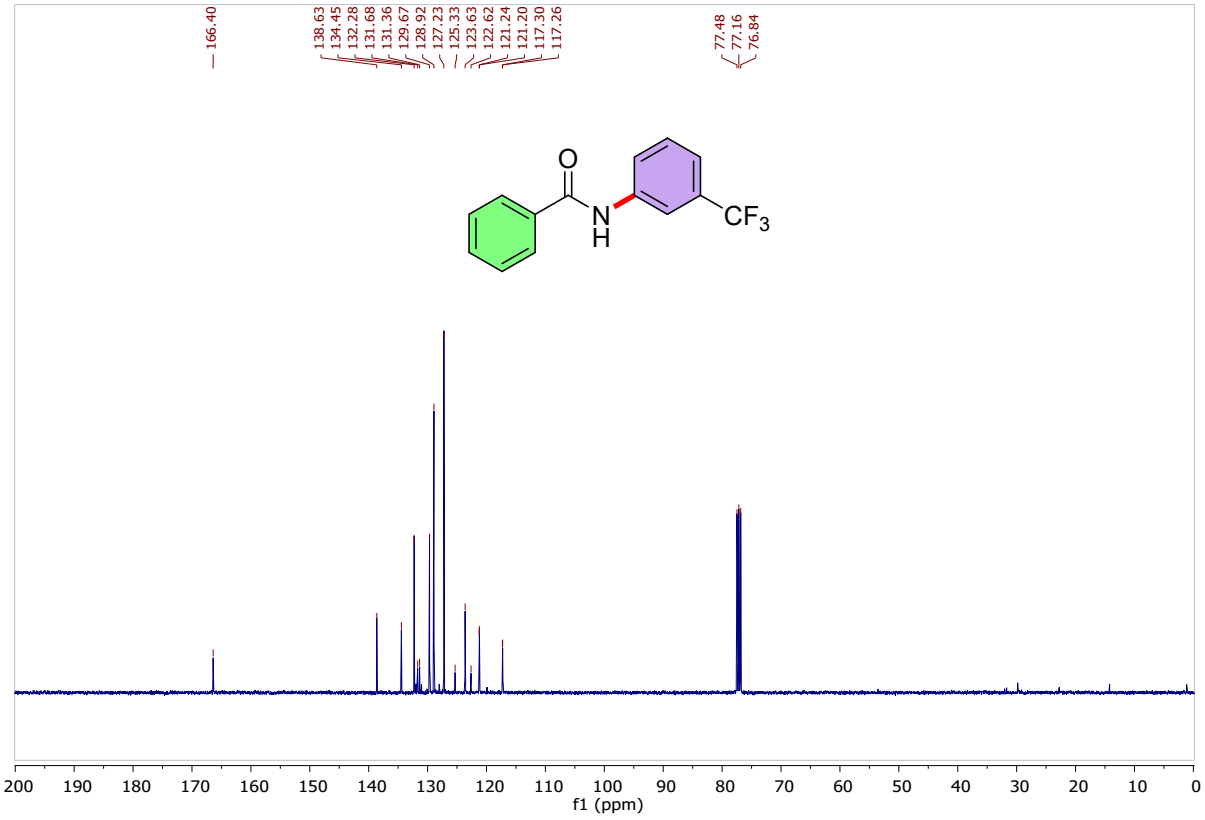
N-(4-acetylphenyl)benzamide (8)



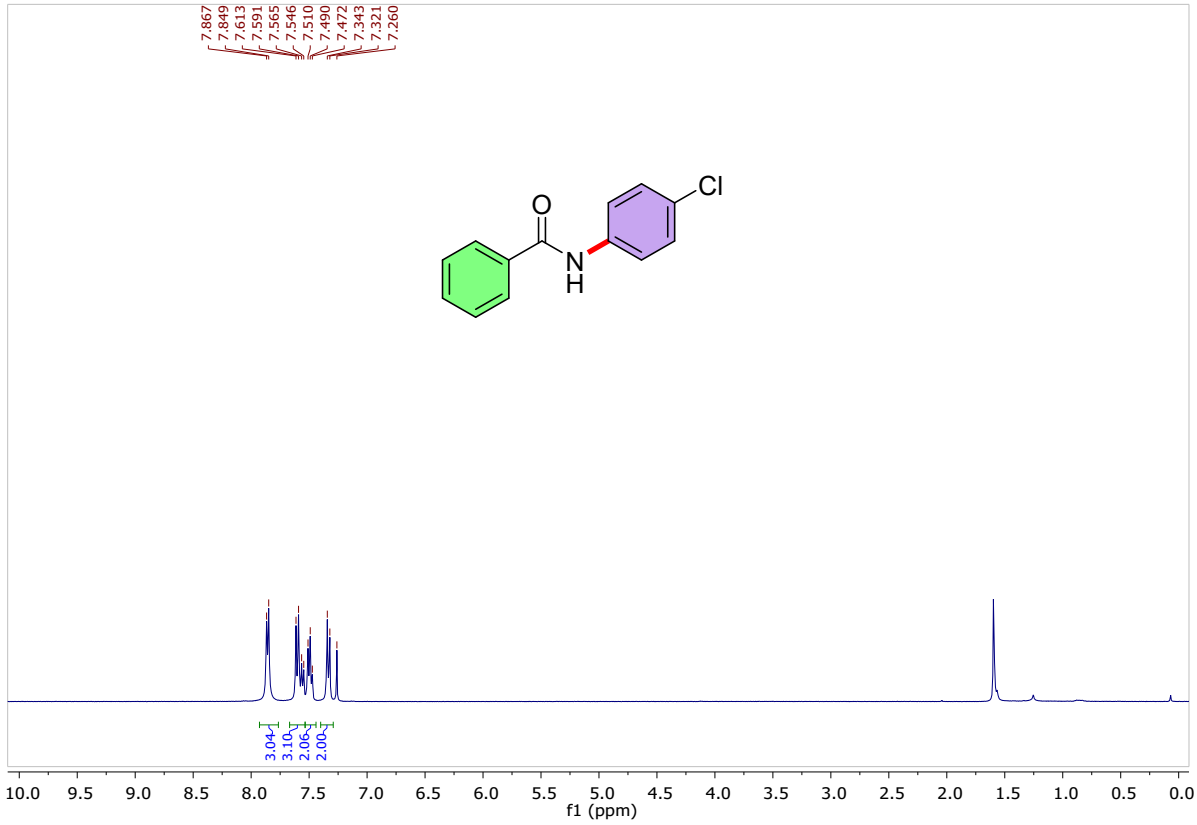


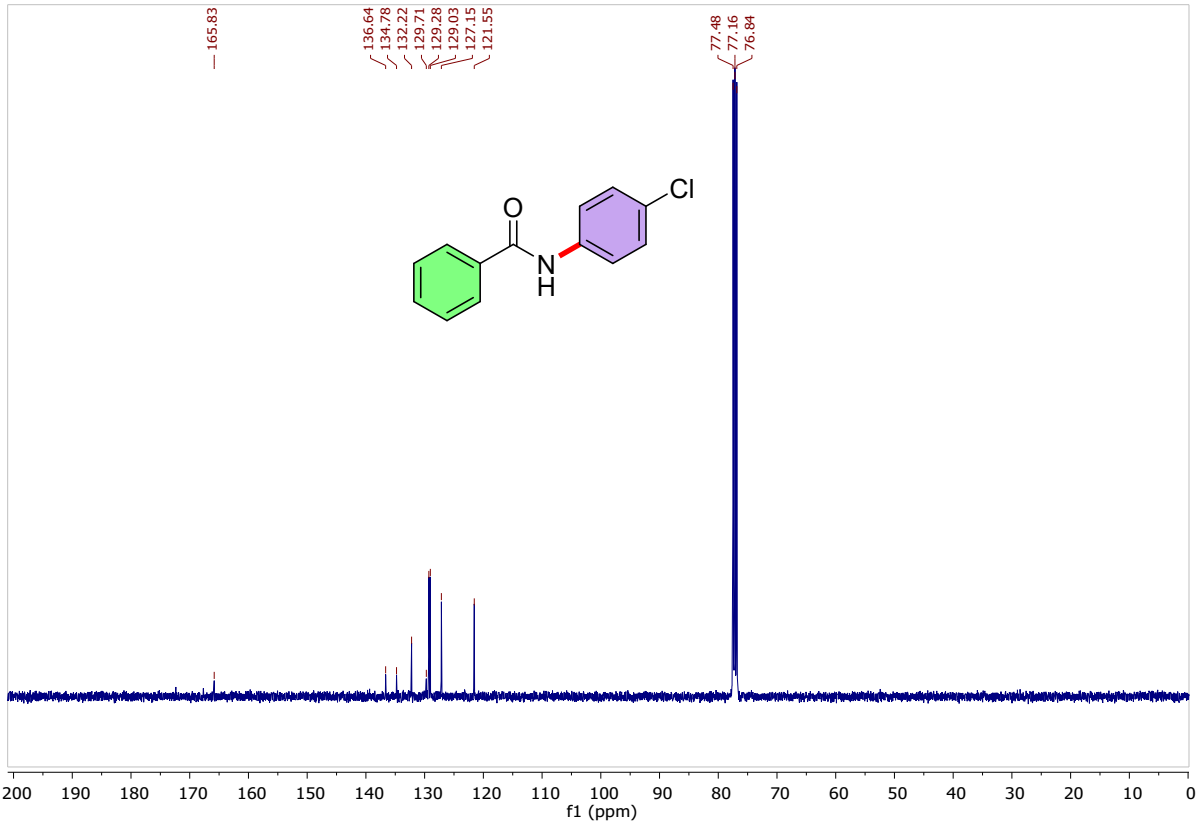
N-(3-(trifluoromethyl)phenyl)benzamide (9)



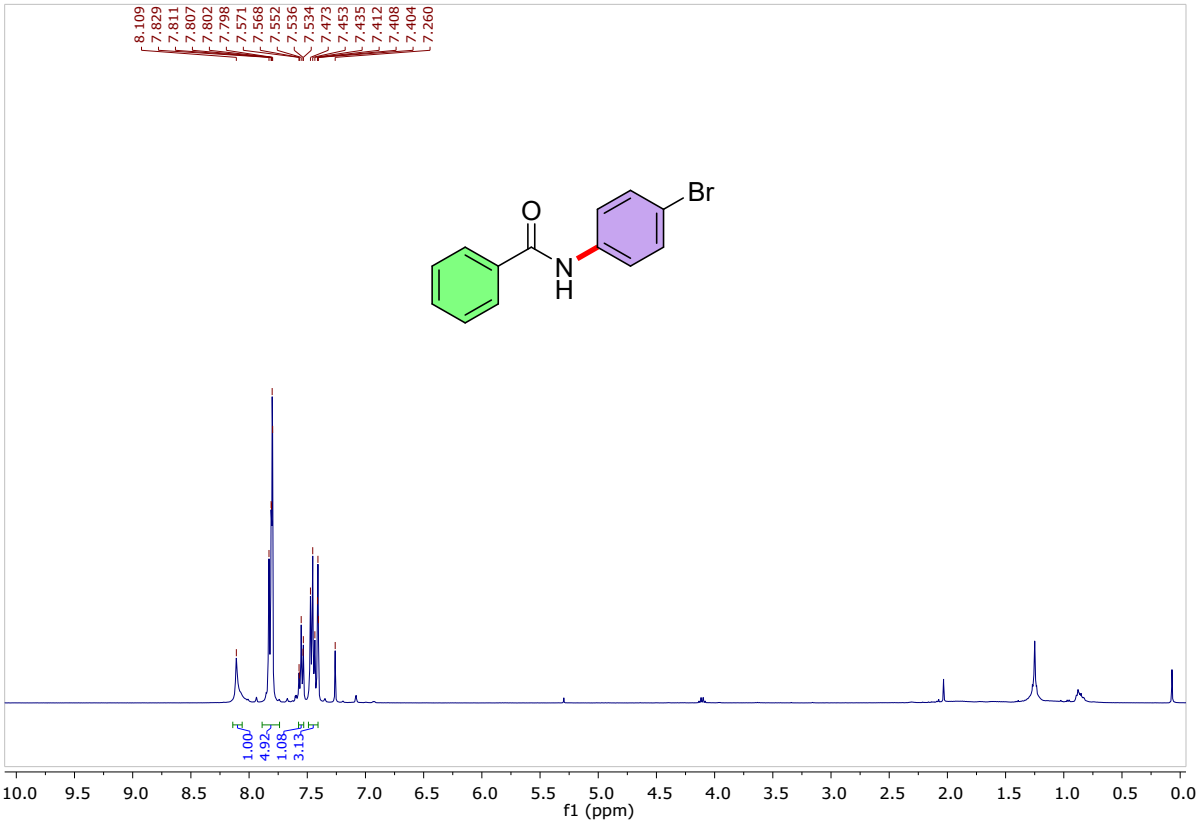


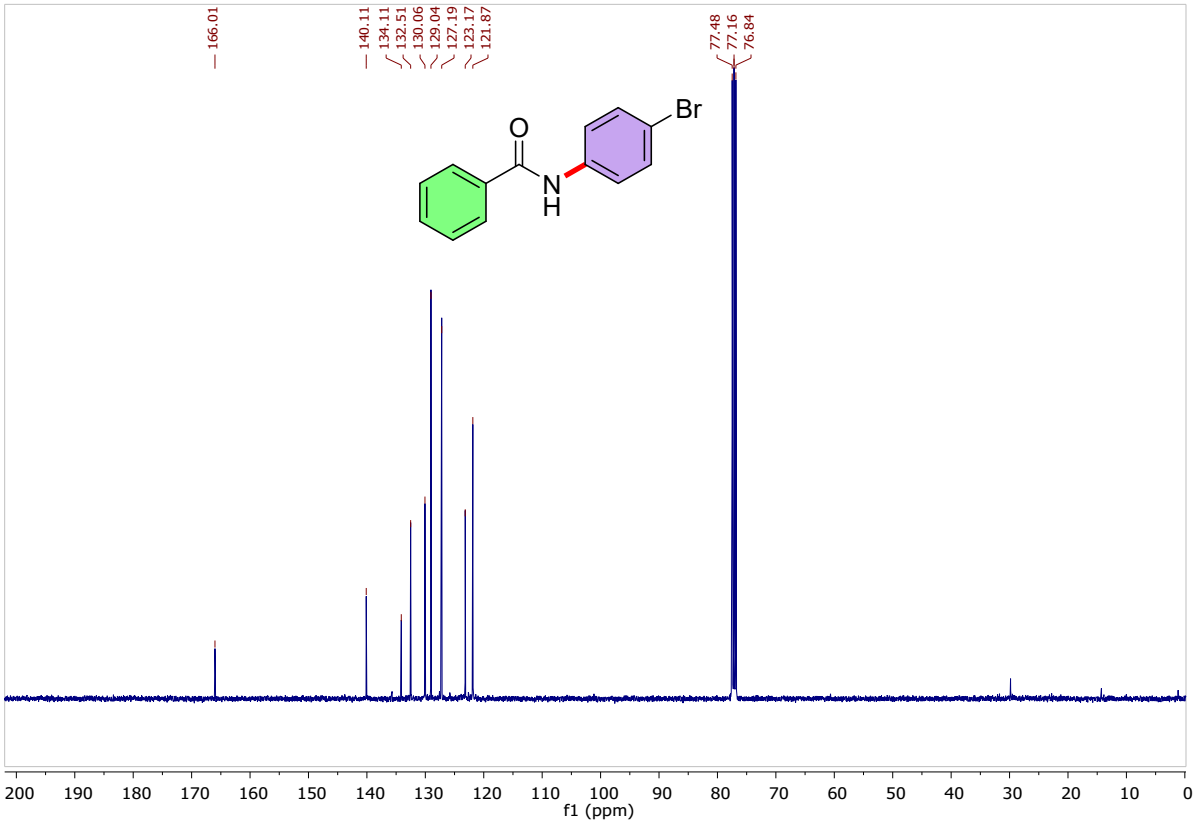
N-(4-chlorophenyl)benzamide (10)



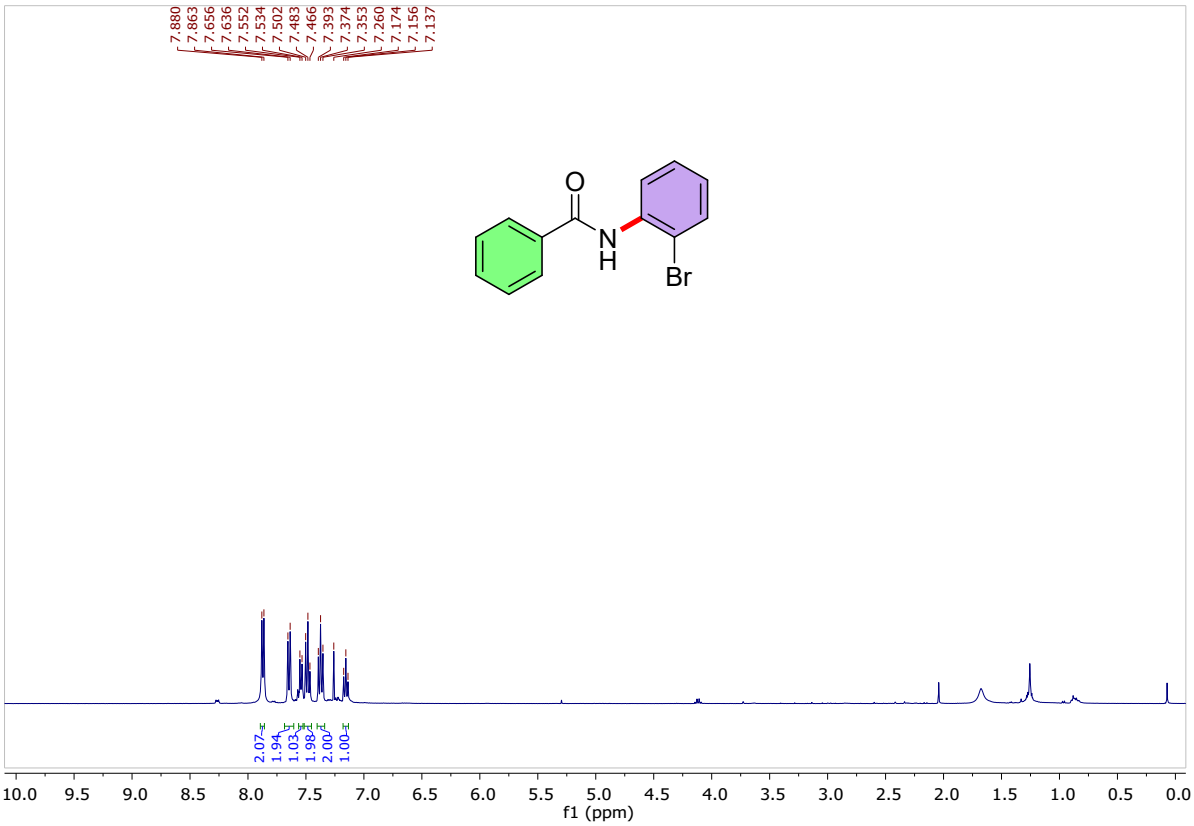


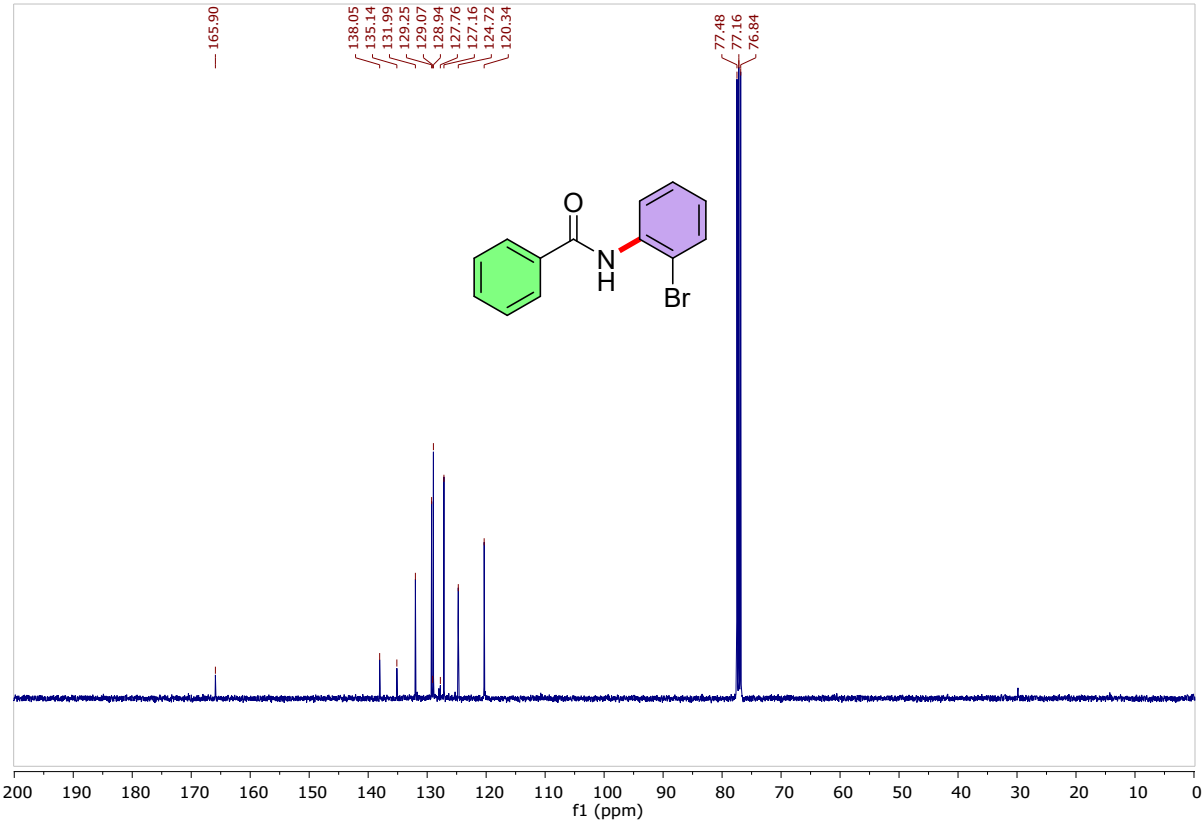
N-(4-bromophenyl)benzamide (11)



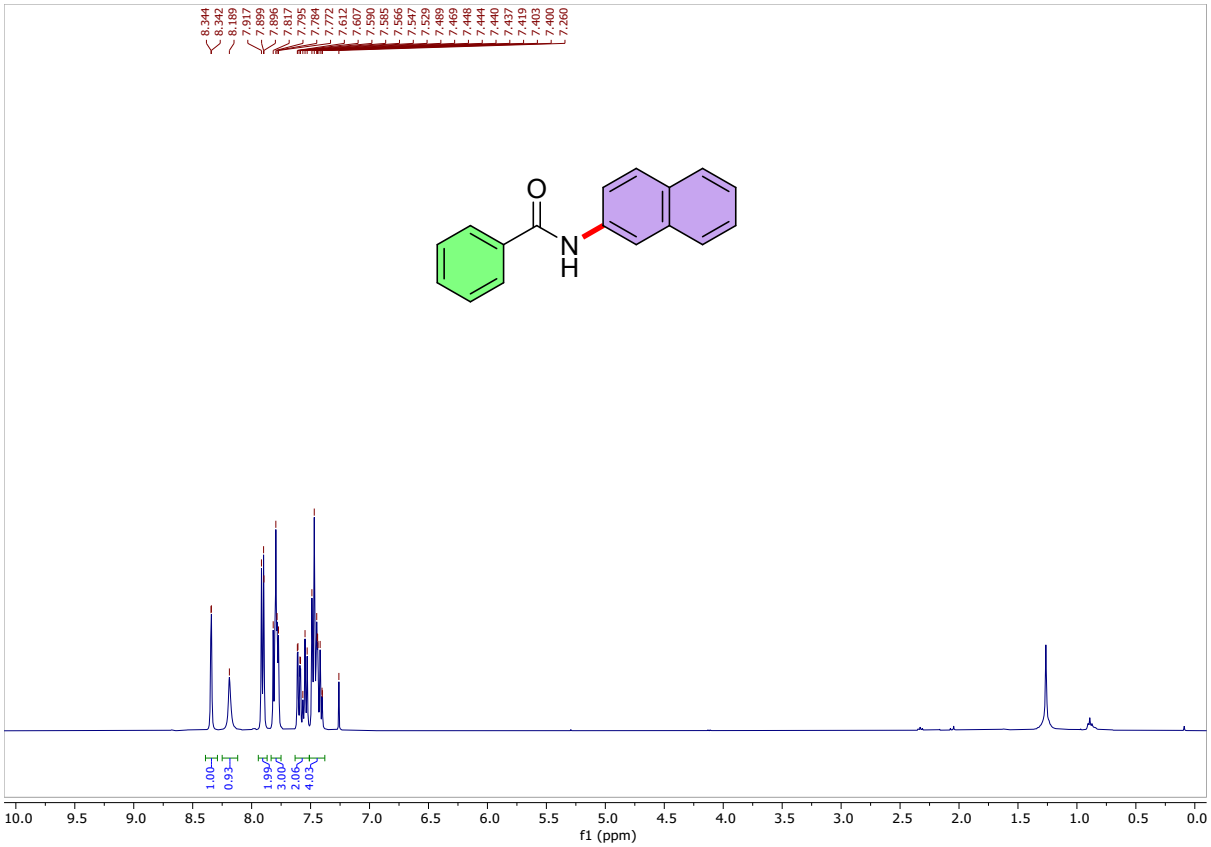


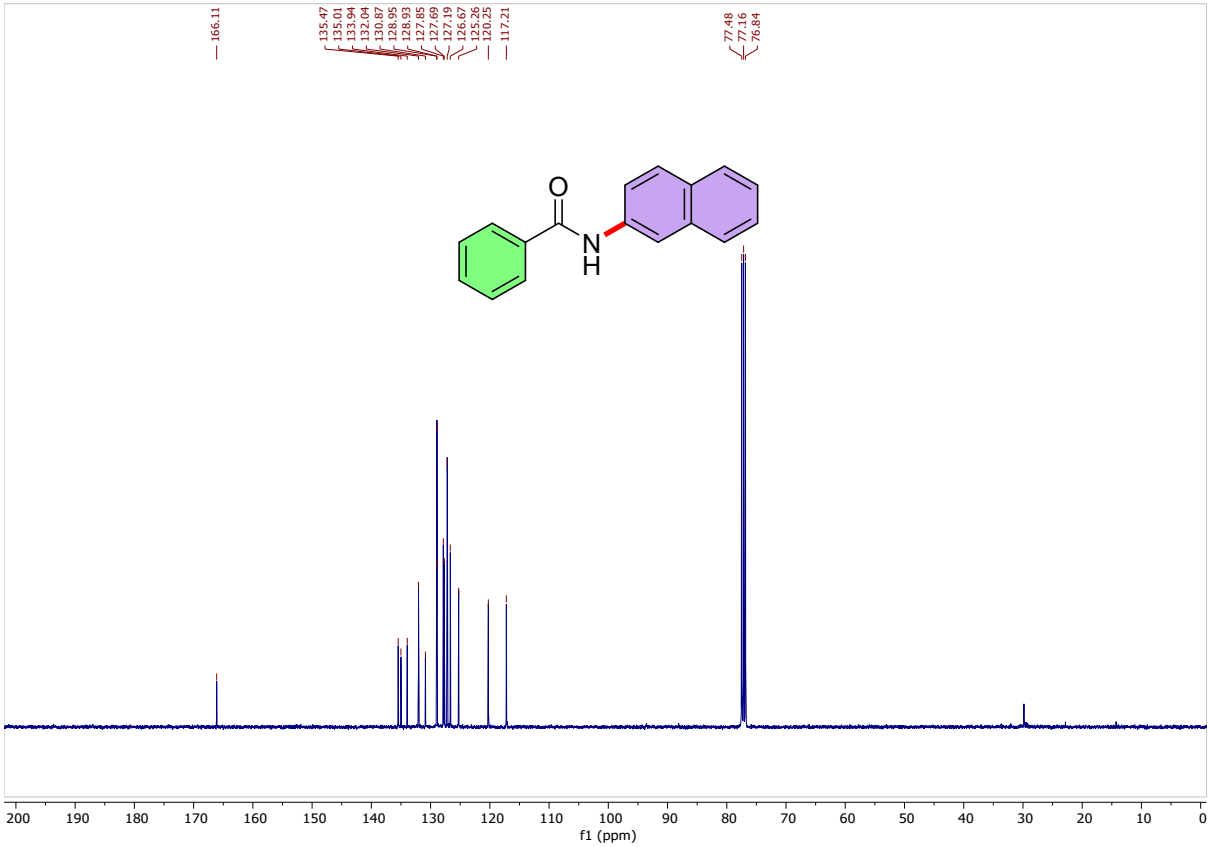
N-(2-bromophenyl)benzamide (12)



