Supporting Information

1,2,3-Triazole-Boranes: Stable and Efficient Reagents for Ketone and Aldehyde Reductive Amination in Organic Solvents or in Water

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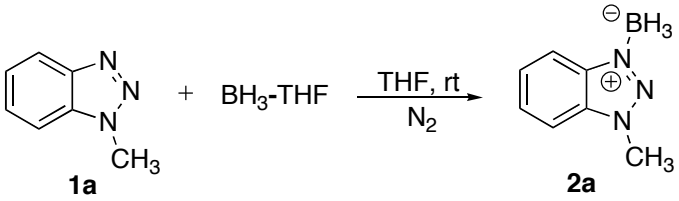
I. General Methods and materials:

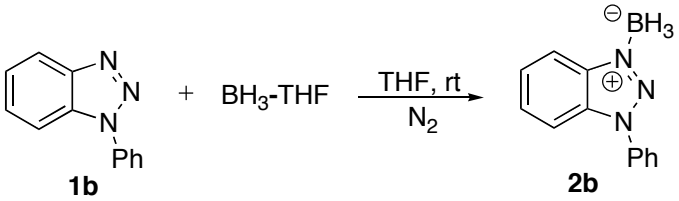
All of the reactions dealing with air and/or moisture-sensitive reactions were carried out under an atmosphere of nitrogen using oven/flame-dried glassware and standard syringe/septa techniques. Unless otherwise noted, all commercial reagents and solvents were obtained from the commercial provider and used without further purification. ^{1}H NMR and ^{13}C NMR spectra were recorded on Varian 600 MHz spectrometers. Chemical shifts were reported relative to internal tetramethylsilane (δ 0.00 ppm), $CDCl_3$ (δ 7.26 ppm) for ^{1}H and $CDCl_3$ (δ 77.0 ppm) for ^{13}C, CD_3OD (δ 4.87, 3.31 ppm) for ^{1}H and CD_3OD(δ 49.1 ppm) for ^{13}C. Flash column chromatography was performed on 230-430 mesh silica gel. Analytical thin layer chromatography was performed with precoated glass baked plates (250μ) and visualized by fluorescence and by charring after treatment with potassium permanganate stain. Melting points were measured on a Mel-Temp 1001D apparatus and uncorrected. HRMS were recorded on LTQ-FTUHRA spectrometer.

Triazoles **1a-1h** were synthesized according to the literature:
Liu, Y.; Yan, W.; Chen, Y., Petersen, J. L.; Shi, X. *Org. Lett.* **2008**, *10*, 5389-5392.

Representative Procedure for synthesis of 1,2,3-Triazole-Borane complexes:



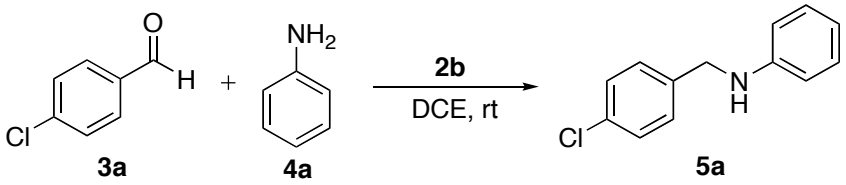
The N-1 methyl benzotriazole **1a** (1.331 g, 10 mmol, 1 equiv) was dissolved in dry THF (10 mL, 1.0 M) in a 50ml round bottom flask under N_2 atmosphere. To this solution was added BH_3-THF (11 mL, 1.0 M in THF, 1.1 equiv) drop wise by a syringe. The resulting solution was stirred at room temperature and checked by TLC. A white precipitate was formed in about 10 min. After the completion of the reaction, **2a** (1.470 g, 10 mmol, yield: 99%) was obtained by filtration as white solid.



The N-1 phenyl benzotriazole **1b** (1.952 g, 10 mmol, 1 equiv) was dissolved in dry THF (10 mL, 1.0 M) in a 50 mL round bottom flask under N_2 atmosphere. To this solution

was added BH_3-THF (11ml, 1.0 M in THF, 1.1 equiv) drop wise by a syringe. The resulting solution was stirred at room temperature and checked by TLC. When the reaction was completed, the resulting solution was concentrated and then added dry hexanes (10 mL), A white precipitate was formed immediately. **2b** (2.090 g, 10 mmol, yield: 99%) was obtained by filtration as white solid.