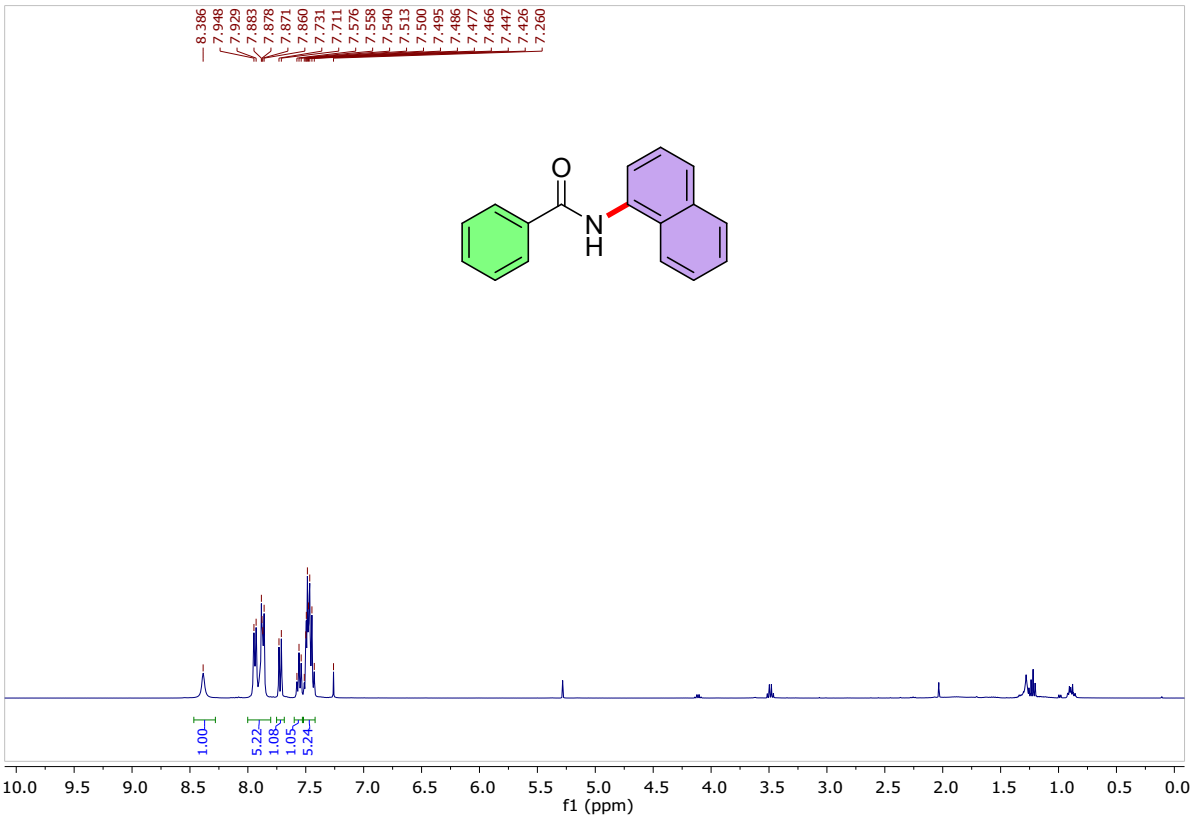


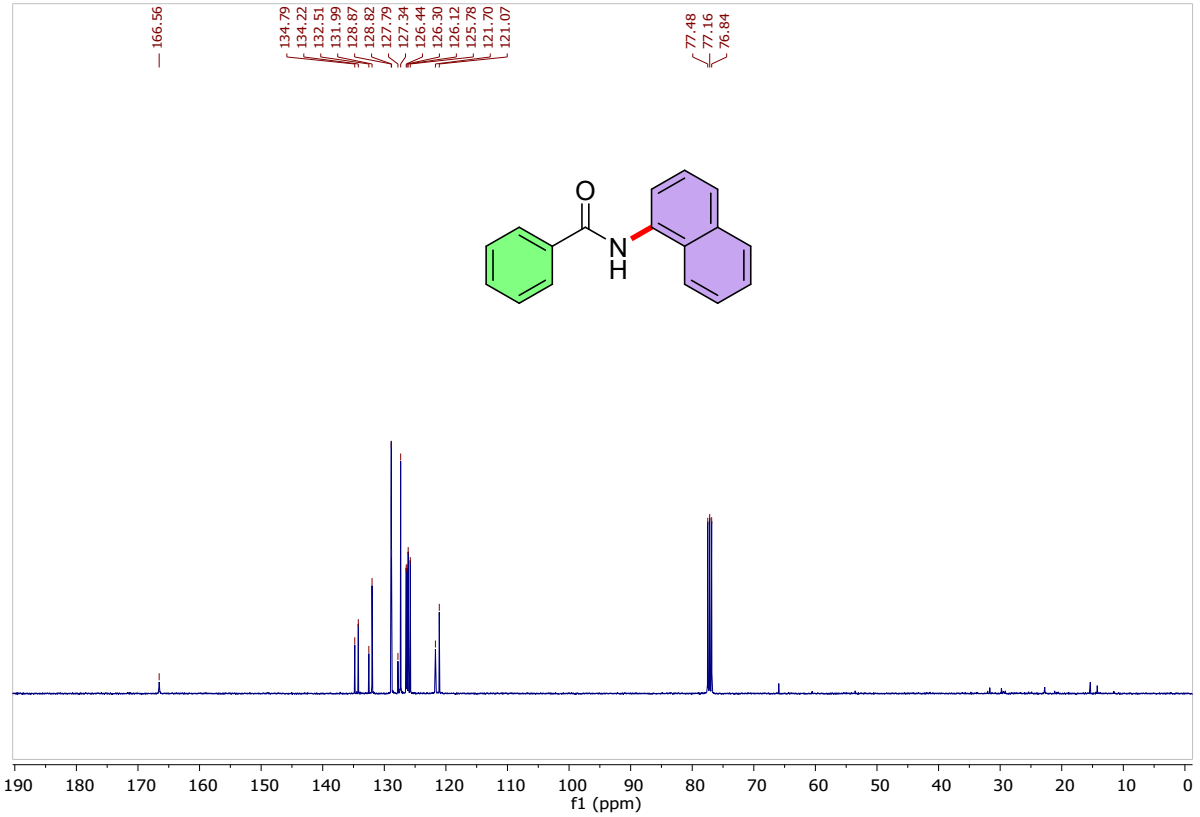
_N_-(naphthalen-2-yl)benzamide (13)



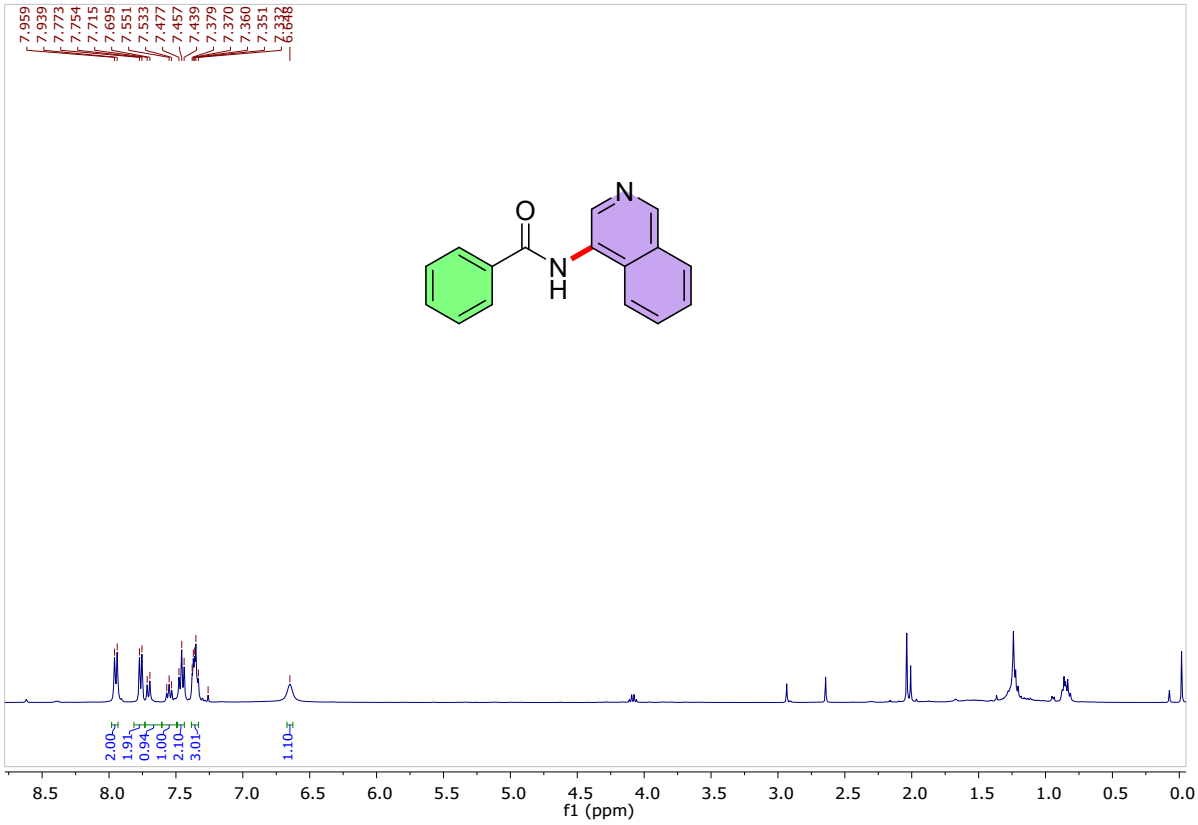


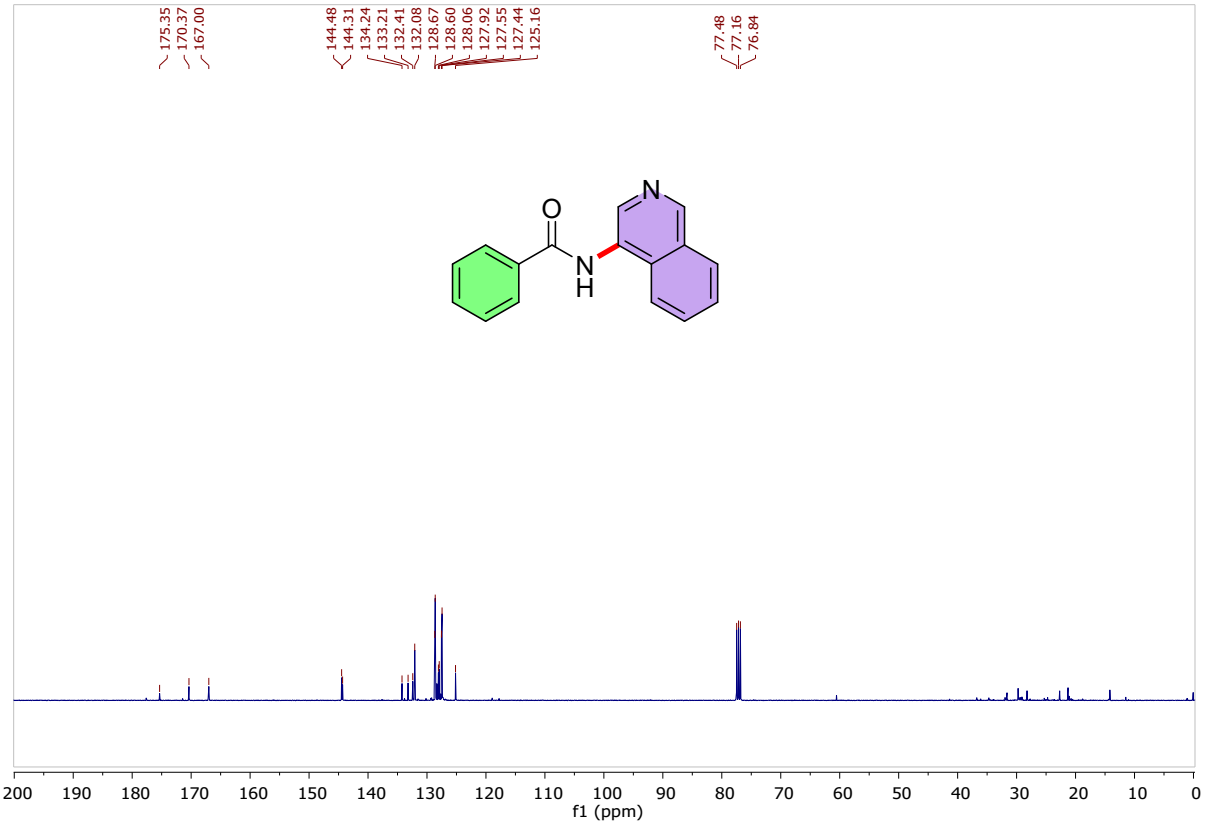
***N*-(naphthalen-1-yl)benzamide (14)**



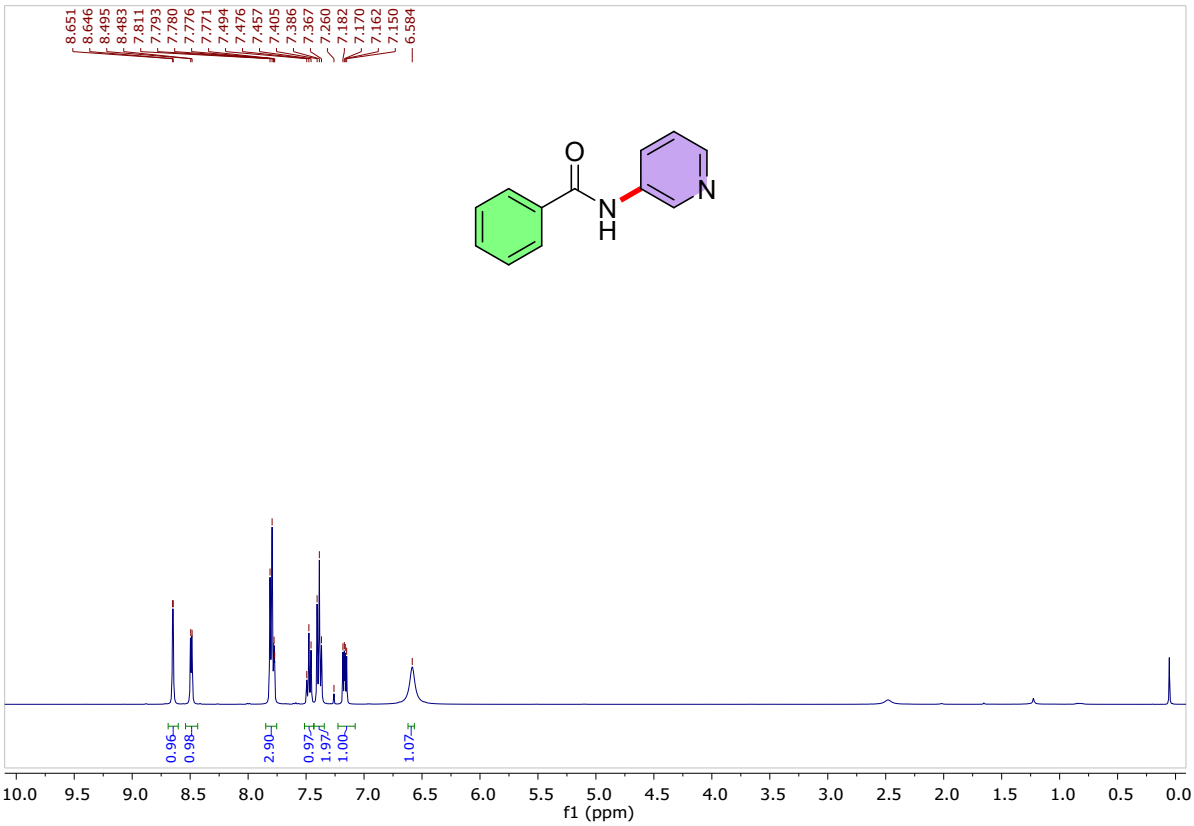


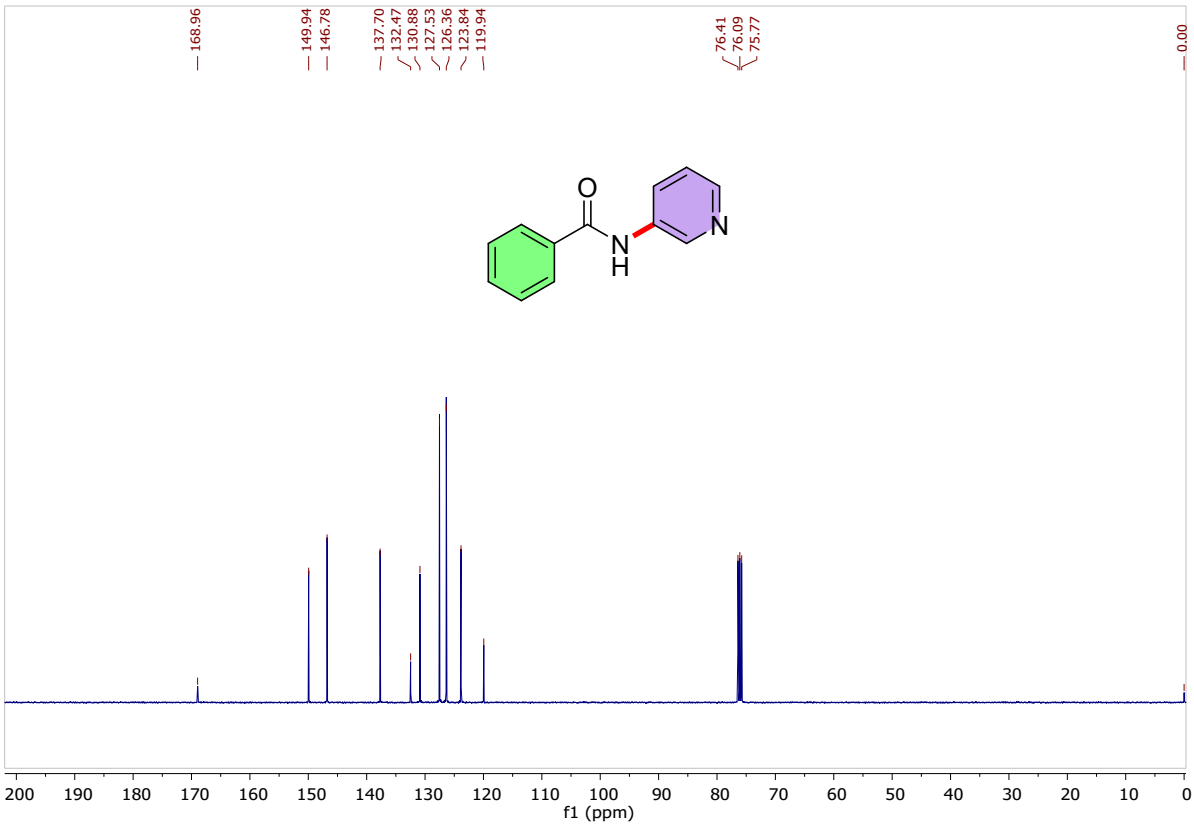
_N_-(quinolin-3-yl)benzamide (15)



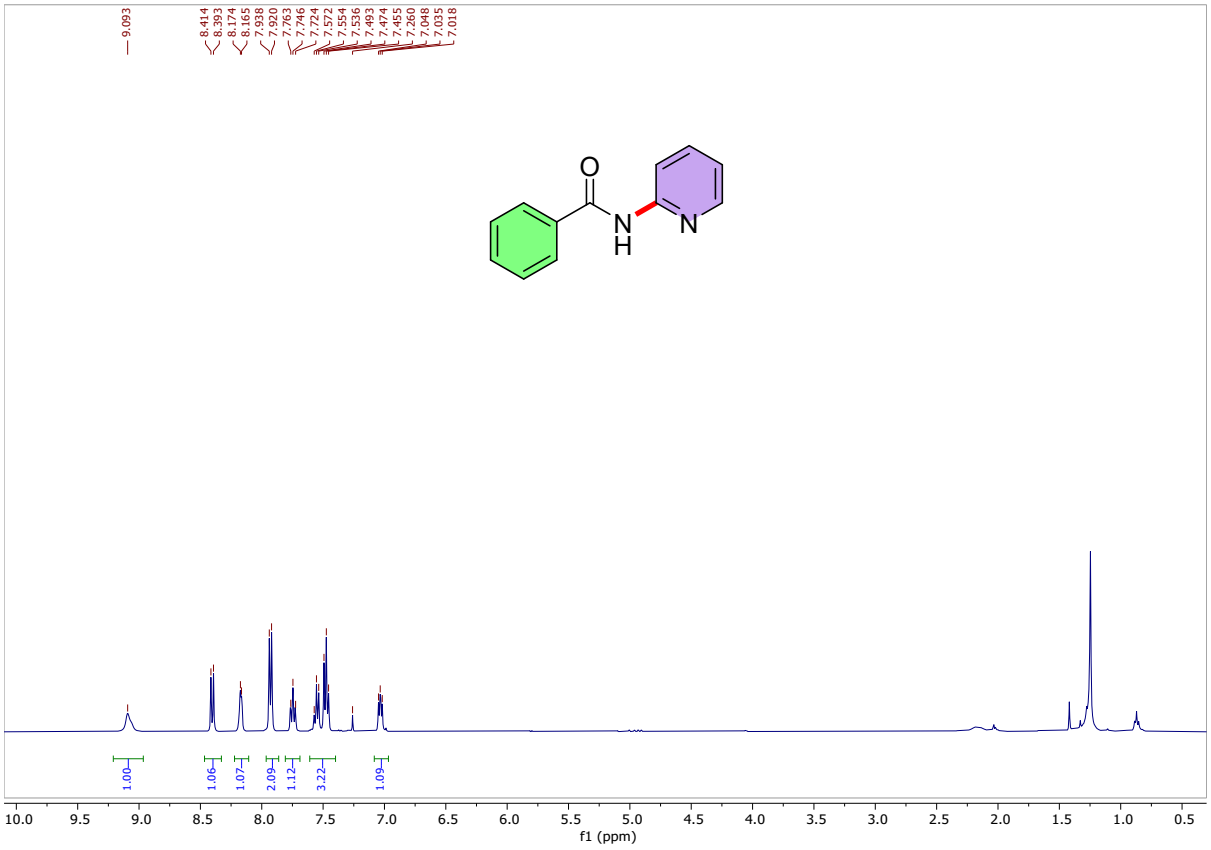


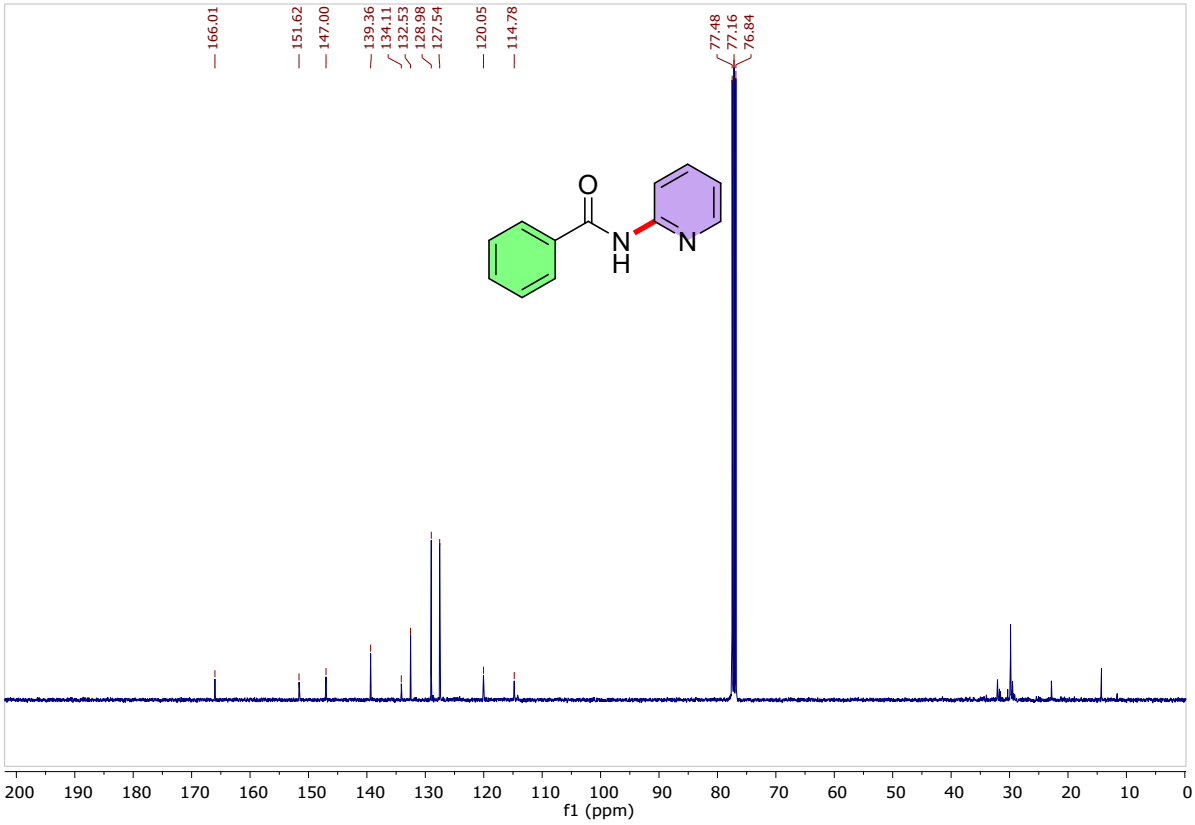
***N*-(pyridin-3-yl)benzamide (16)**



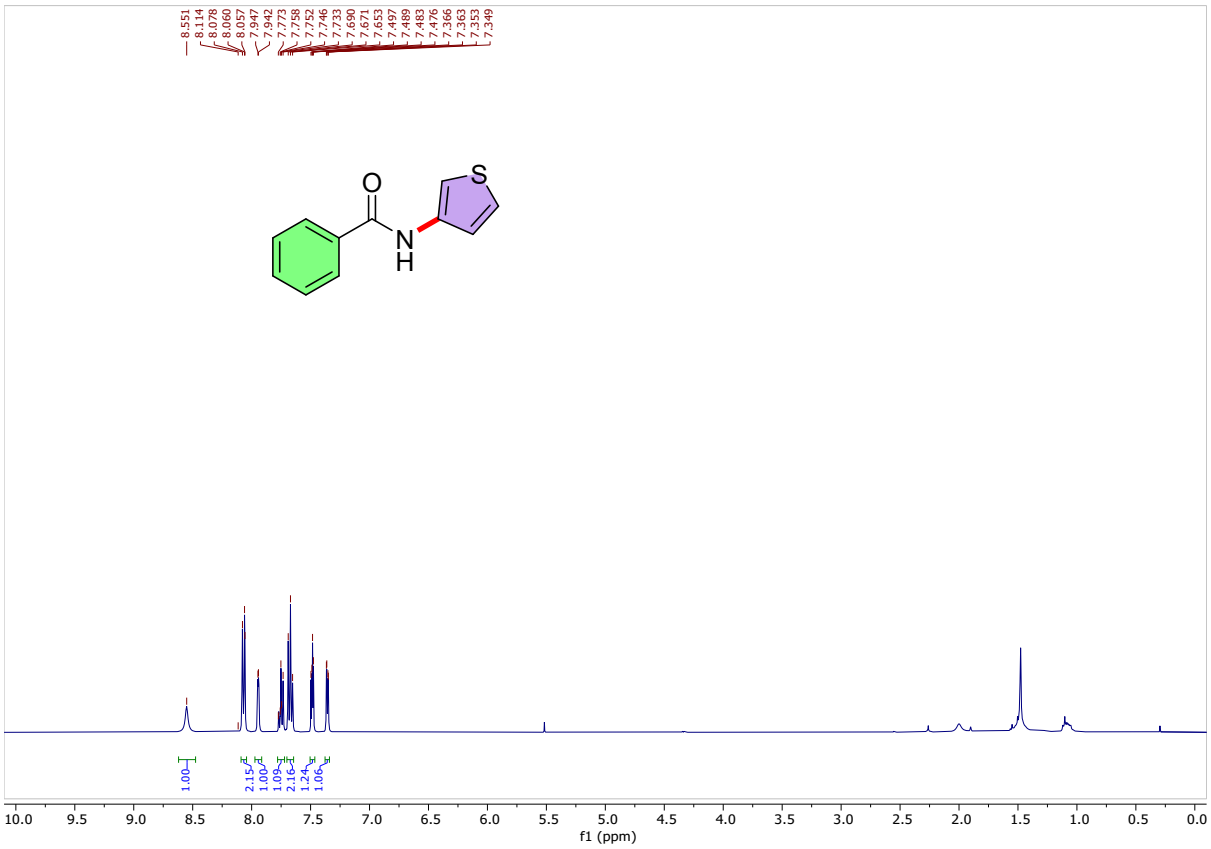


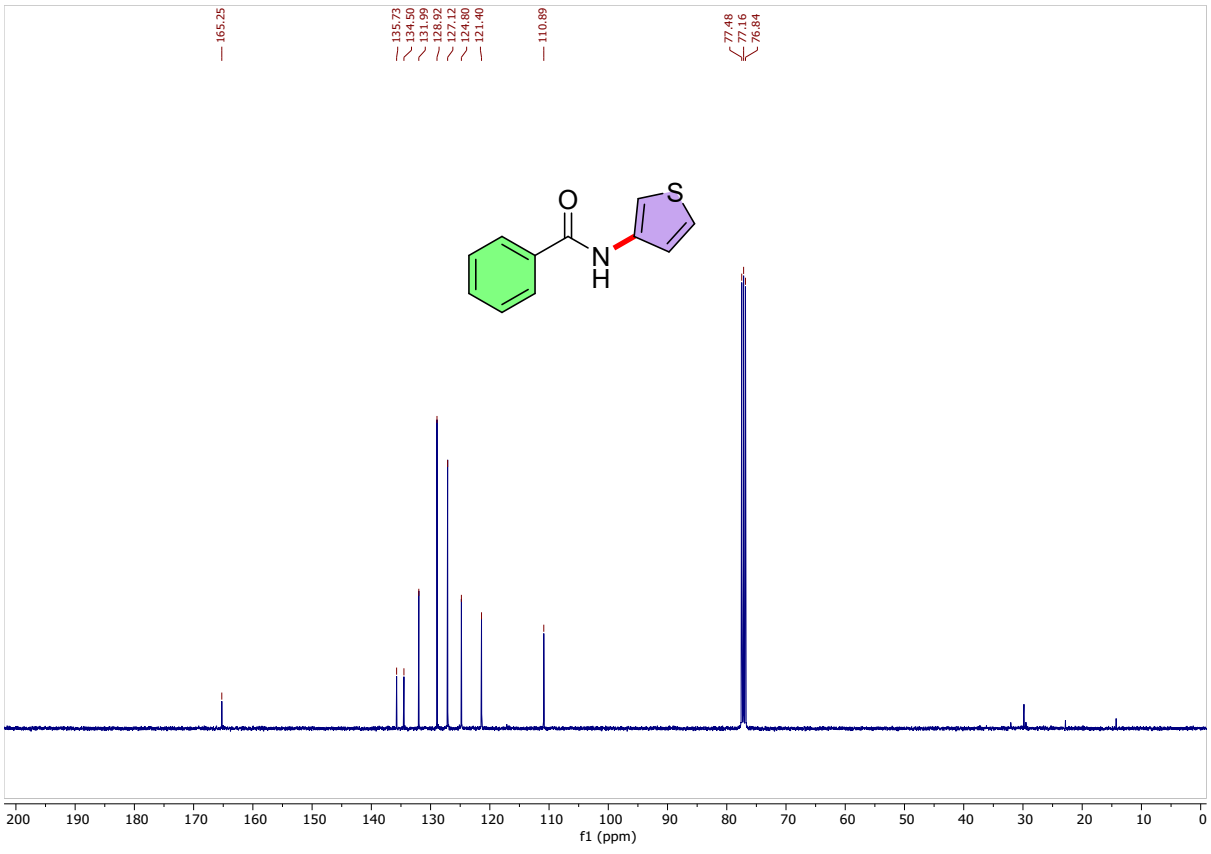
***N*-(pyridin-2-yl)benzamide (17)**



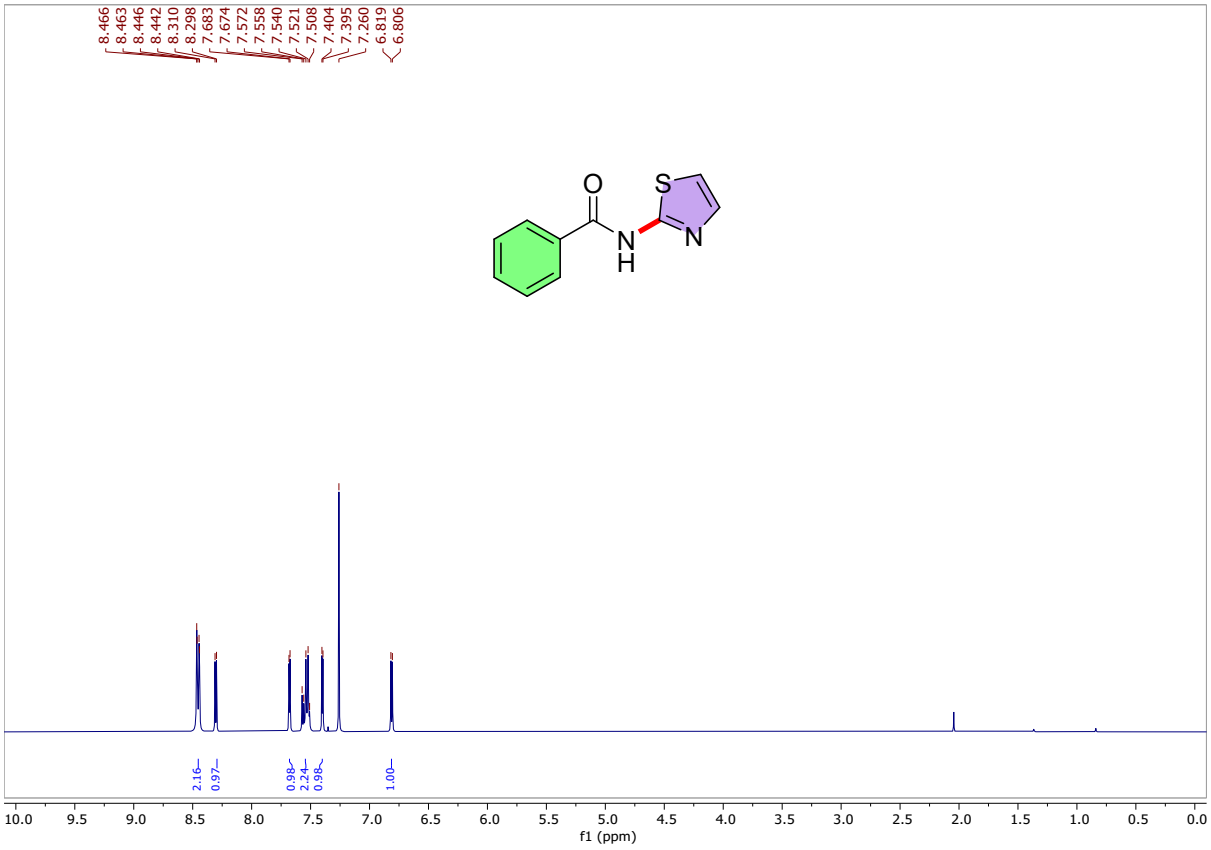


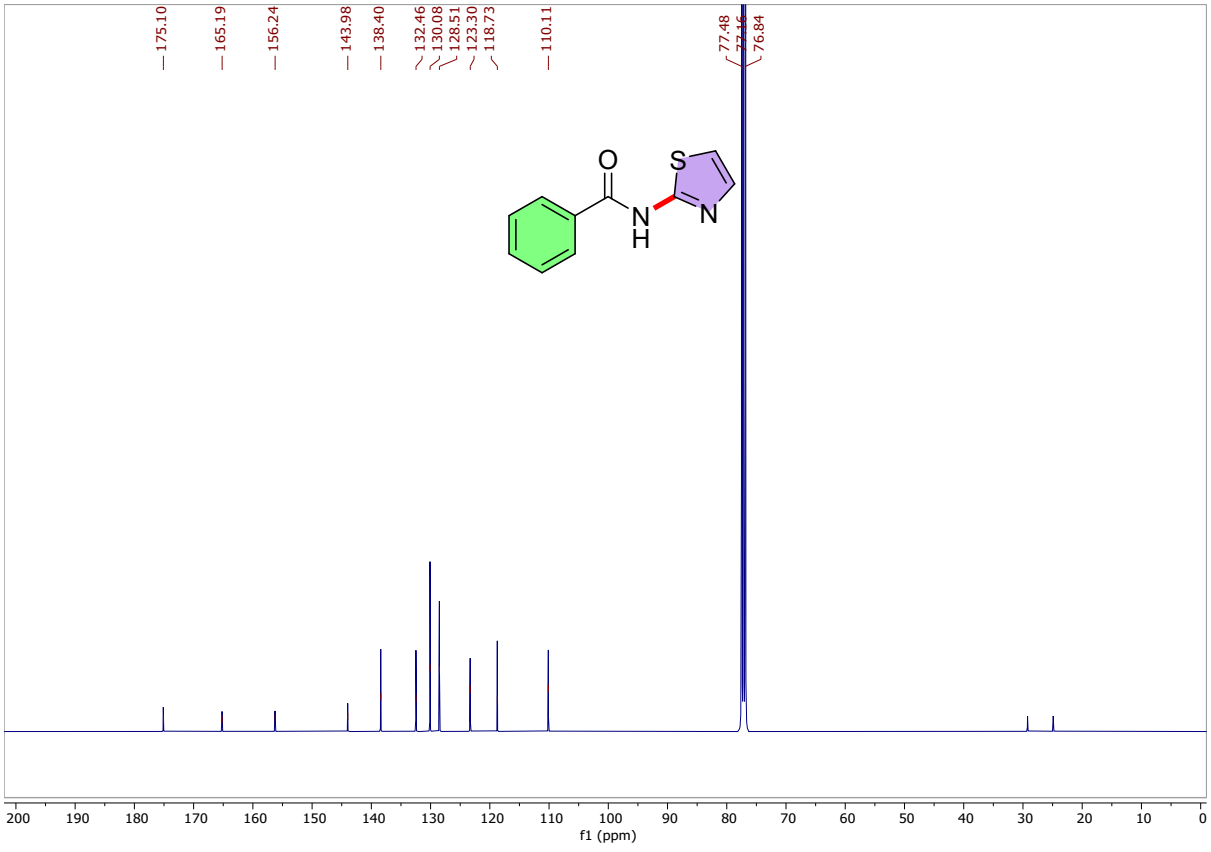
_N_-(thiophen-3-yl)benzamide (18)



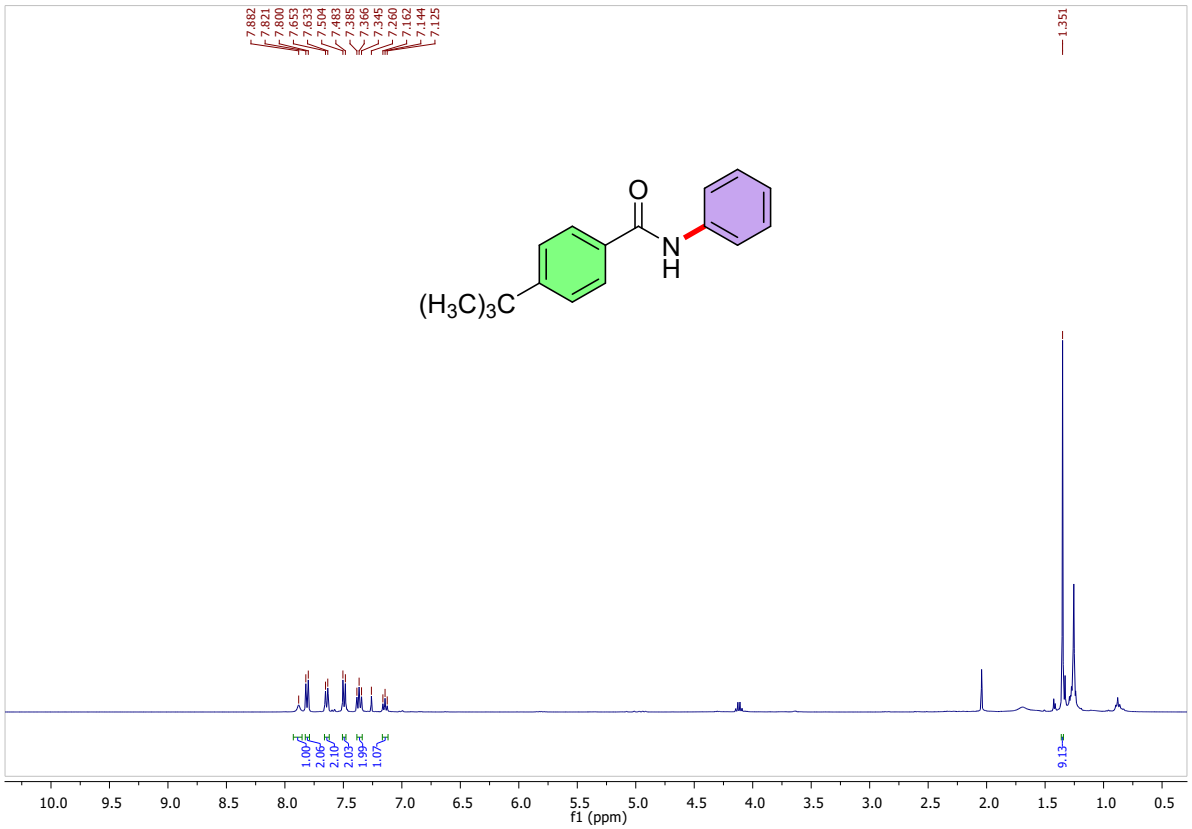


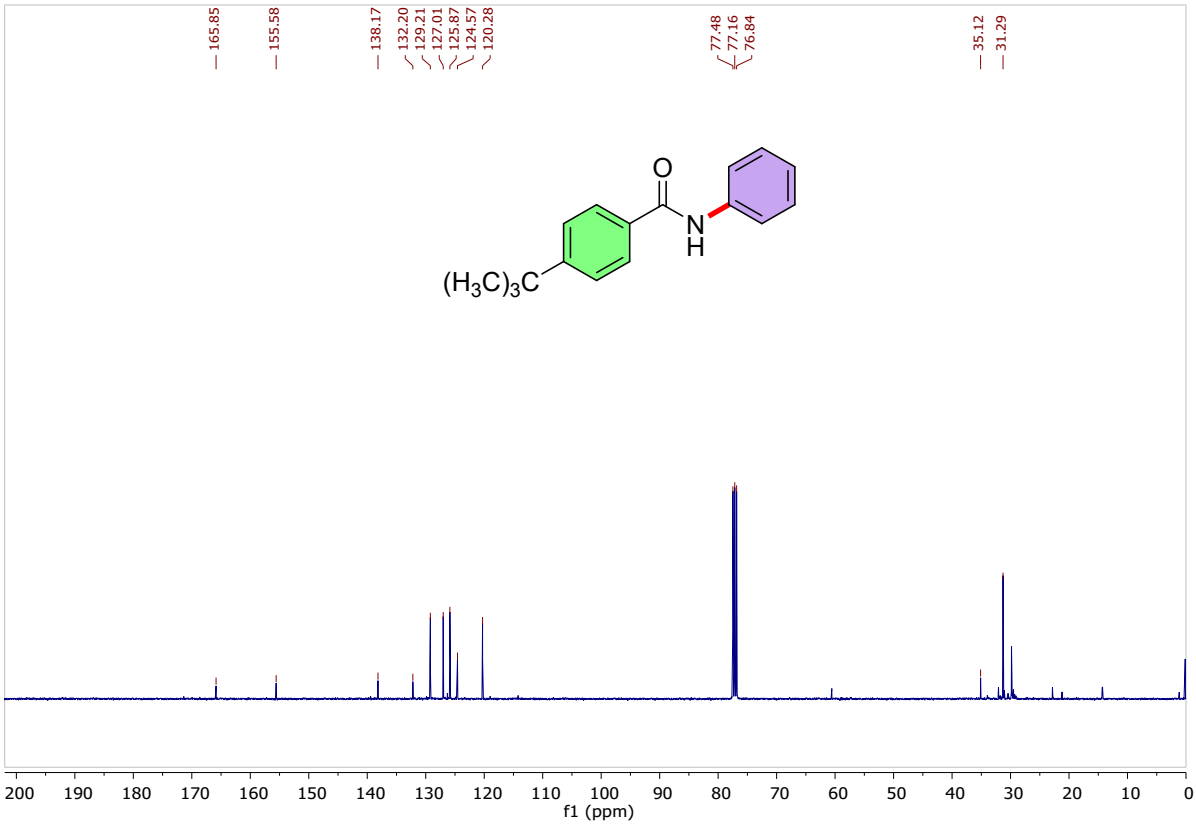
***N-(*thiazol-2-yl)benzamide (19)**



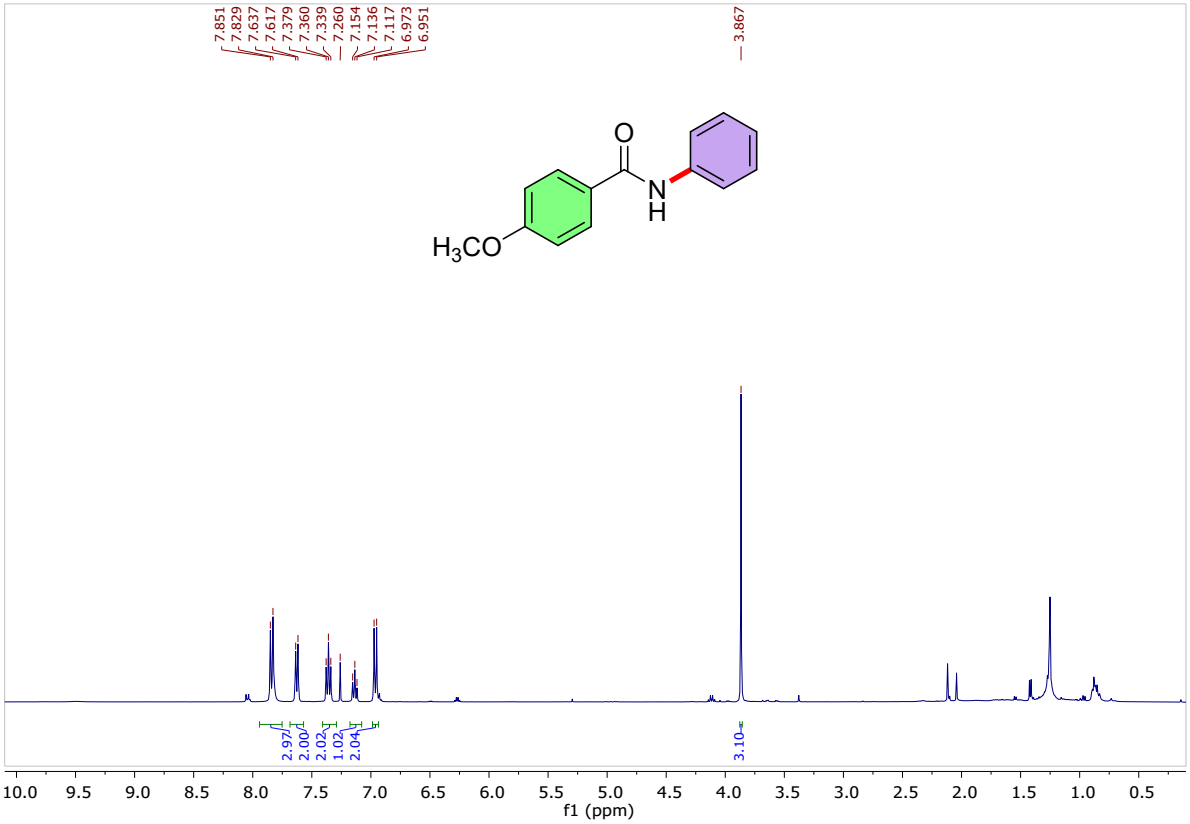


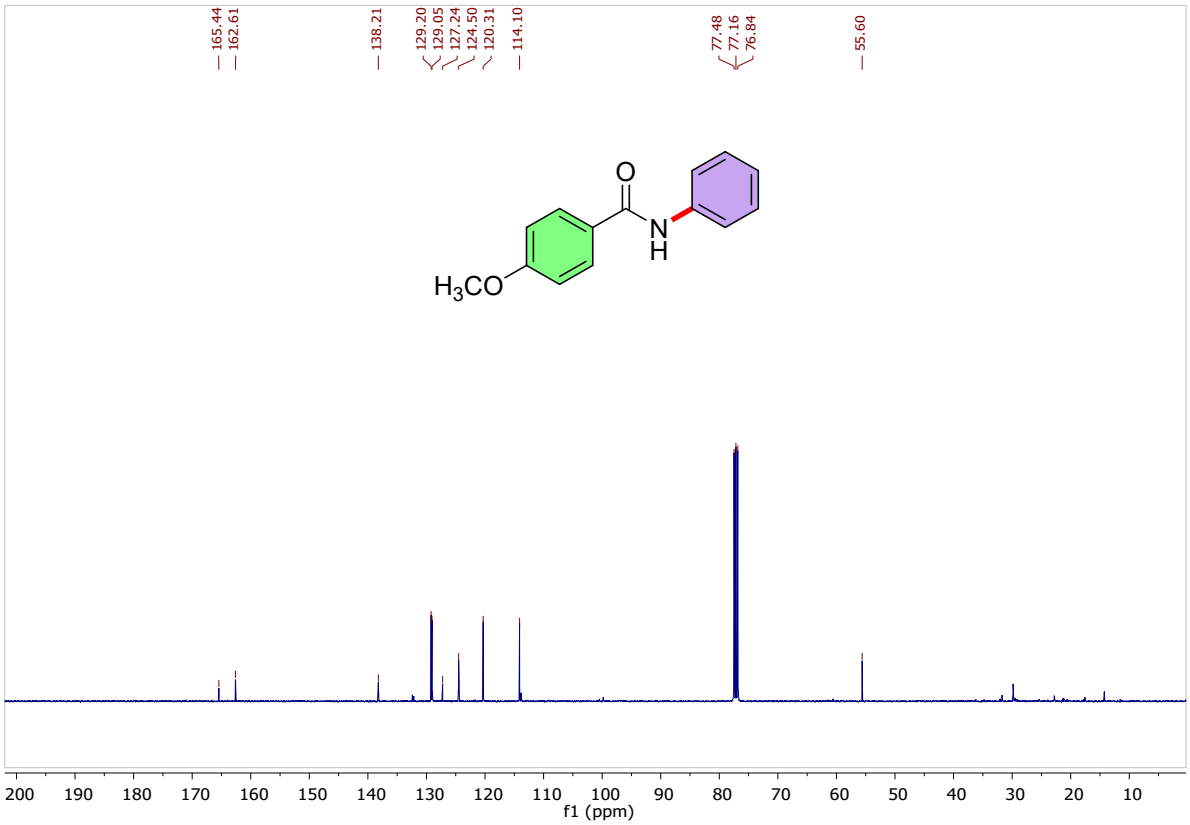
4-(tert-butyl)-*N*-phenylbenzamide (20)