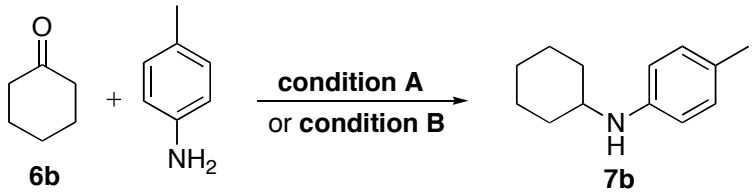
Representative Procedure for Reductive Amination of Aldehydes



3a **4a** **5a**

The 4-chlorobenzaldehyde **3a** (147.6 mg, 1.05 mmol, 1.05 equiv) and aniline **4a** (93.13 mg, 1 mmol, 1 equiv) were dissolved in DCE (4 mL, 0.25 M). To this solution was added **2b** (83.6 mg, 0.4 mmol, 0.4 equiv) at room temperature. The resulting mixture was then stirred and checked by TLC. After the completion of the reaction, the mixture was quenched with water (10 mL), concentrated and extracted with ethyl acetate (10 mL x 3). The combined organic layer was washed with brine and dried over with anhydrous Na_2SO_4. The solvent was removed under reduced pressure to give a residue. The residue was purified by flash silica gel chromatography to obtain **5a** (218.0 mg, 1 mmol, yield: 99%) as colorless oil.

Representative Procedure for Reductive Amination of Ketones



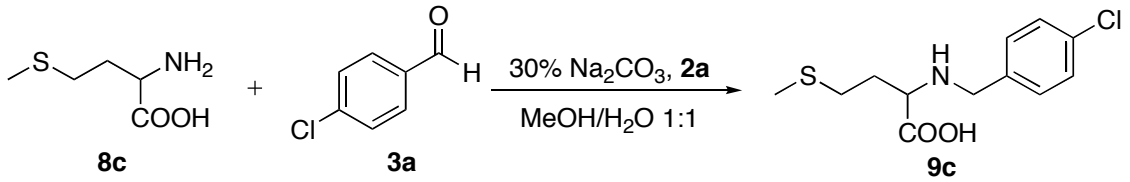
6b **7b**

Condition A: The cyclohexanone **6b** (127.6 mg, 1.3 mmol, 1.3 equiv), *p*-toluidine (107.2 mg, 1 mmol, 1 equiv) and AcOH (18 mg, 0.3 mmol, 0.3 equiv) were dissolved in DCE (4 mL, 0.25 M). To this solution was added the **2a** (117.6 mg, 0.8 mmol, 0.8 equiv) at room temperature. The resulting mixture was then stirred and checked by TLC. After the completion of the reaction, the mixture was quenched with water (10 mL), concentrated and extracted with ethyl acetate (10 mL x 3). The combined organic layer was washed with brine and dried over with anhydrous Na_2SO_4. The solvent was removed under reduced pressure to give a residue. The residue was purified by flash silica gel chromatography to obtain **7b** (189.1 mg, 1 mmol, yield: 99%) as white solid.

Condition B: The cyclohexanone **6b** (127.6 mg, 1.3 mmol, 1.3 equiv), *p*-toluidine (107.2

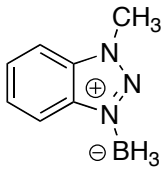
mg, 1 mmol, 1 equiv) were dissolved in DCE (4 mL, 0.25 M). To this solution was added the **2a** (88.2 mg, 0.6 mmol, 0.6 equiv) at room temperature. The resulting mixture was then stirred at 60°C and checked by TLC. After the reaction was completed, the mixture was cooled down and quenched with water (10 mL), concentrated and extracted with ethyl acetate (10 mL x 3). The combined organic layer was washed with brine and dried over with anhydrous Na_2SO_4. The solvent was removed under reduced pressure to give a residue, the residue was purified by flash silica gel chromatography to obtain **7b** (189.1 mg, 1 mmol, yield: 99%) as white solid.