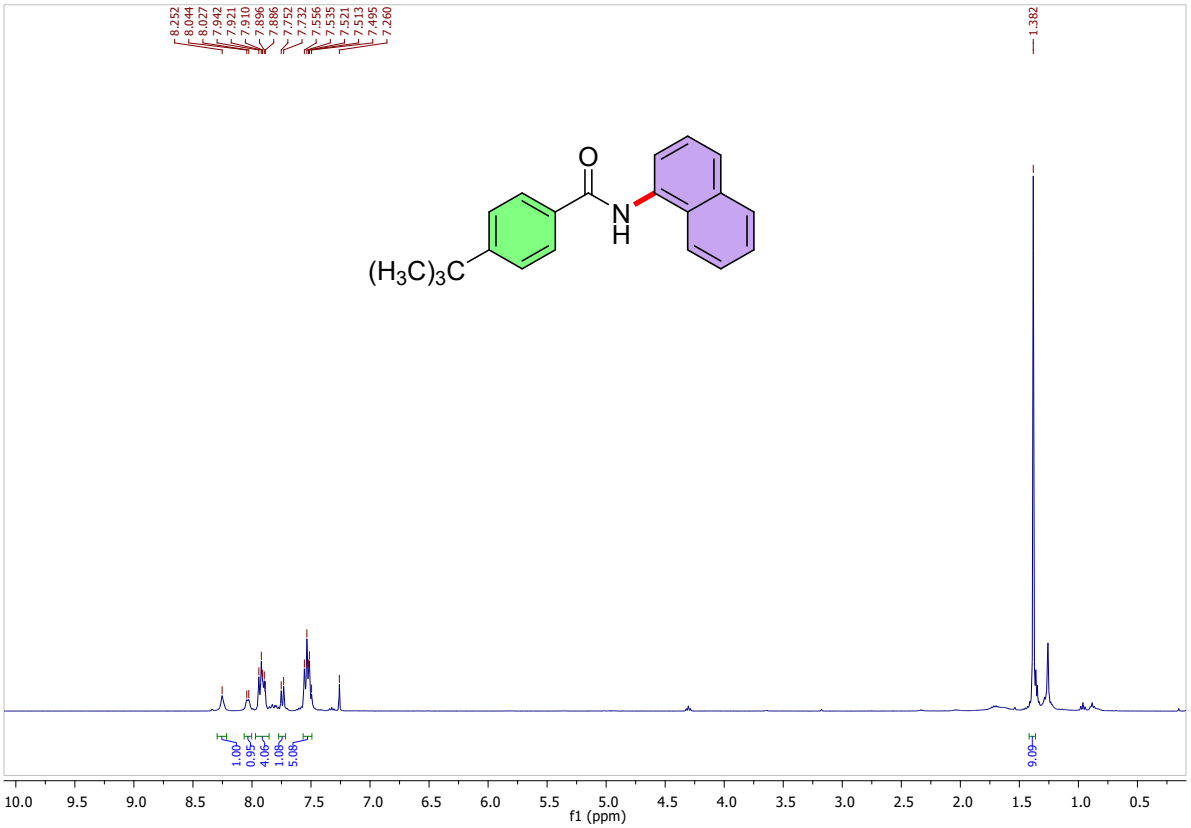


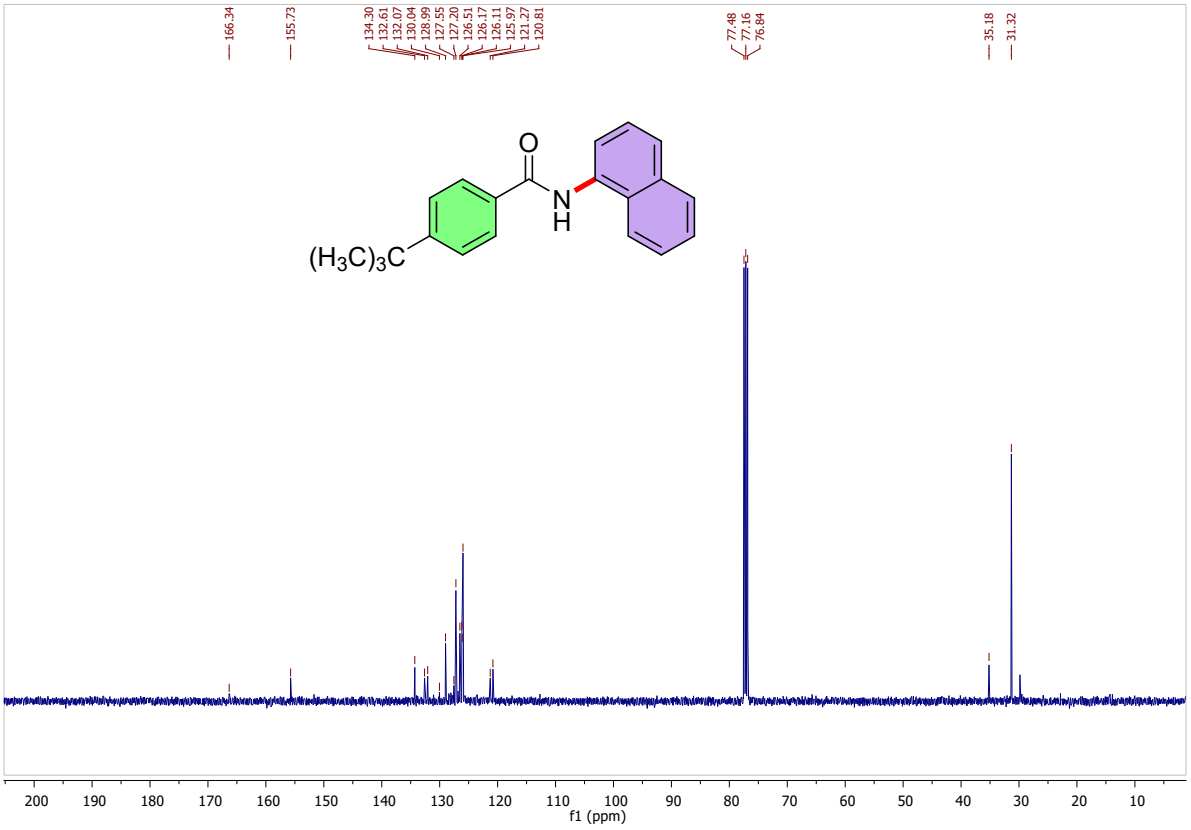
4-methoxy-*N*-phenylbenzamide (21)



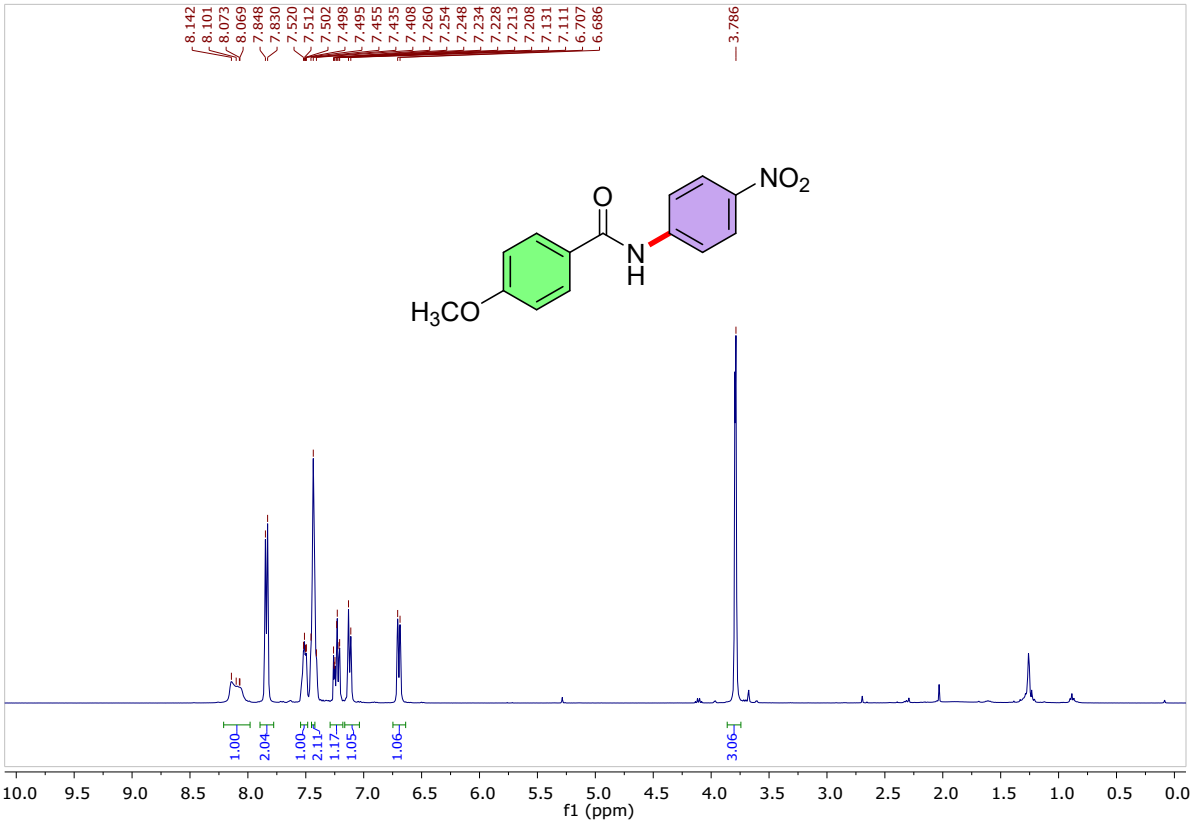


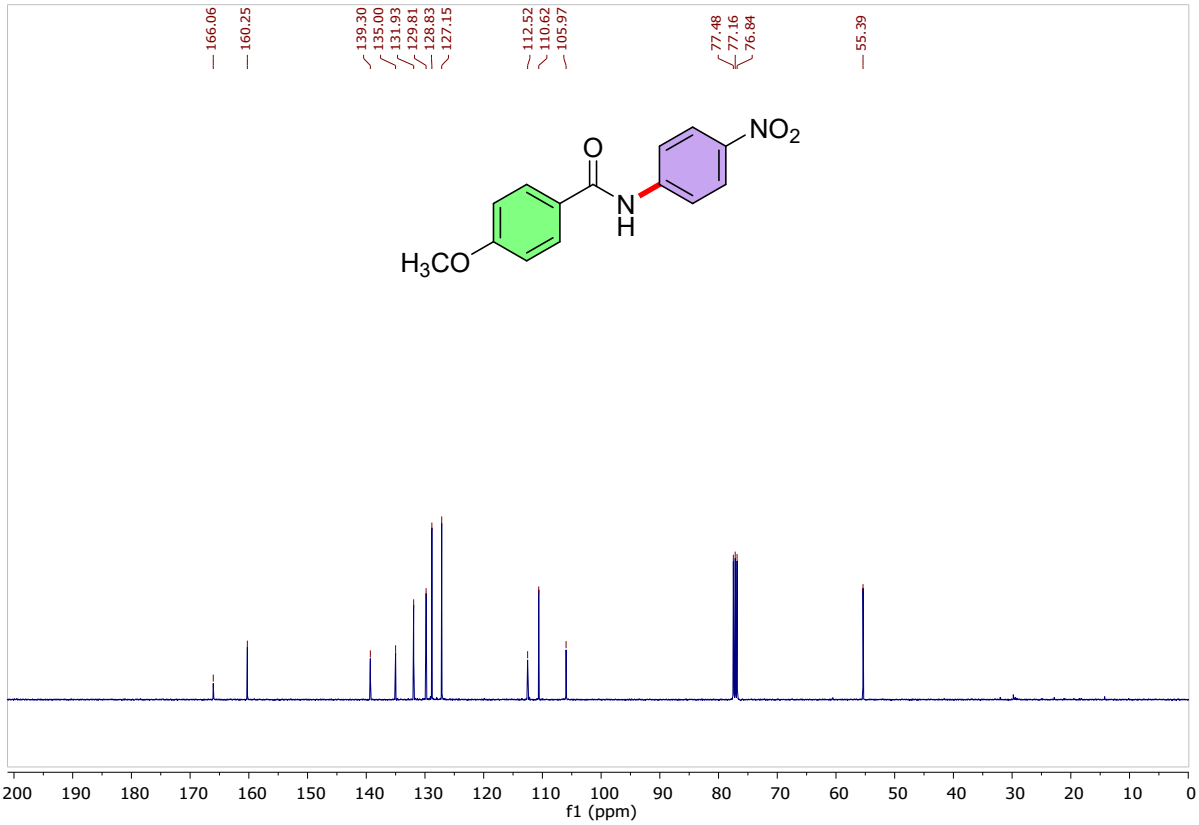
4-(tert-butyl)-*N*-(naphthalen-1-yl)benzamide (22)



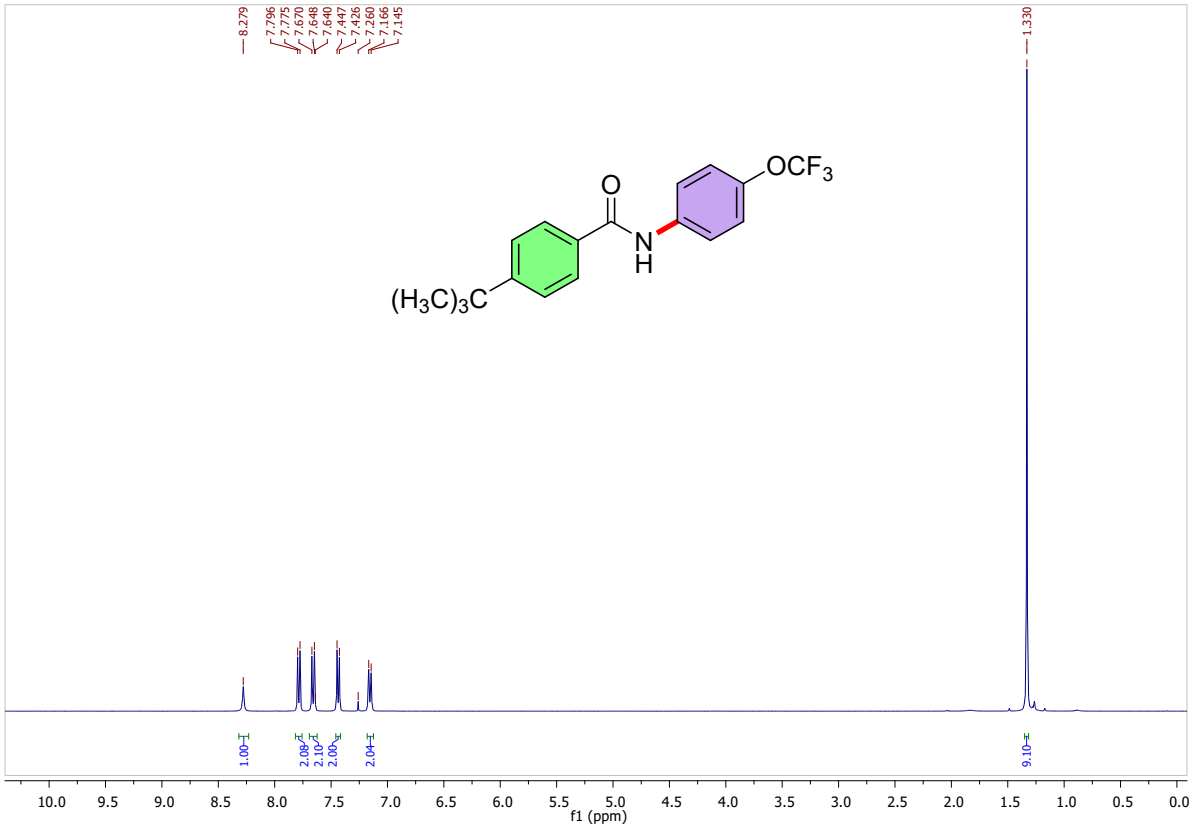


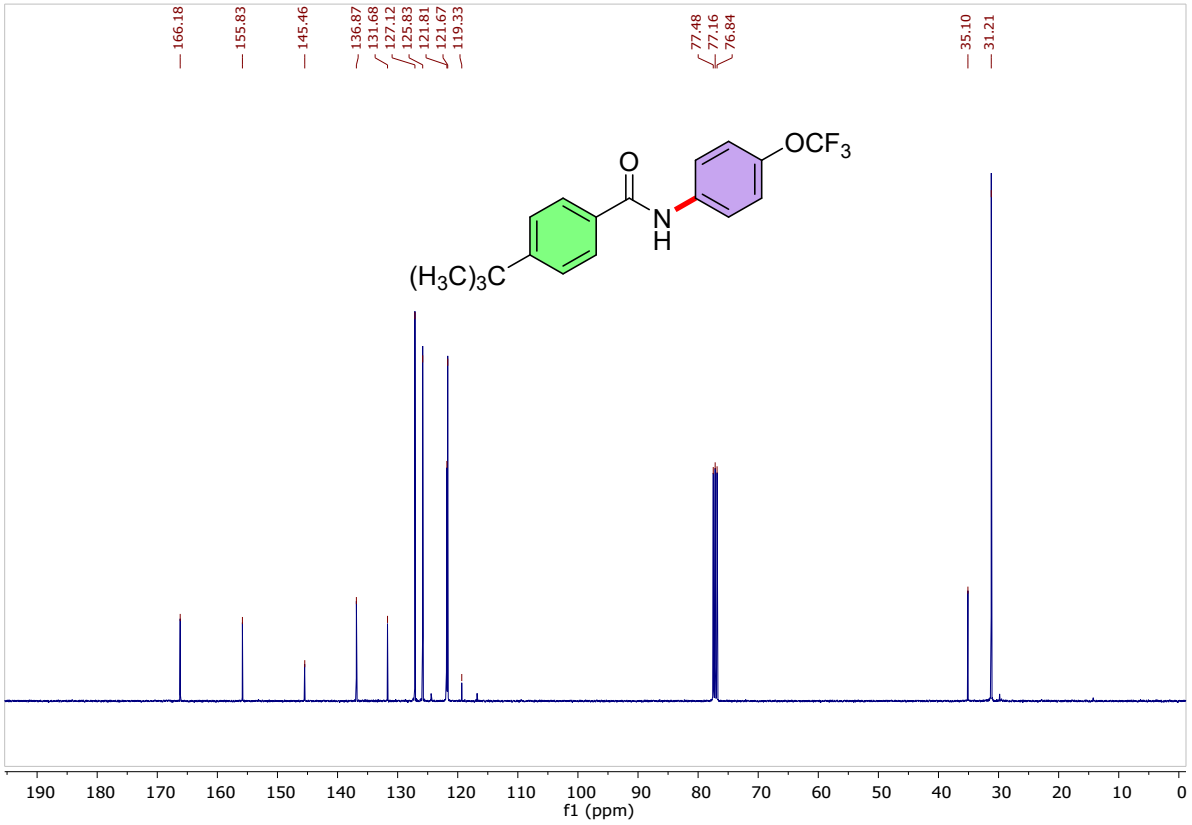
4-methoxy-*N*-(4-nitrophenyl)benzamide (23)



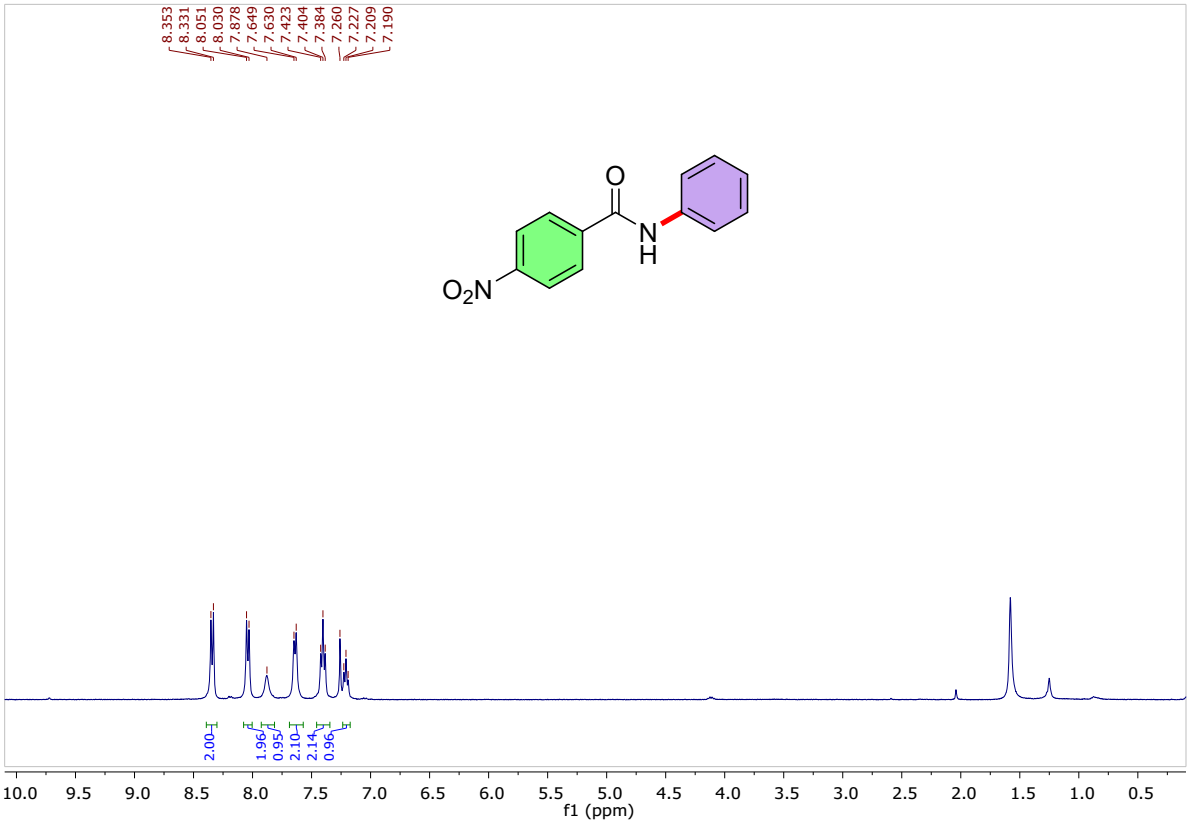


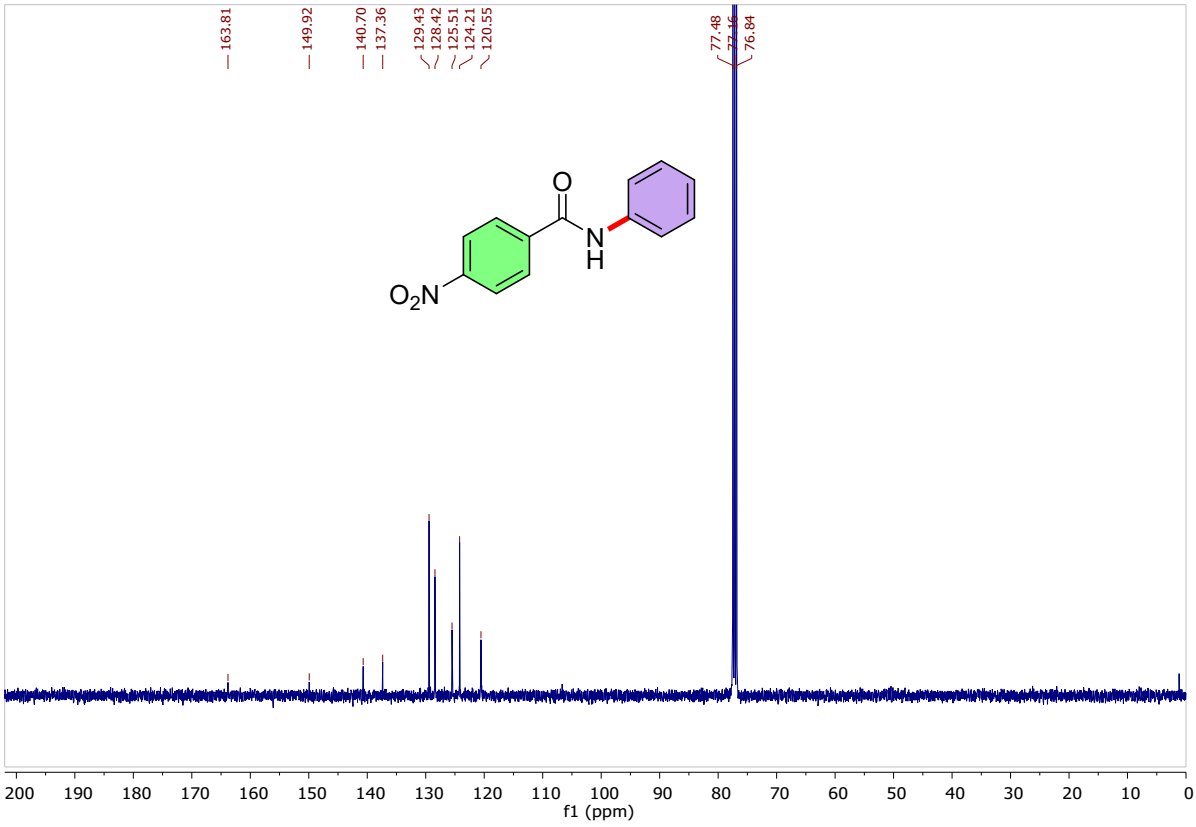
4-(tert-butyl)-*N*-(4-(trifluoromethoxy)phenyl)benzamide (24)