Representative Procedure for Reductive Amination of Amino Acid



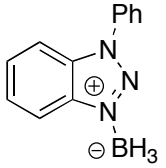
The methionine **8c** (149.2 mg, 1 mmol, 1 equiv) and Na_2CO_3 (31.8 mg, 0.3 mmol, 0.3 equiv) were dissolved in water (3 mL). To this solution was added 4-chlorobenzaldehyde **3a** (210.8 mg, 1.5 mmol, 1.5 equiv), methanol (2 mL) and **2a** (220.5 mg, 1.5 mmol, 1.5 equiv) successively at room temperature. The resulting mixture was then stirred and checked by TLC. After the completion of the reaction, the resulting mixture was filtered to remove the indissoluble solid (**1a**). The solvent of the filtered solution was removed to get a residue. The residue was then diluted with CH_2Cl_2 (5 mL) and water (5 mL). 0.1 M HCl solution was added to the solution until pH = 7, then a white solid was obtained by filtration of the mixture. **9c** was purified by recrystallization ($MeOH/H_2O$ = 3:1) from the white solid as white crystal (232 mg, 0.85 mmol, yield: 85%).

II. Compound Characterization:



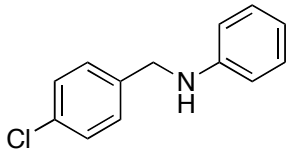
2a

1-methyl benzotriazole borane (2a): m.p. 187.2-188.9 °C. ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.17-8.15 (m, 1H), 7.68-7.64 (m, 2H), 7.63-7.58 (m, 1H), 4.37 (s, 3H), 2.73-2.54 (br m, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 139.7, 134.1, 129.3, 127.3, 118.0, 110.2, 35.7. HRMS Calculated for $C_7H_{11}BN_3$ $[M+H]^+$: 147.10769, Found: 147.10763.



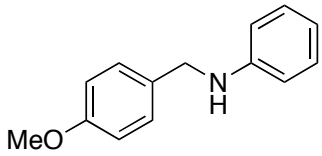
2b

1-phenyl benzotriazole borane (2b): m.p. 91.9-92.6 °C. ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.31 (d, J = 8.4 Hz, 1H), 7.81-7.77 (m, 3H), 7.73-7.70 (m, 1H), 7.69-7.66 (m, 3H), 7.64-7.62 (m, 1H), 2.88-2.65 (br m, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 140.3, 135.3, 133.2, 130.5, 130.2, 127.6, 123.6, 118.9, 118.7, 111.3. HRMS Calculated for $C_{12}H_{13}BN_3$ $[M+H]^+$: 209.04728, Found: 209.04723.



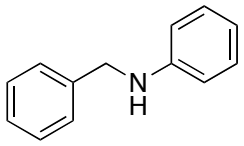
5a

***N*-(4-chlorobenzyl)benzenamine (5a). 5a** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 30:1) as colorless oil, yield: 99%. m.p. 110.1-112.3 °C. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.36-7.32 (m, 4H), 7.24-7.21 (m, 2H), 6.80-6.77 (m, 1H), 6.66-6.64 (m, 2H), 4.35 (s, 2H), 4.09 (br, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 147.8, 138.0, 132.8, 129.2, 128.7, 128.6, 117.7, 112.8, 47.5. HRMS Calculated for $C_{13}H_{13}ClN$ $[M+H]^+$: 218.07310, Found: 218.07318.



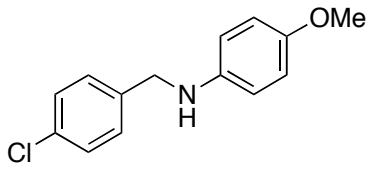
5b

***N*-(4-methoxybenzyl)benzenamine (5b). 5b** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 30:1) as colorless oil, yield: 99%. m.p. 112.8-114.0 °C. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.33-7.31 (m, 2H), 7.22-7.20 (m, 2H), 6.93-6.91 (m, 2H), 6.77-6.74 (m, 1H), 6.68-6.66 (m, 2H), 4.28 (s, 2H), 4.03 (br, 1H), 3.83 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 158.8, 148.1, 131.3, 129.2, 128.8, 117.5, 114.0, 112.9, 55.2, 47.8. HRMS Calculated for $C_{14}H_{16}NO$ $[M+H]^+$: 214.12264, Found: 214.12278.