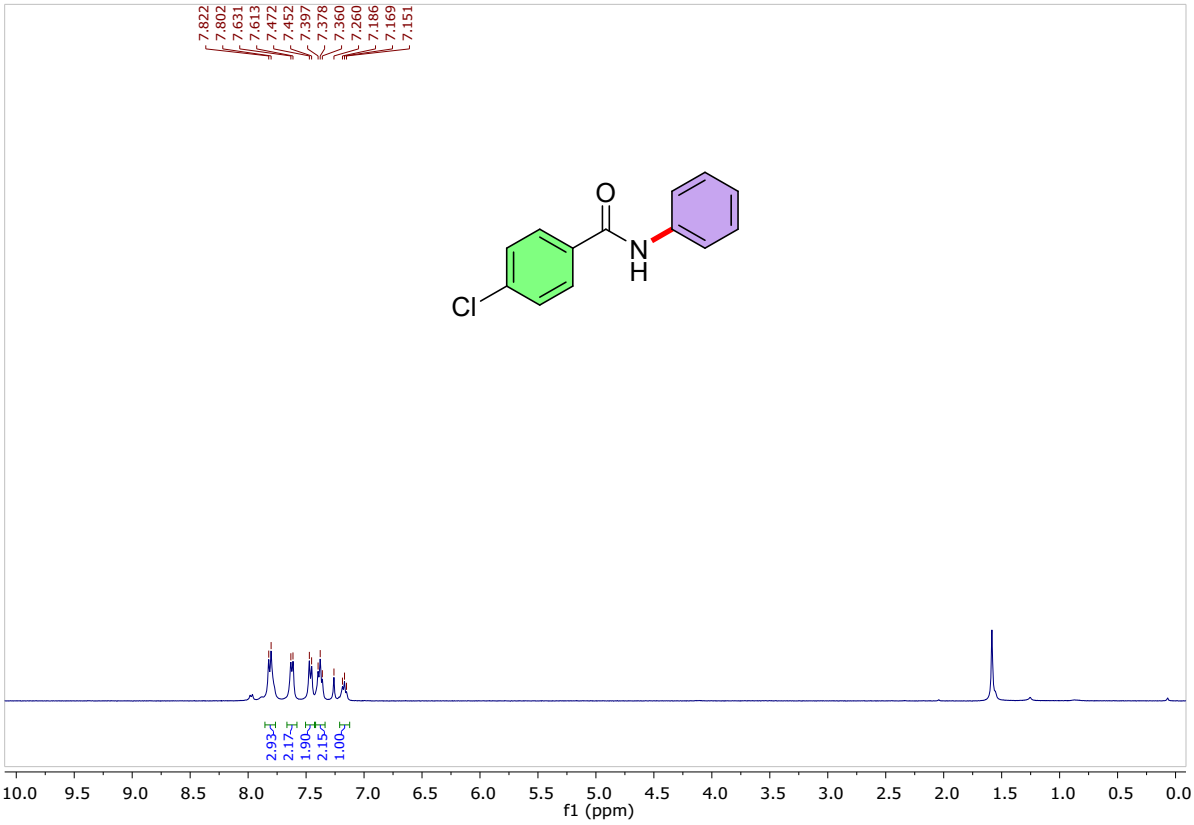


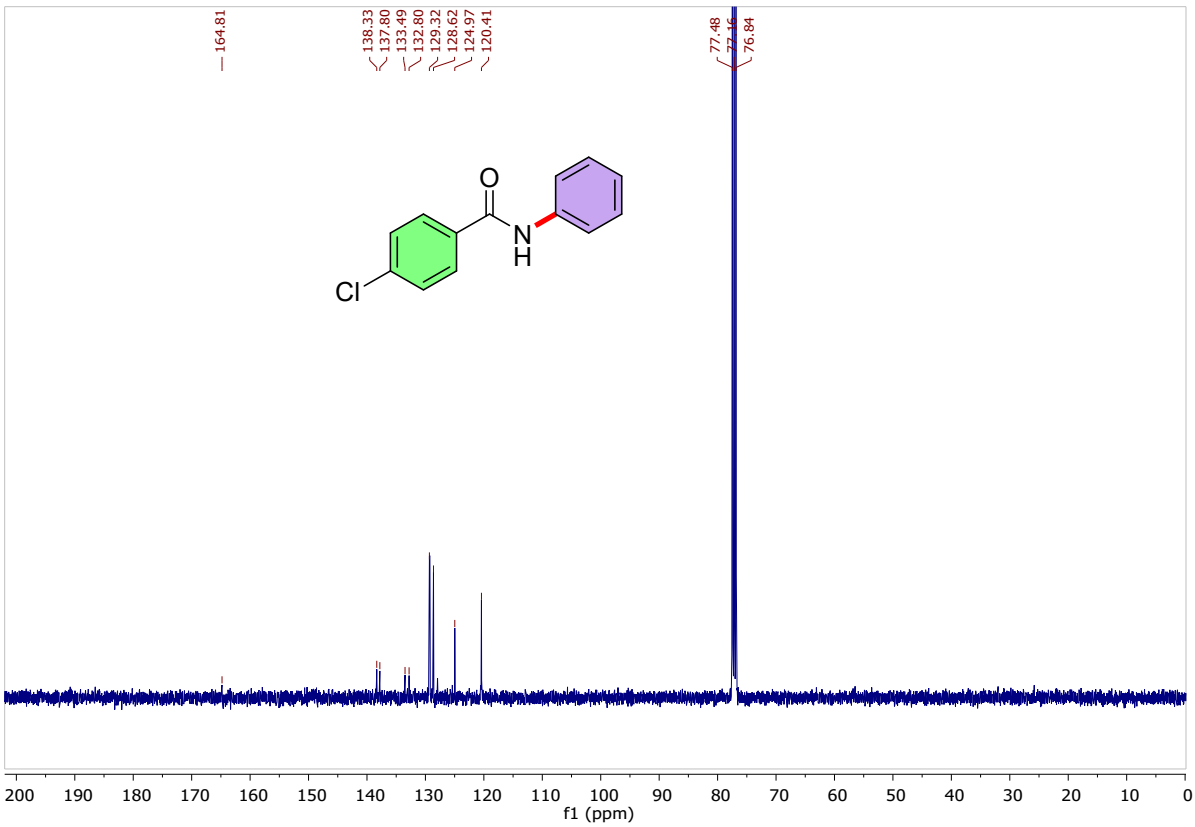
4-nitro-*N*-phenylbenzamide (25)



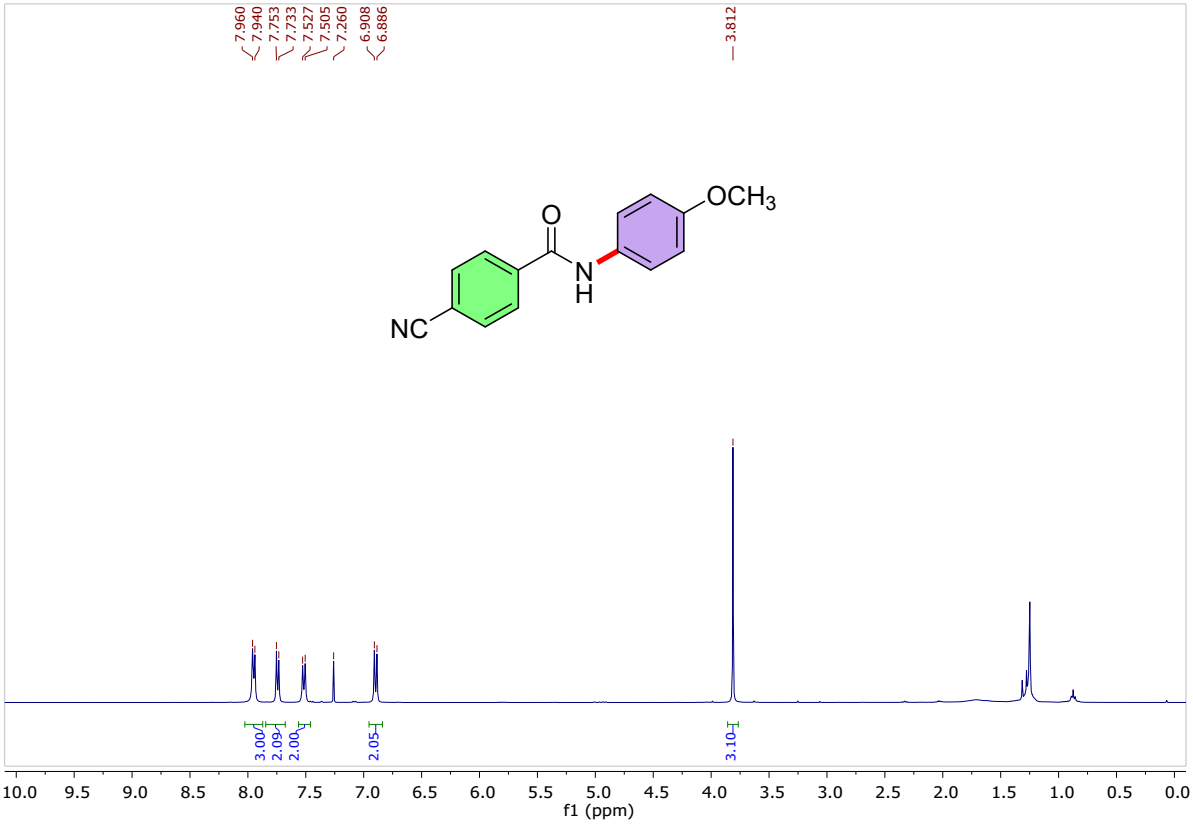


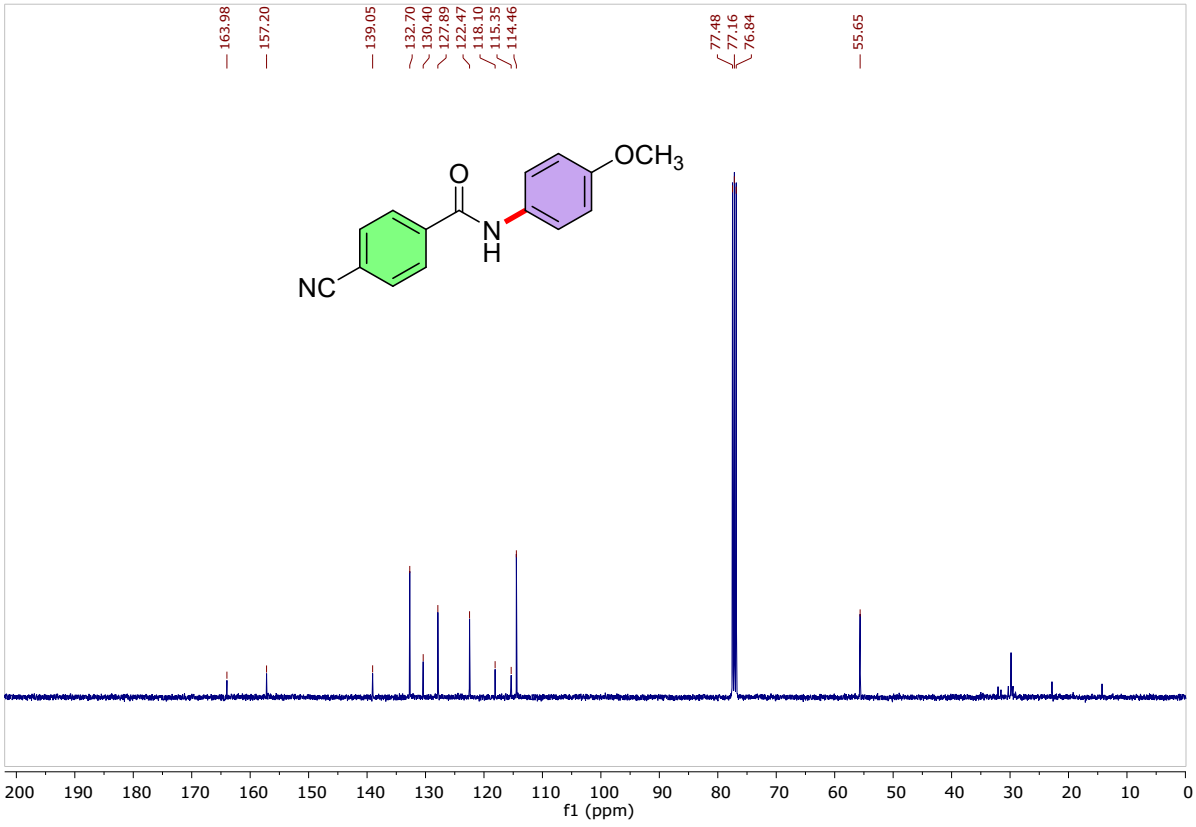
4-chloro-*N*-phenylbenzamide (26)



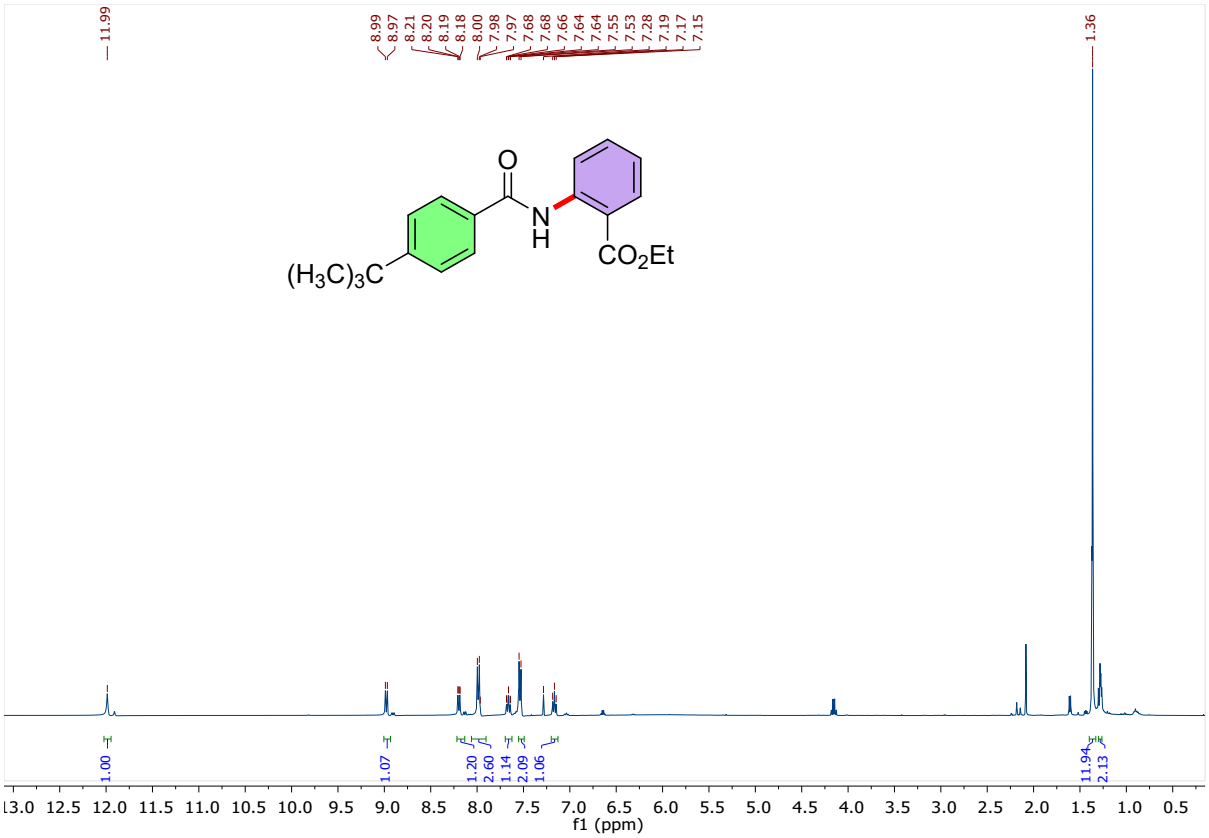


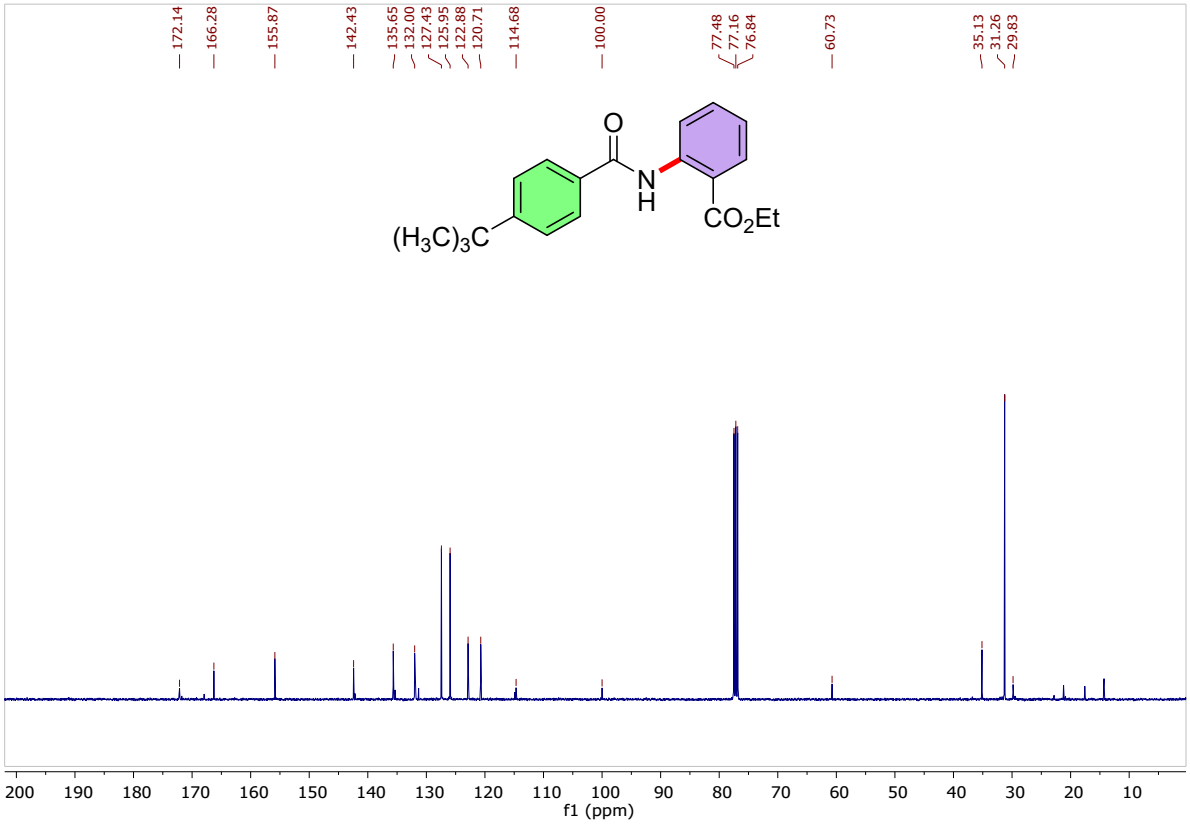
4-cyano-*N*-(4-methoxyphenyl)benzamide (27)



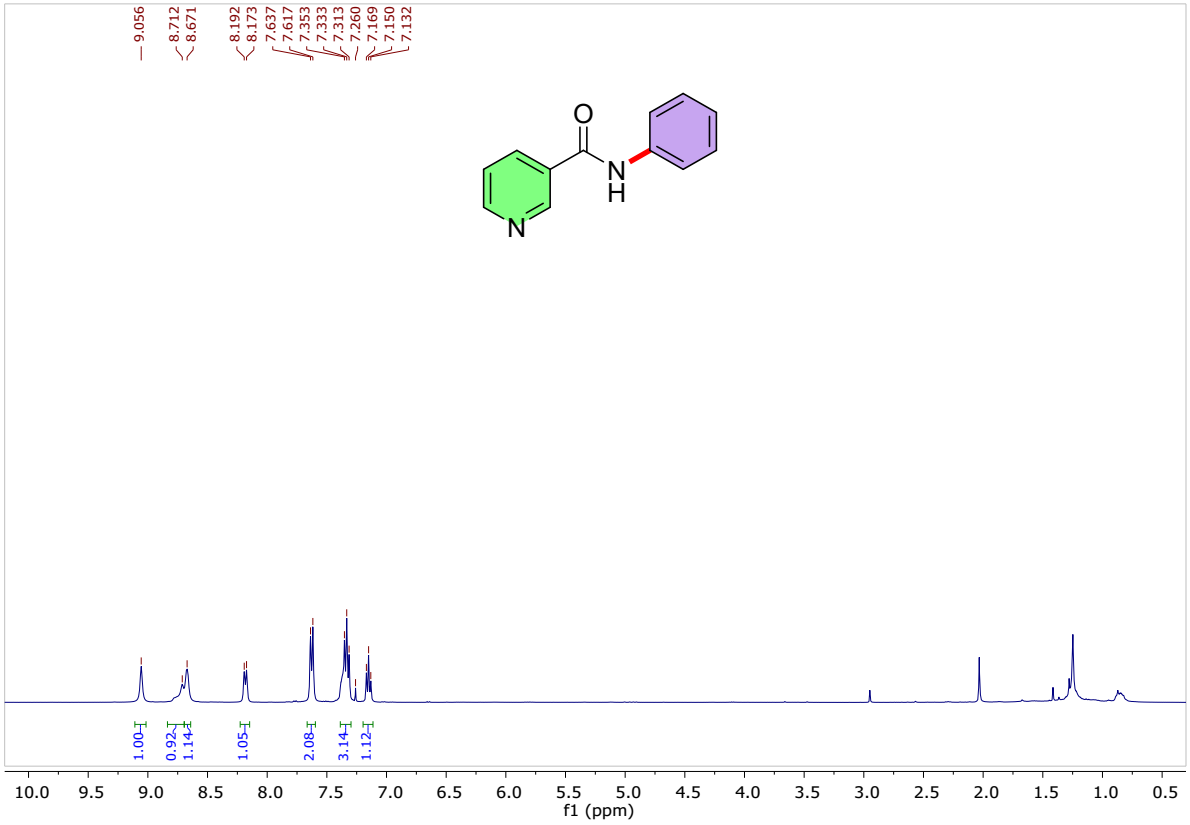


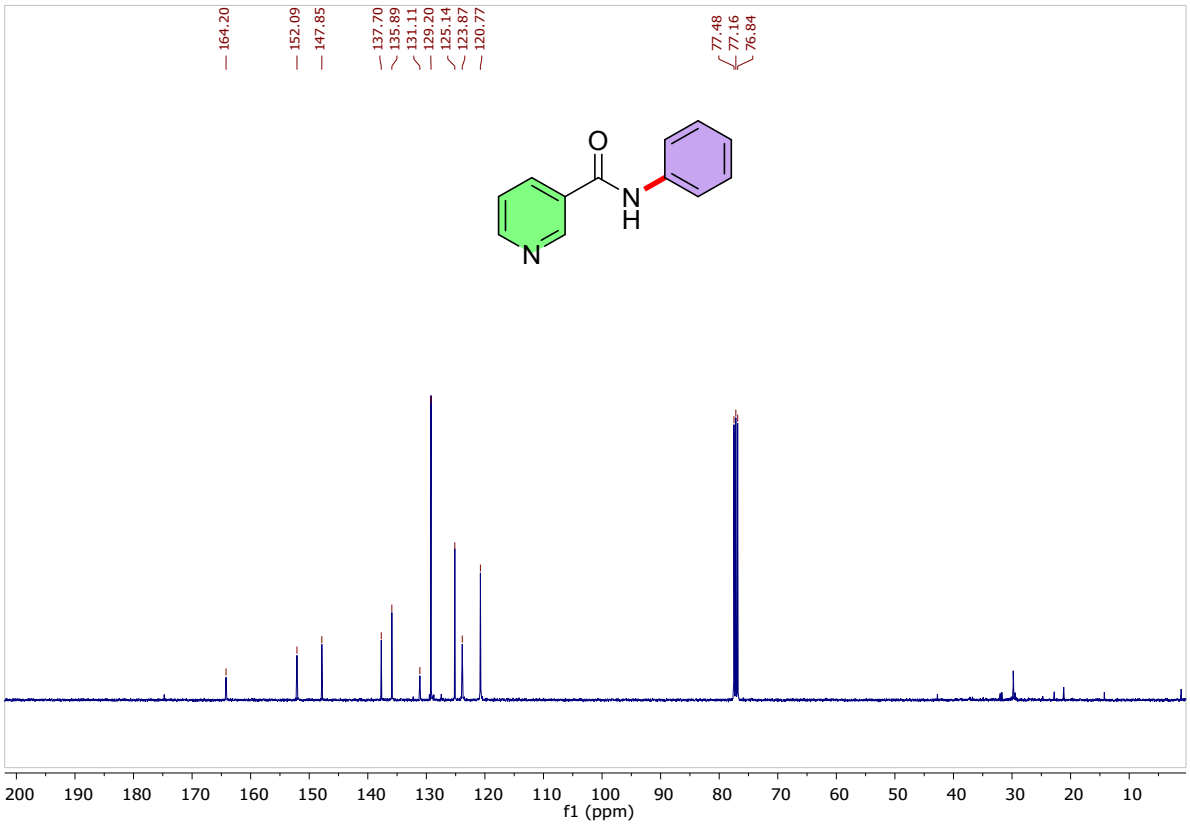
ethyl 2-(4-(tert-butyl)benzamido)benzoate (28)