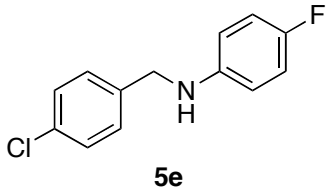
5c

***N*-benzylbenzenamine (5c). 5c** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 50:1) as white solid, yield: 99%. m.p. 67.3-68.2 °C.^{1}H NMR (600 MHz, $CDCl_3$): δ 7.43-7.39 (m, 4H), 7.35-7.32 (t, *J* = 7.2Hz, 1H), 7.25-7.22 (m, 2H), 6.80-6.77 (m, 1H), 6.70-6.69 (m, 2H), 4.38 (s, 2H), 4.09 (br, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 148.1, 139.4, 129.2, 128.6, 127.5, 127.1, 117.6, 112.8, 48.3. HRMS Calculated for $C_{13}H_{14}N$ $[M+H]^+$: 184.11207, Found: 184.11220.



5d

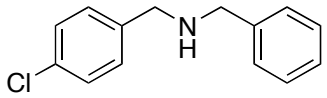
***N*-(4-chlorobenzyl)-4-methoxybenzenamine (5d). 5d** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 30:1) as white solid, yield: 99%. m.p. 156.1-157.8 °C.^{1}H NMR (600 MHz, $CDCl_3$): δ 7.30 (s, 4H), 6.77-6.76 (m, 2H), 6.60-6.58 (m, 2H), 4.26 (s, 2H), 3.74 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 151.4, 141.0, 139.2, 136.5, 129.0, 128.9, 115.2, 114.6, 56.0, 48.9. HRMS Calculated for $C_{14}H_{15}ClNO$ $[M+H]^+$: 248.08367, Found: 248.08373.



5e

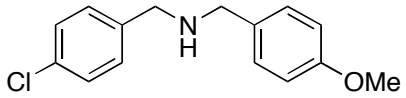
***N*-(4-chlorobenzyl)-4-fluorobenzenamine (5e). 5e** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 30:1) as white solid, yield: 99%. m.p. 123.1-124.6 °C.^{1}H NMR (600 MHz, $CDCl_3$): δ 7.32-7.28 (m, 4H), 6.90-6.87 (m, 2H), 6.56-

6.54 (m, 2H), 4.27 (s, 2H), 4.10 (br, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 156.8, 155.3, 144.0, 137.5, 133.0, 128.7, 115.7, 113.8, 48.3. HRMS Calculated for $C_{13}H_{12}ClFN$ $[M+H]^+$: 236.06368, Found: 236.06398.



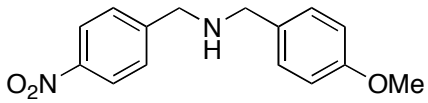
5f

***N*-(4-chlorobenzyl)(phenyl)methanamine (5f). 5f** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 5:1) as white solid, yield: 95%. m.p. 121.3-122.2 ^{o}C. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.35-7.26 (m, 8H), 3.80 (s, 2H), 3.78 (s, 2H), 1.76 (br, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 140.0, 138.7, 132.6, 129.5, 128.5, 128.4, 128.1, 127.0, 53.0, 52.3. HRMS Calculated for $C_{14}H_{15}ClN$ $[M+H]^+$: 232.08875, Found: 232.08887.



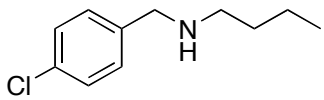
5g

***N*-(4-chlorobenzyl)(4-methoxyphenyl)methanamine (5g). 5g** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 6:1) as white solid, yield: 96%. m.p. 168.1-170.2 ^{o}C. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.28-7.25 (m, 4H), 7.24-7.22 (m, 2H), 6.86-6.85 (m, 2H), 3.79 (s, 3H), 3.76 (s, 2H), 3.75(s, 2H), 1.52 (br, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 158.6, 138.9, 132.5, 132.2, 129.4, 129.2, 128.4, 113.8, 55.2, 52.5, 52.2. HRMS Calculated for $C_{15}H_{17}ClNO$ $[M+H]^+$: 262.09932, Found: 262.09947.