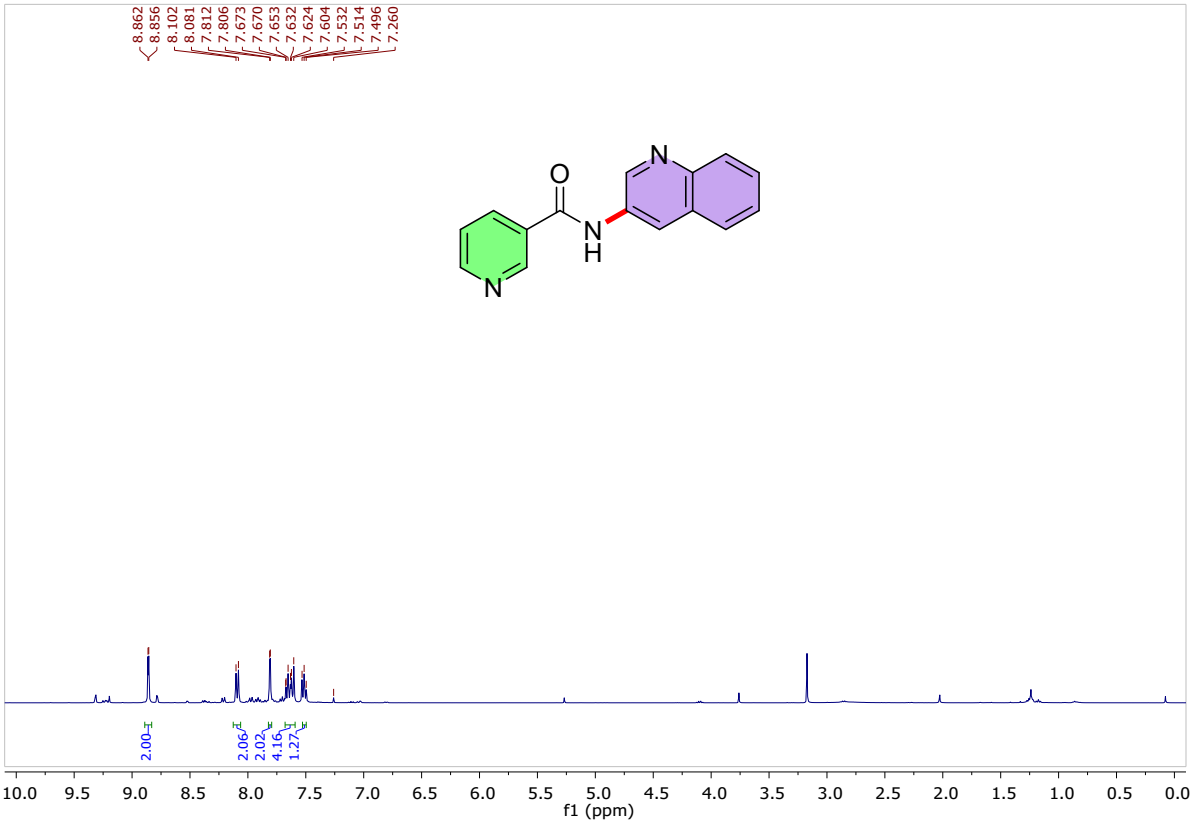


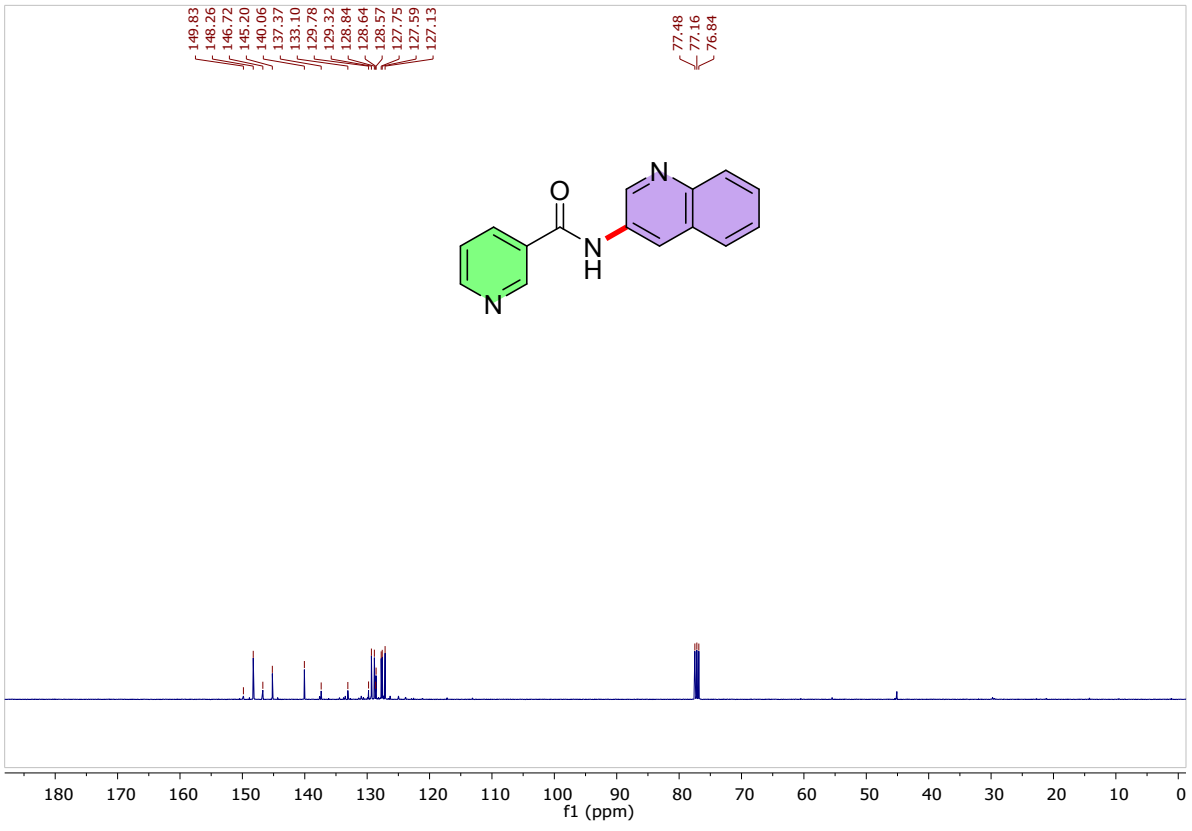
_N_-phenylnicotinamide (29)


9.056
8.712
8.671
8.192
8.173
7.637
7.617
7.353
7.333
7.313
7.260
7.169
7.150
7.132
O
N
H
N
1.00
0.92
1.14
1.05
2.08
3.14
1.12
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

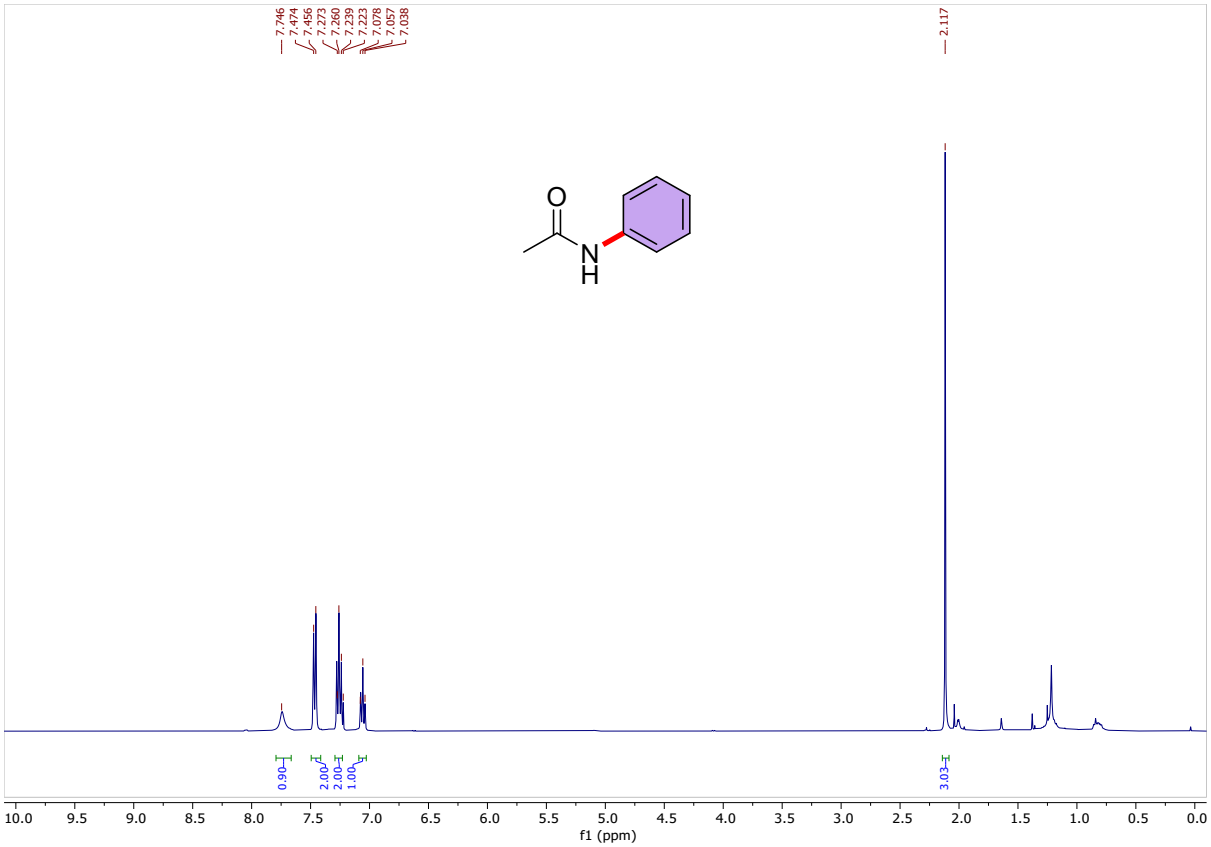

164.20
152.09
147.85
137.70
135.89
131.11
129.20
125.14
123.87
120.77
77.48
77.16
76.84
O
N
H
N
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

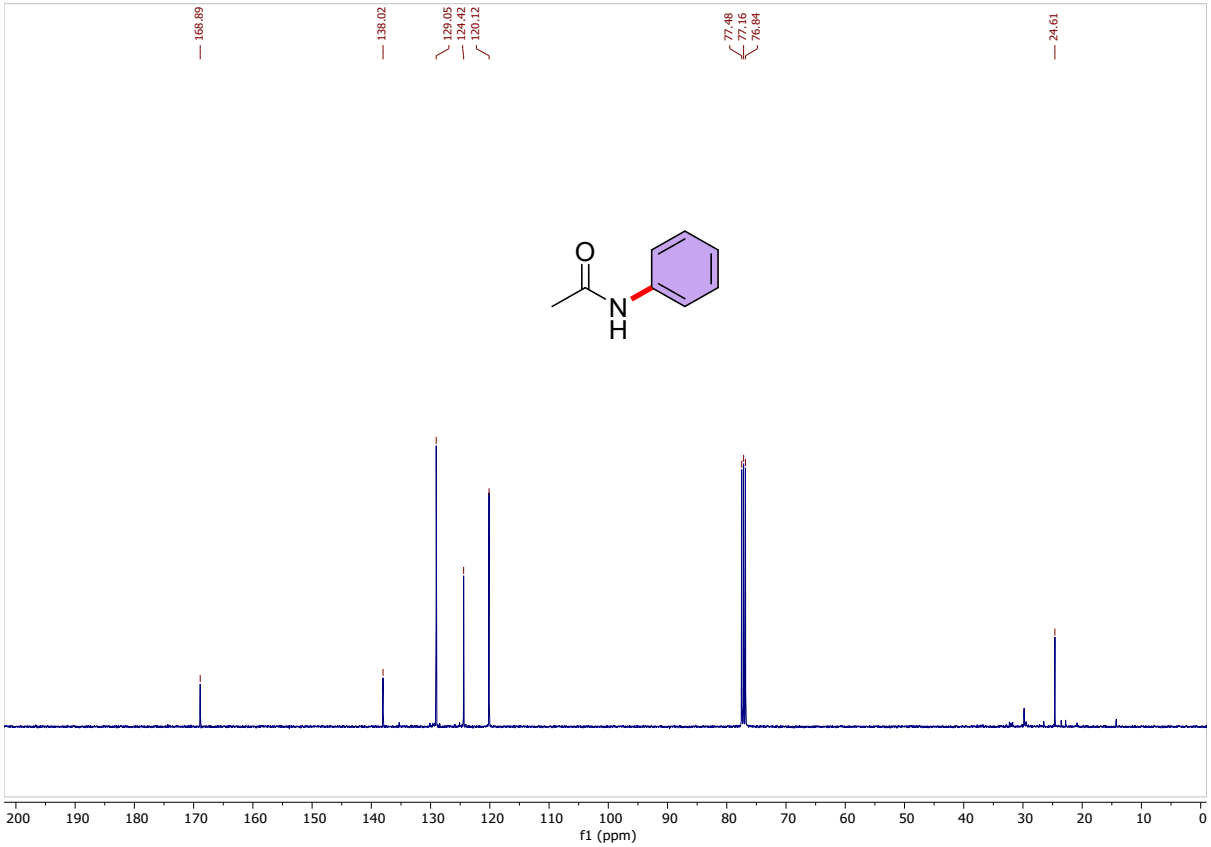
N-(quinolin-3-yl)nicotinamide (30)



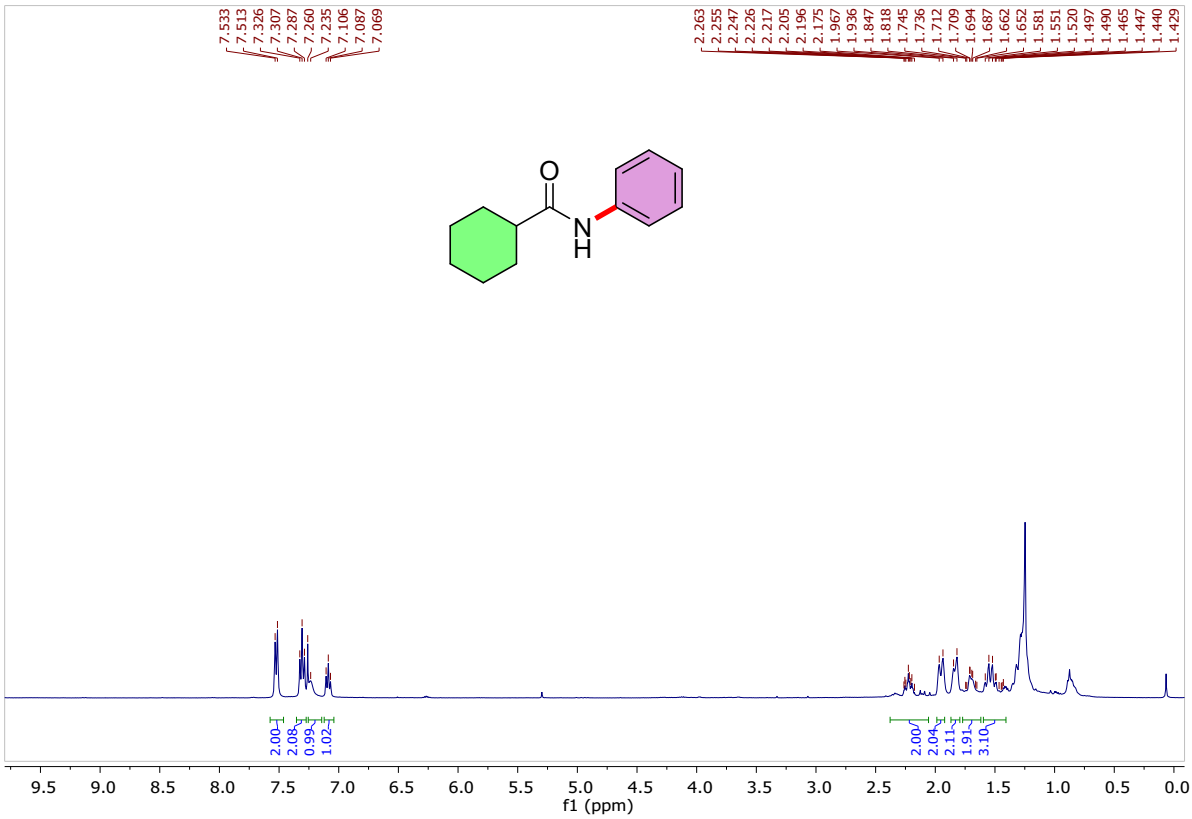


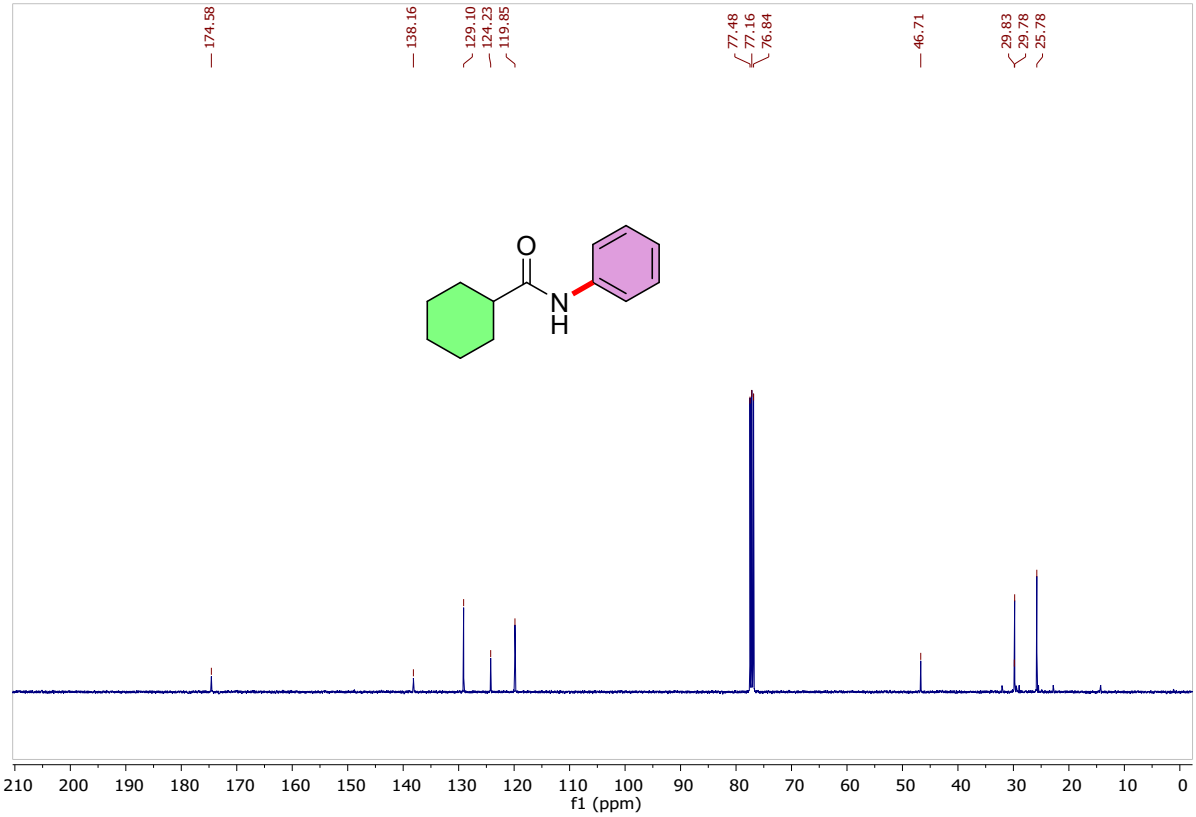
N-phenylacetamide (31)



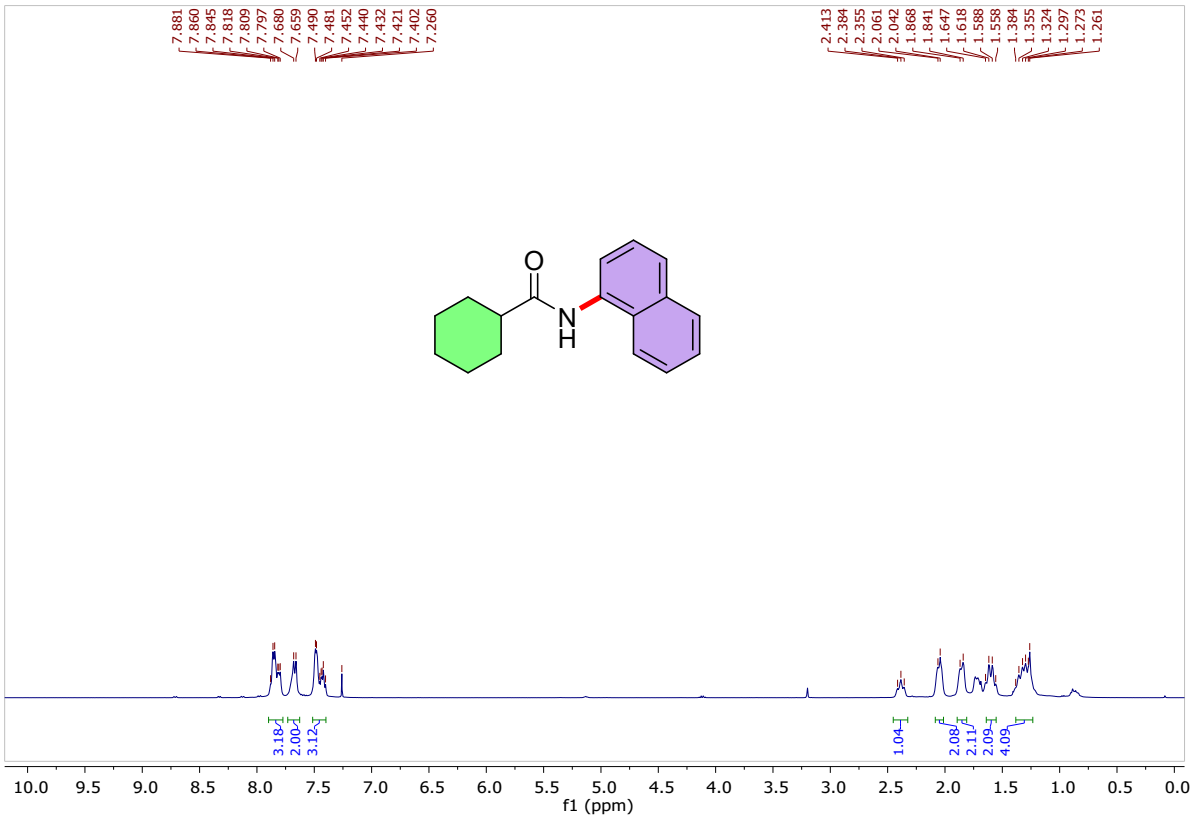


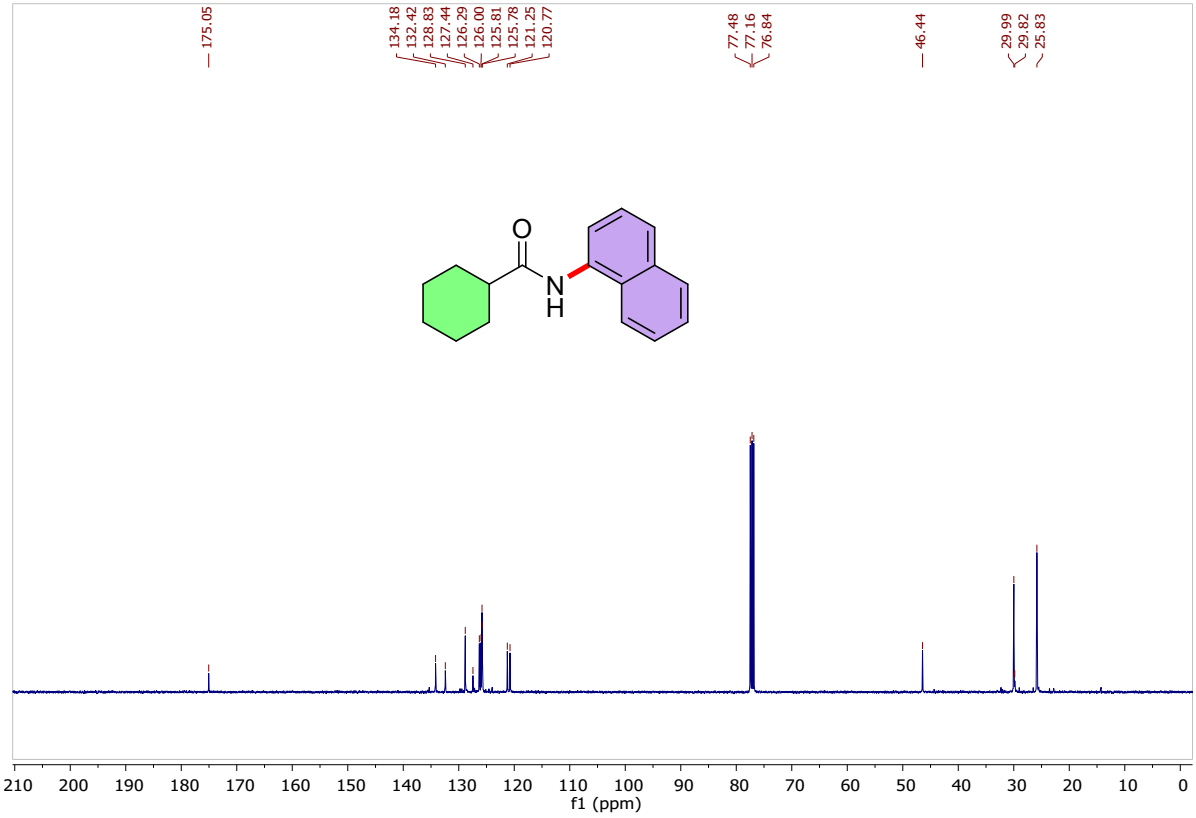
_N_-phenylcyclohexanecarboxamide (32)



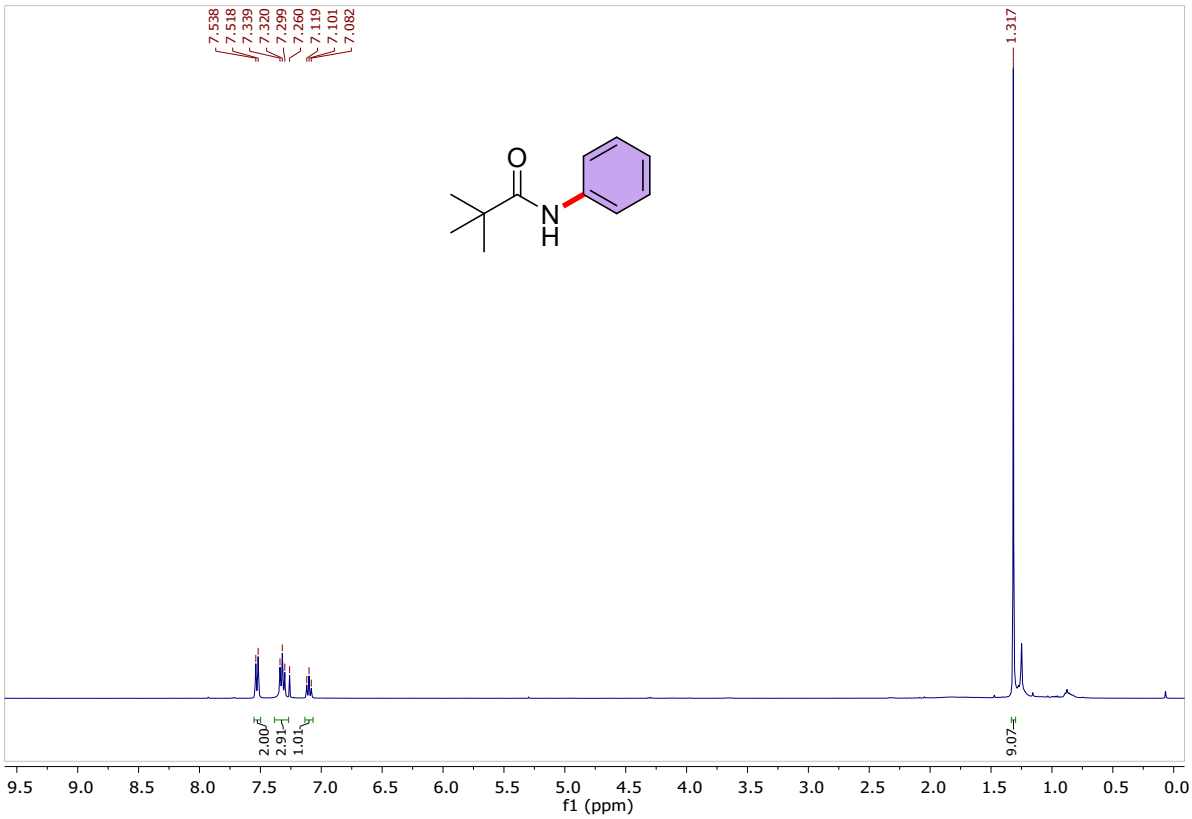


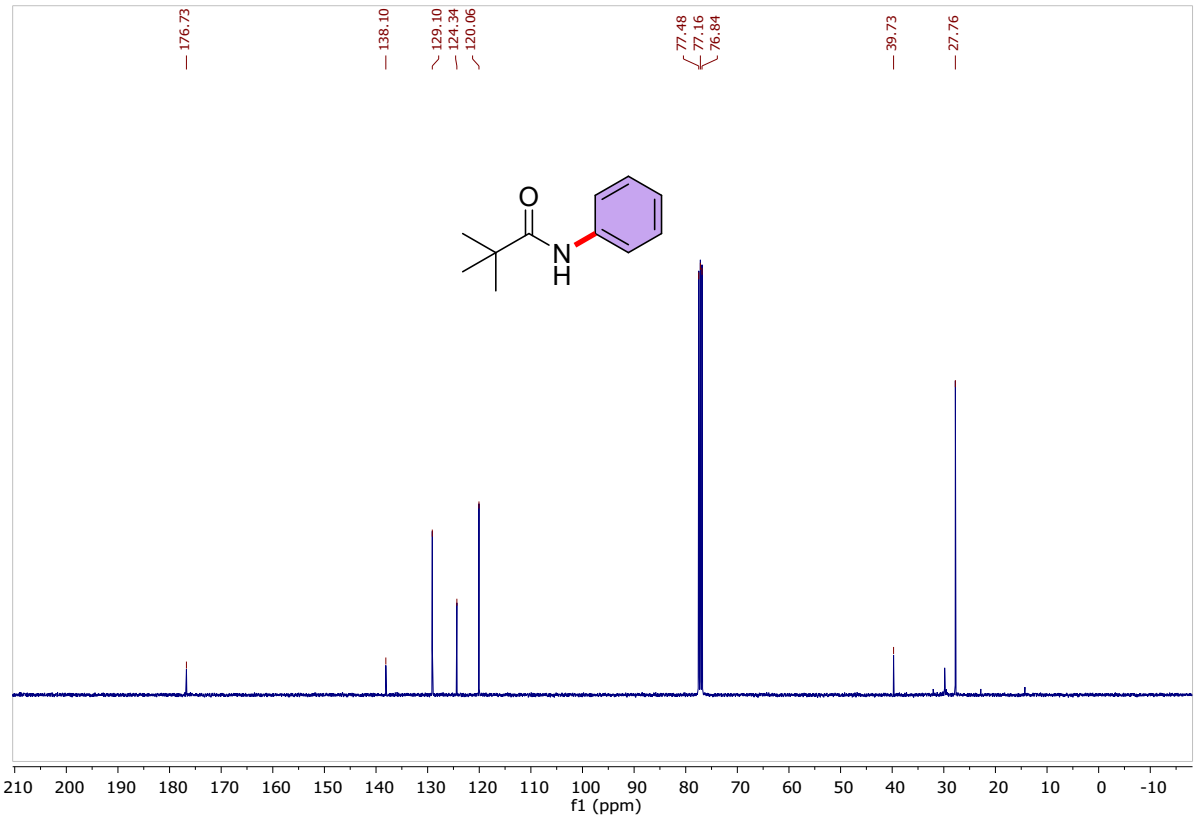
_N_-(naphthalen-1-yl)cyclohexanecarboxamide (33)



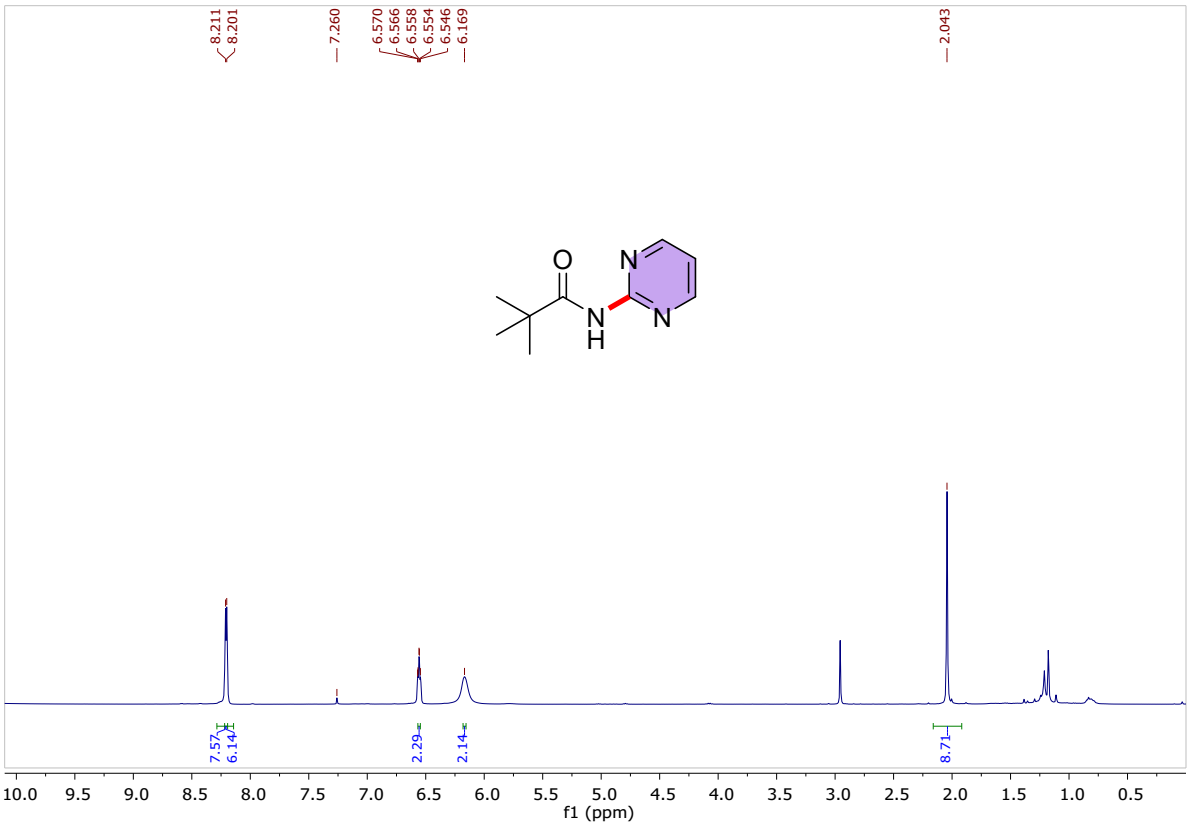


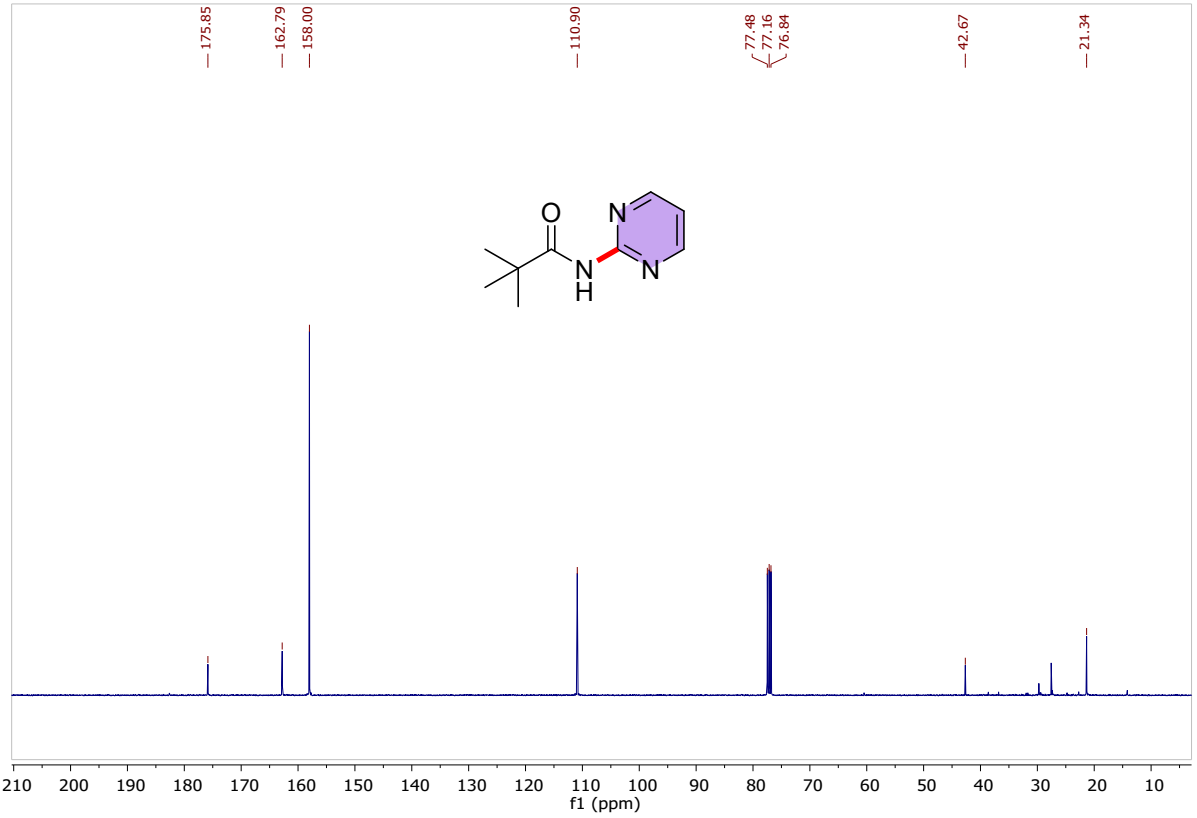
_N_-phenylpivalamide (34)



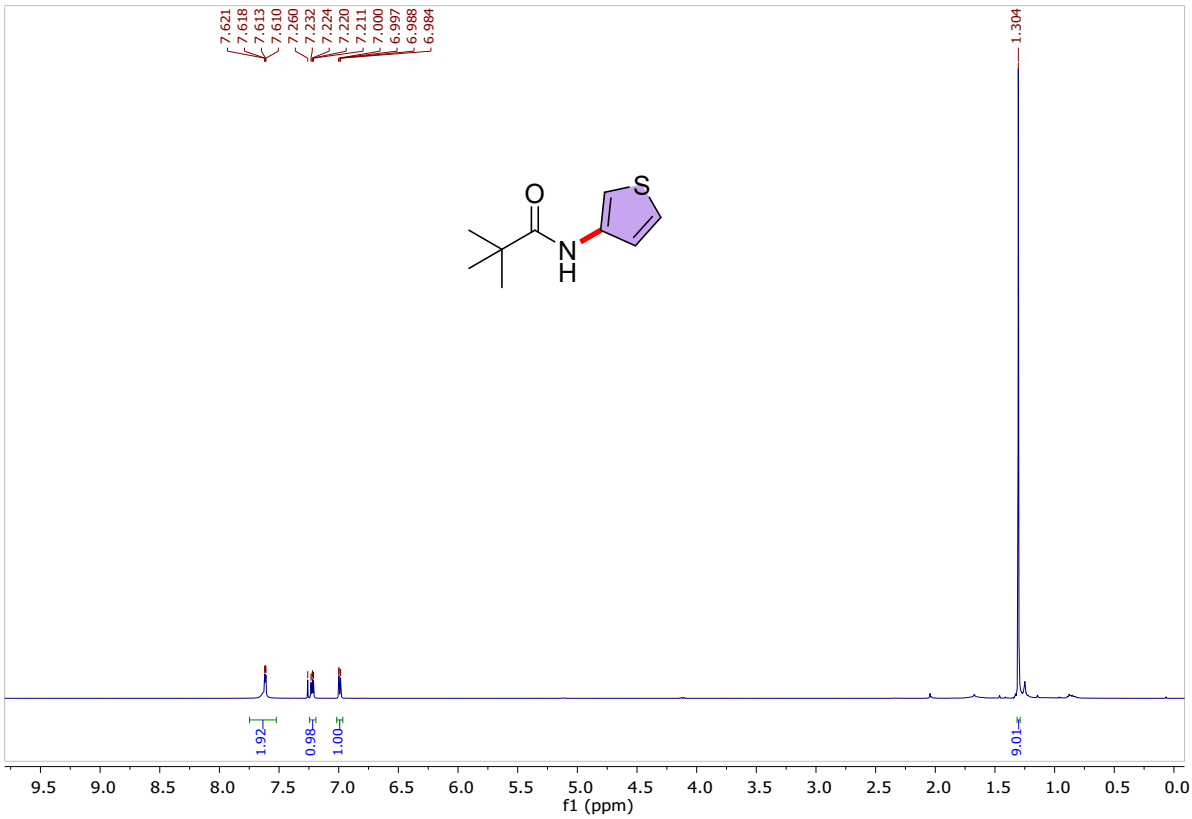


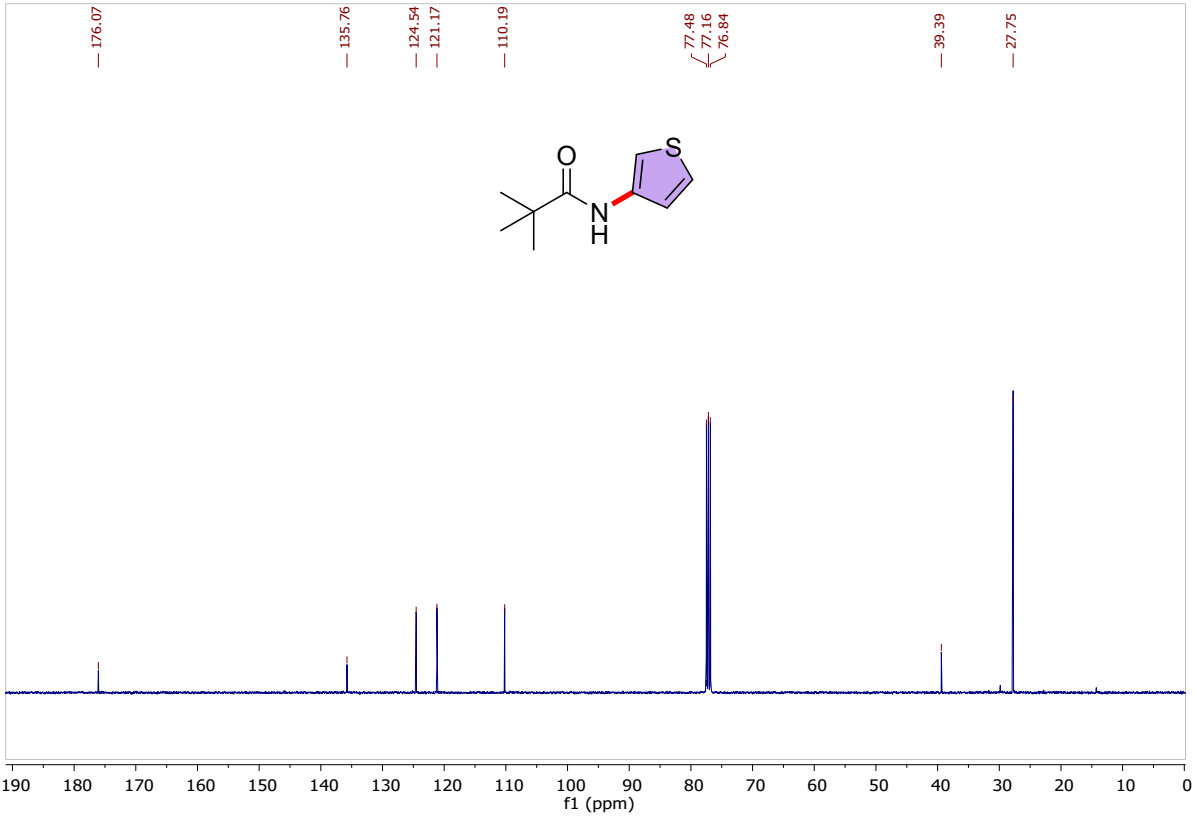
_N_-(pyrimidin-2-yl)pivalamide (35)



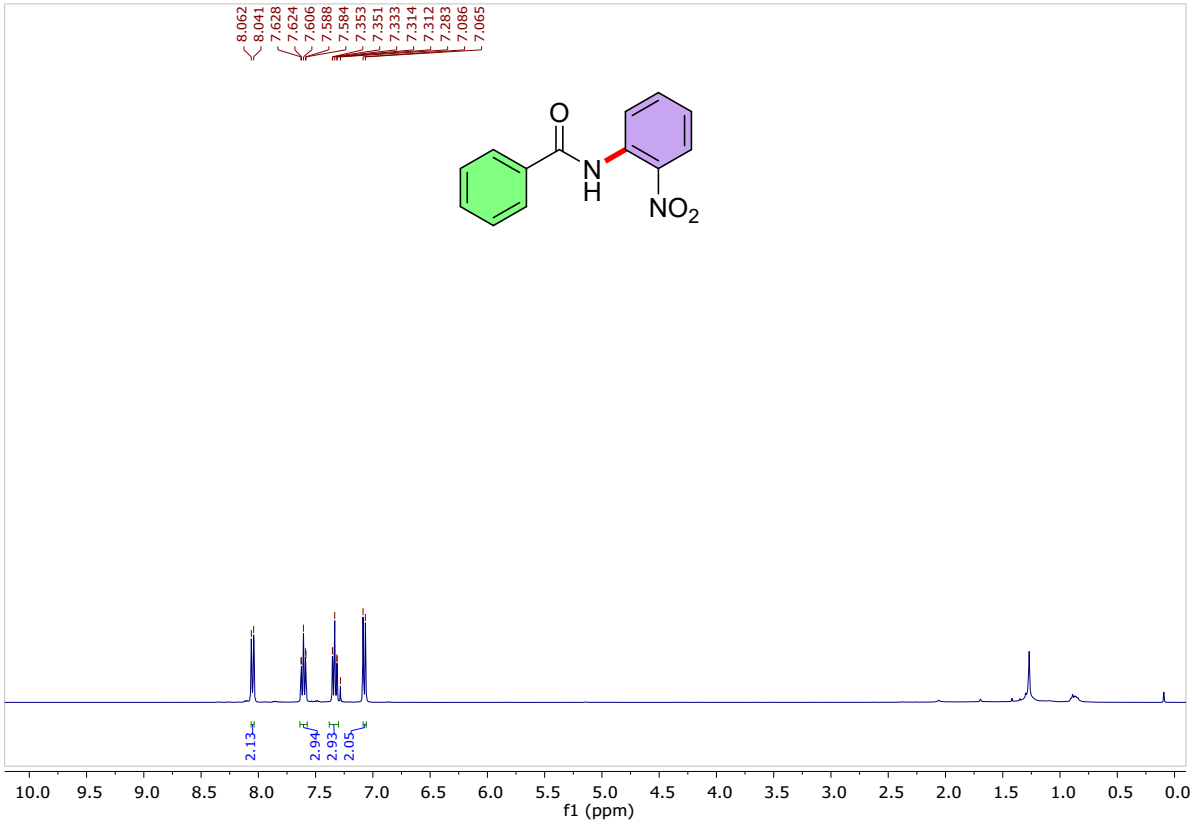


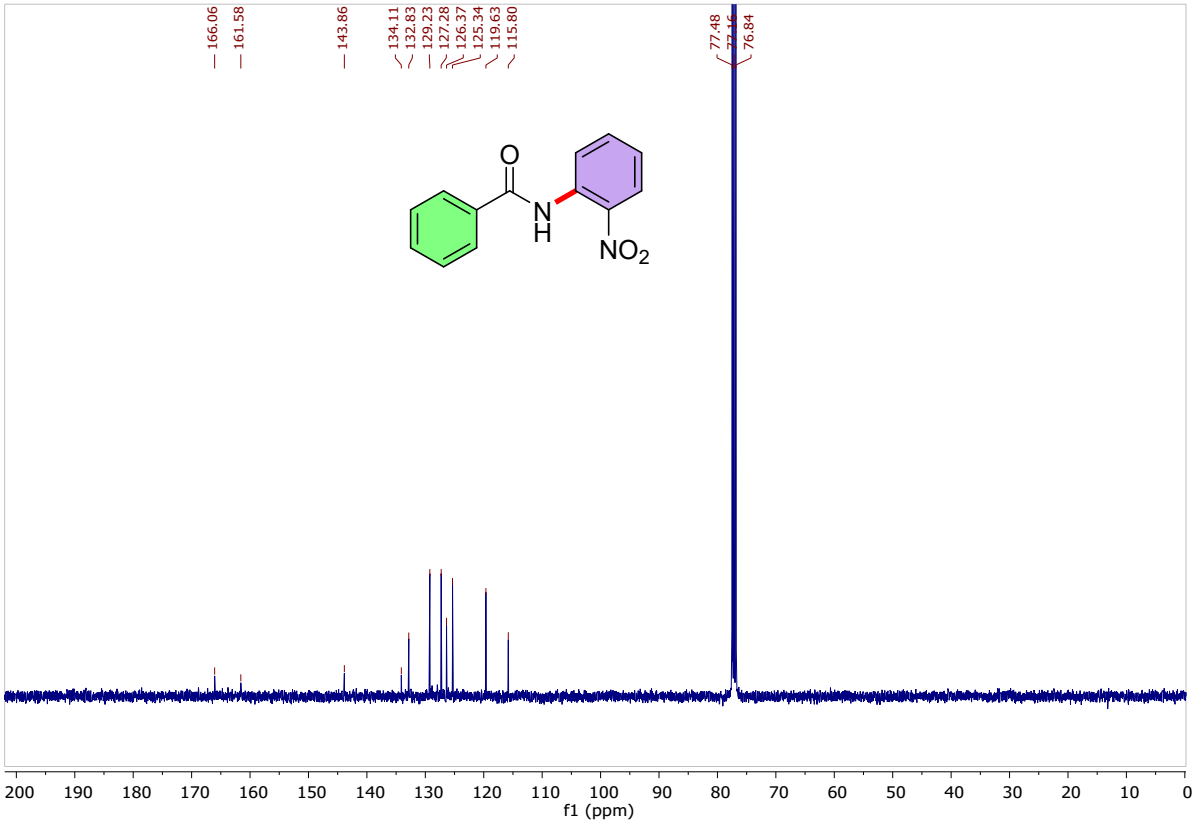
_N_-(thiophen-3-yl)pivalamide (36)



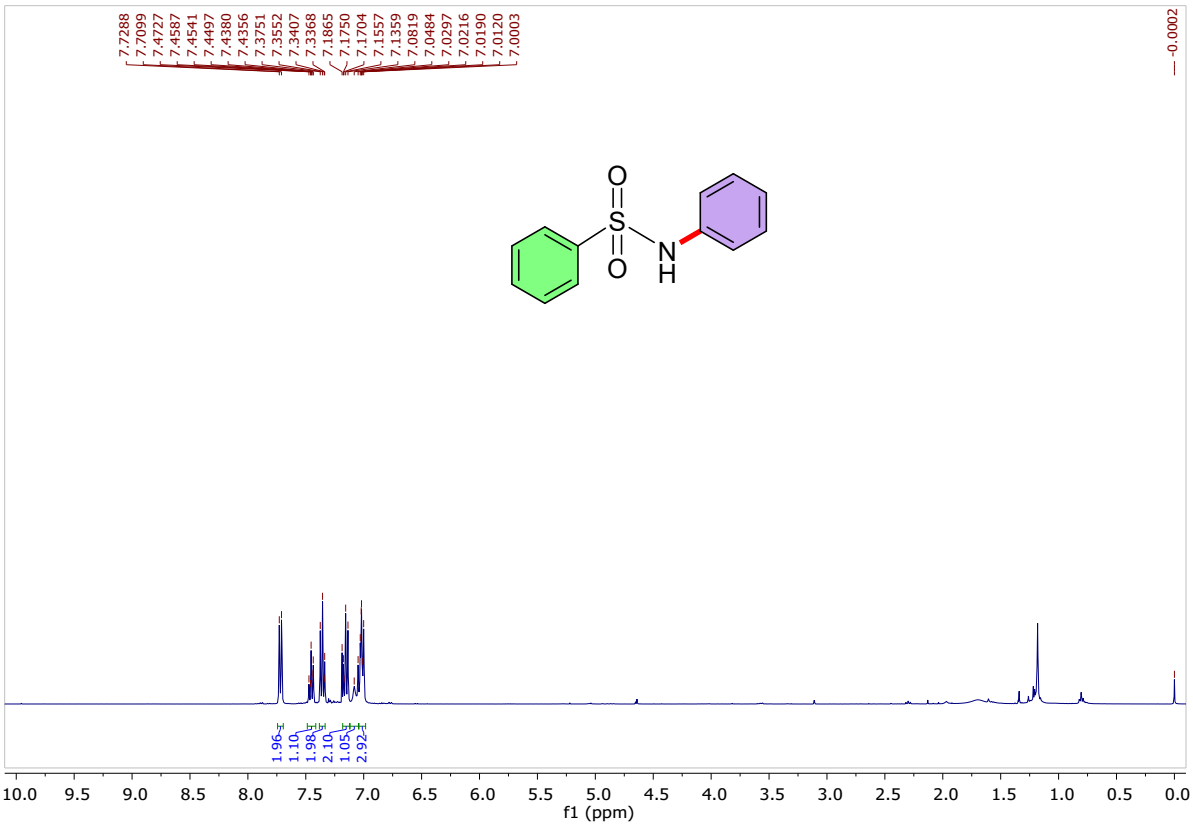


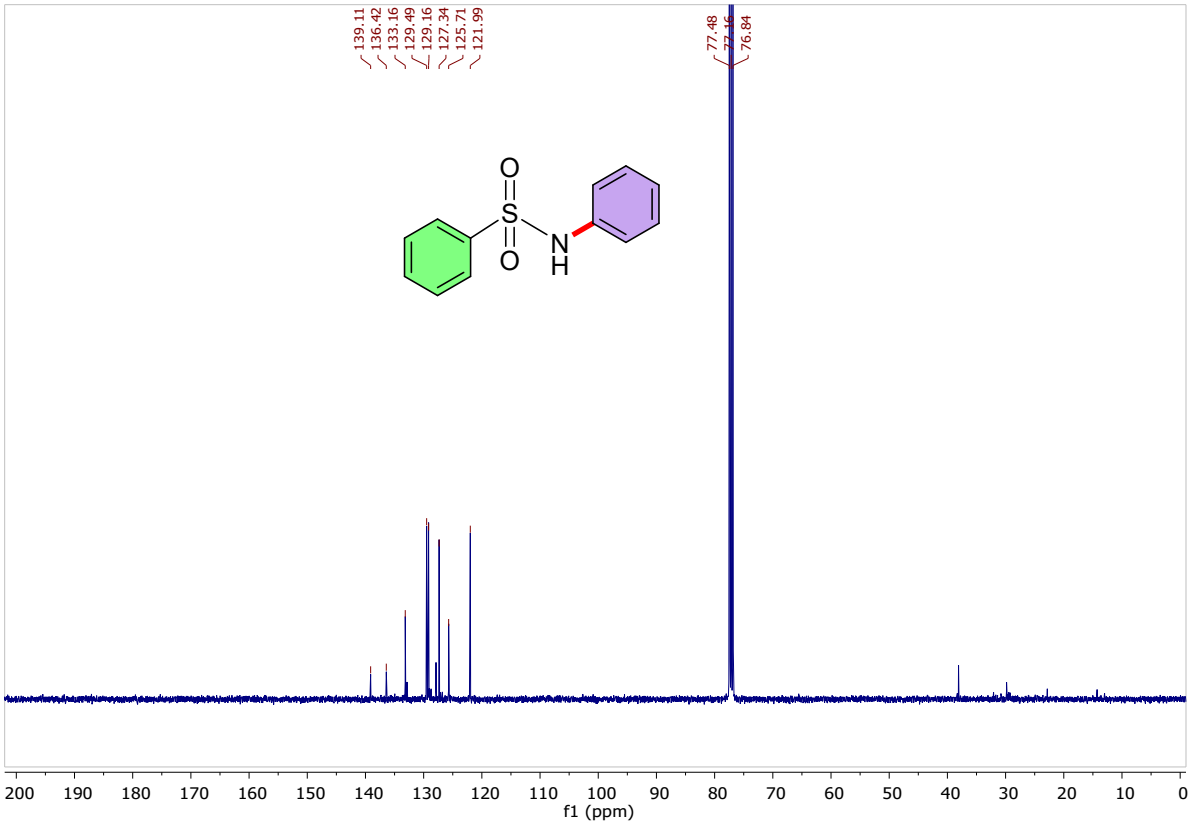
_N_-(2-nitrophenyl)benzamide (37)



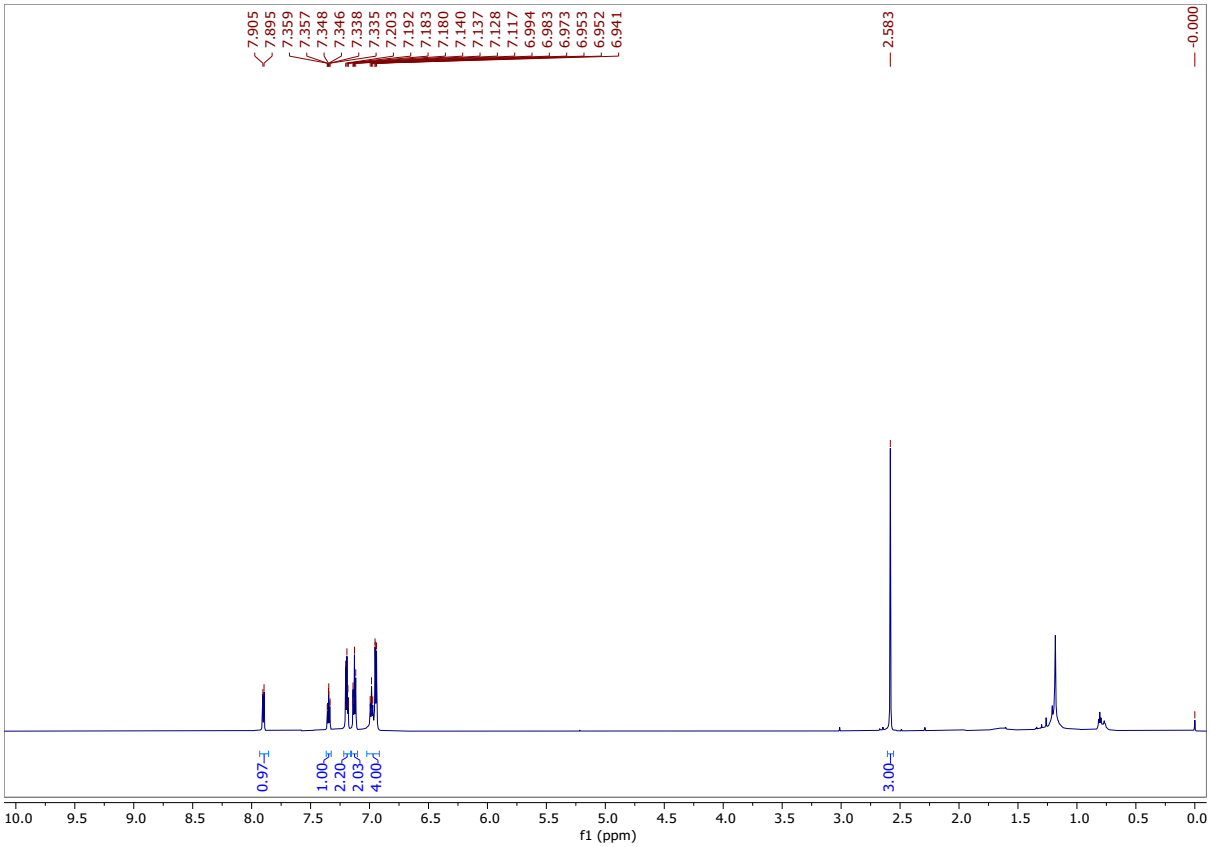


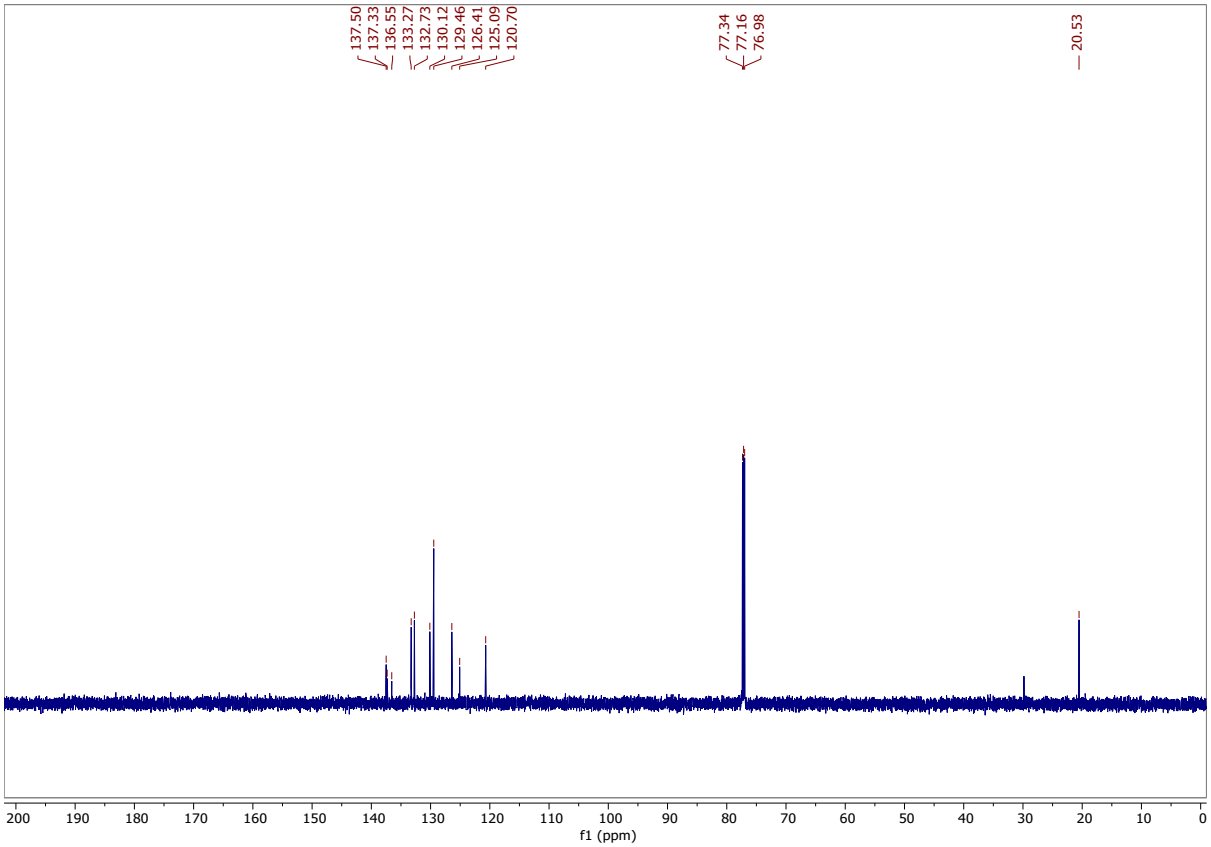
_N_-phenylbenzenesulfonamide (38):



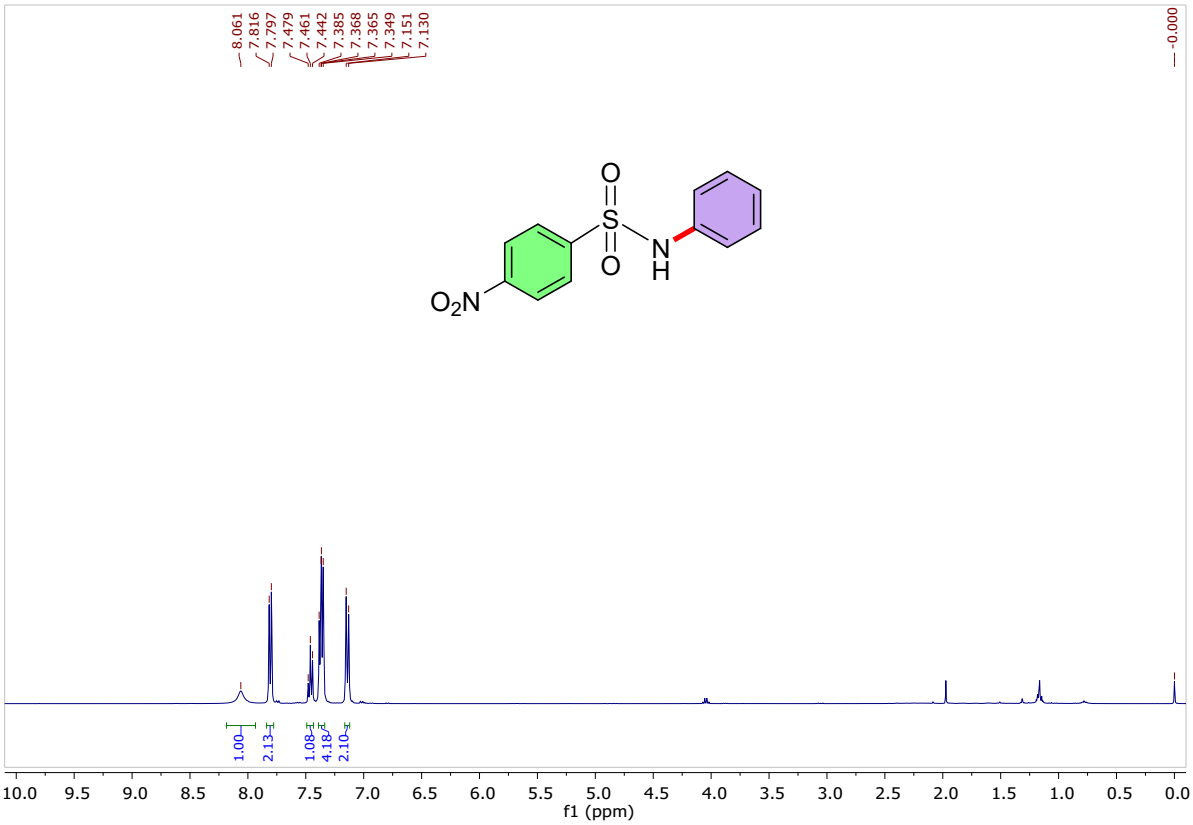


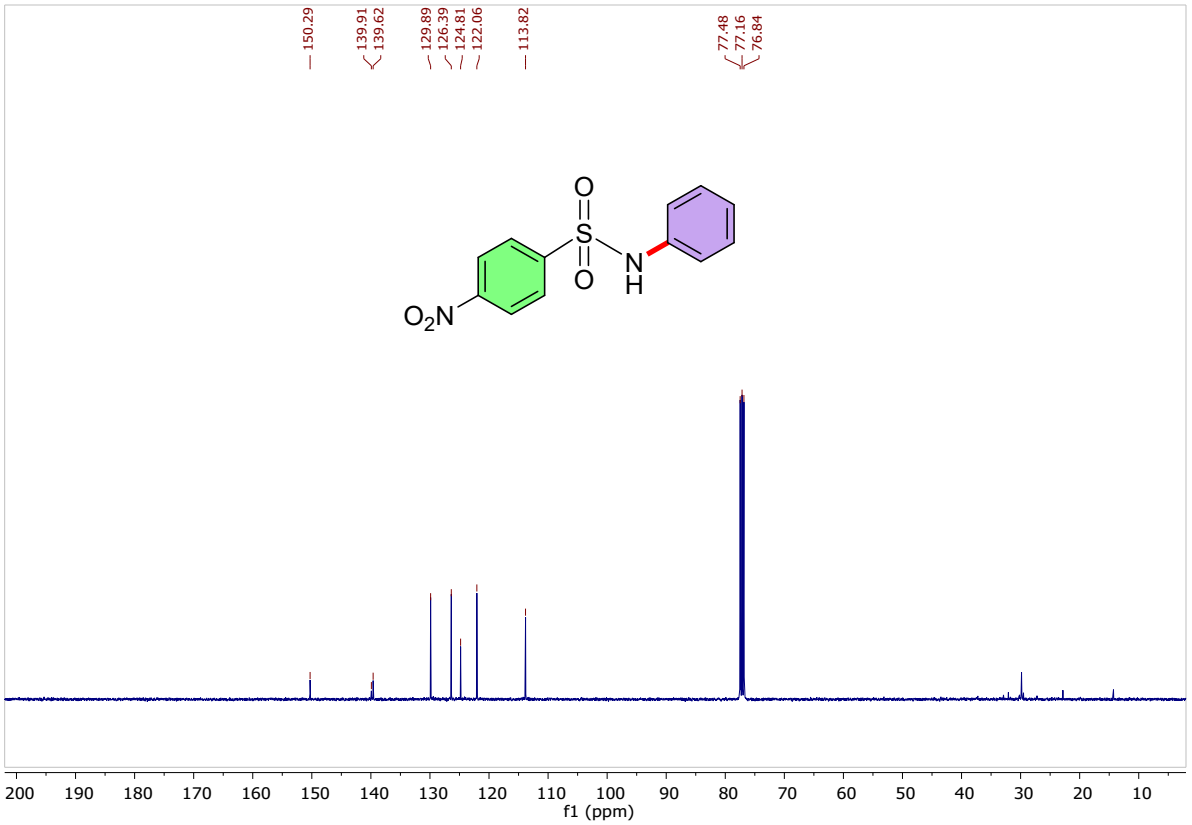
2-methyl-*N*-phenylbenzenesulfonamide (39):



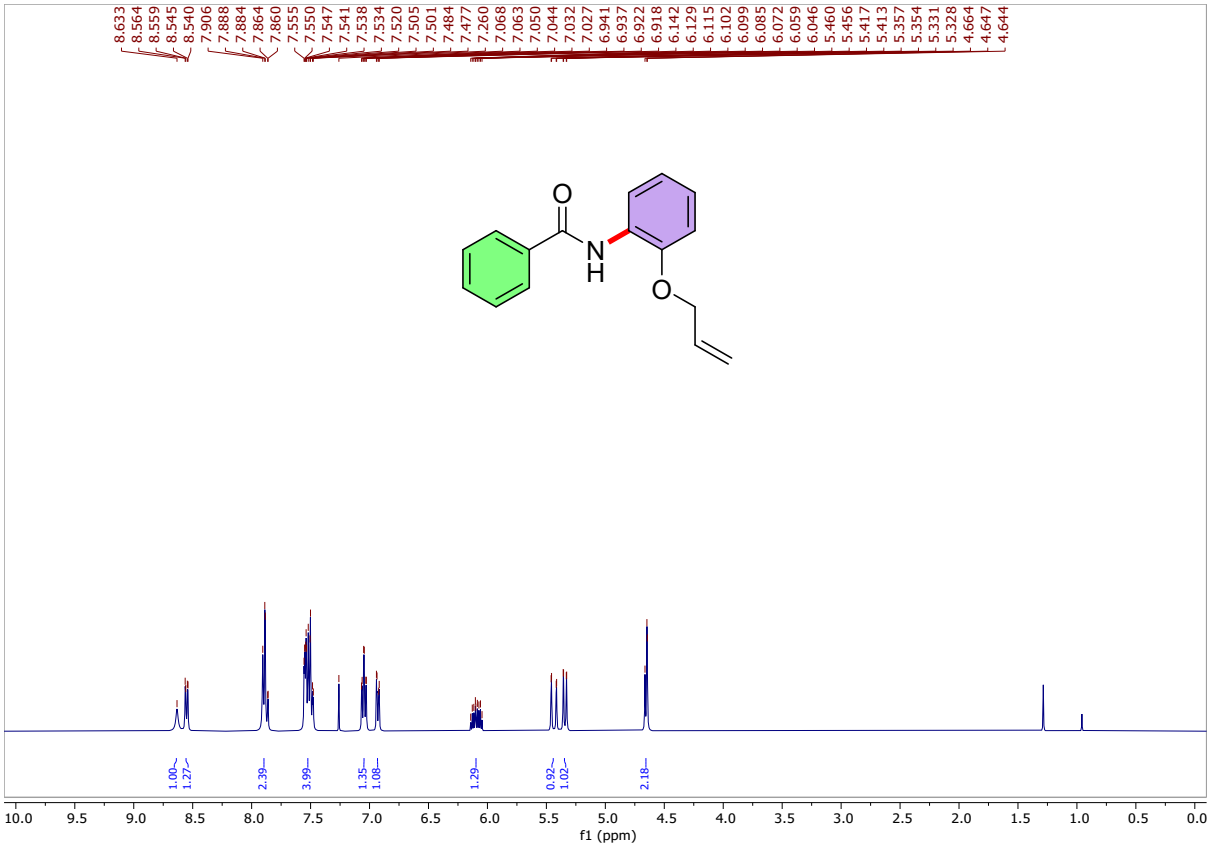


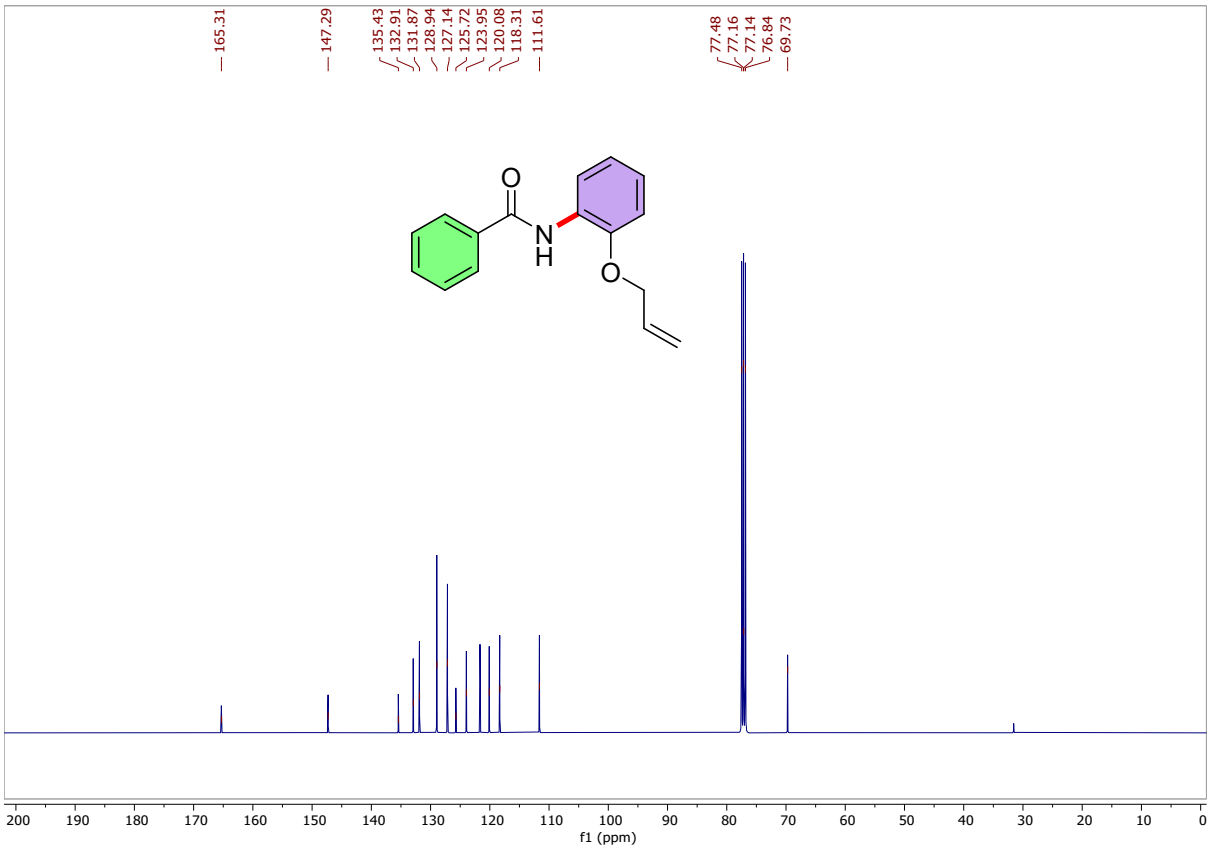
4-nitro-*N*-phenylbenzenesulfonamide (40):





_N_-(2-(allyloxy)phenyl)benzamide (41)


8.633
8.564
8.559
8.545
8.540
7.906
7.888
7.884
7.864
7.860
7.555
7.550
7.547
7.541
7.538
7.534
7.520
7.505
7.501
7.484
7.477
7.260
7.068
7.063
7.050
7.044
7.032
7.027
6.941
6.937
6.922
6.918
6.142
6.129
6.115
6.102
6.099
6.085
6.072
6.059
6.046
5.460
5.456
5.417
5.413
5.357
5.354
5.331
5.328
4.664
4.647
4.644
O
N
H
O
1.00
1.27
2.39
3.99
1.35
1.08
1.29
0.92
1.02
2.18
f1 (ppm)


165.31
147.29
135.43
132.91
131.87
128.94
127.14
125.72
123.95
120.08
118.31
111.61
77.48
77.16
77.14
76.84
69.73
O
N
H
O
f1 (ppm)

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Leonid N. TEN,3 Ki Hun PARK,1 and Kyu Young KANG