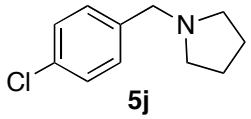
5h

***N*-(4-nitrobenzyl)(4-methoxyphenyl)methanamine (5h). 5h** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 8:1) as white solid, yield: 82%. m.p. 179.0-181.2 ^{o}C. ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.18-8.17 (m, 2H), 7.53-7.51 (m, 2H), 7.26-7.24 (m, 2H), 6.88-6.87(m, 2H), 3.89 (s, 2H), 3.80 (s, 3H), 3.75(s, 2H), 1.64 (br, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 158.8, 148.2, 147.0, 131.9, 129.3, 128.6, 123.6, 113.9, 55.3, 52.6, 52.2. HRMS Calculated for $C_{15}H_{17}N_2O_3$ $[M+H]^+$: 273.12337, Found: 273.12350.



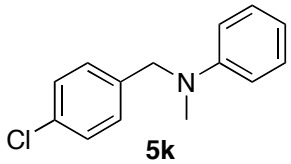
5i

***N*-(4-chlorobenzyl)butan-1-amine (5i). 5i** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 3:1) as colorless oil, yield: 91%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.30-7.26 (m, 4H), 3.76 (s, 2H), 2.61 (t, *J* = 7.2Hz, 2H), 1.81 (br, 1H), 1.53-1.48 (m, 2H), 1.37-1.33 (m, 2H), 0.91 (t, *J* = 7.2Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 148.4, 147.0, 128.6, 123.6, 53.2, 49.2, 32.2, 20.4, 13.9. HRMS Calculated for $C_{11}H_{17}ClN$ $[M+H]^+$: 198.10440, Found: 198.10446.



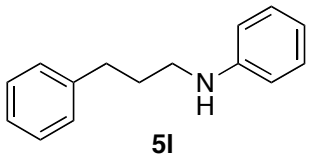
5j

1-(4-chlorobenzyl)pyrrolidine (5j). 5j was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 3:1) as yellow oil, yield: 95%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.30-7.23 (m, 4H), 3.55 (s, 2H), 2.95 (br, 1H), 2.47-2.45 (m, 4H), 1.77-1.74 (m, 4H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 139.6, 137.7, 130.2, 128.3, 59.9, 54.0, 23.4. HRMS Calculated for $C_{11}H_{15}ClN$ $[M+H]^+$: 196.08875, Found: 196.08874.



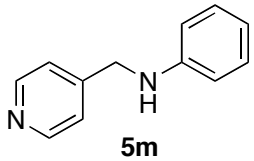
5k

***N*-(4-chlorobenzyl)-*N*-methylbenzenamine (5k). 5k** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 30:1) as yellow oil, yield: 99%. ^{1}H NMR (600 MHz, $CDCl_3$): 7.30-7.28 (m, 2H), 7.25-7.22 (m, 2H), 7.18-7.17 (m, 2H), 6.75-6.74 (m, 3H), 4.50 (s, 2H), 3.01 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 149.5, 137.5, 132.6, 129.2, 128.7, 128.1, 116.9, 112.5, 56.2, 38.5. HRMS Calculated for $C_{14}H_{15}ClN$ $[M+H]^+$: 232.08875, Found: 232.08880.



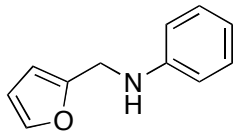
5l

***N*-(3-phenylpropyl)benzenamine (5l). 5l** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 35:1) as yellow oil, yield: 99%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.19-7.17 (m, 2H), 7.10-7.03 (m, 5H), 6.60-6.57 (m, 1H), 6.46-6.44 (m, 2H), 3.44 (b, 1H), 3.01 (t, *J* = 7.2 Hz, 2H), 2.60 (t, *J* = 7.8 Hz, 2H), 1.84-1.79 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 148.3, 141.6, 129.1, 128.4, 128.3, 125.9, 117.1, 112.7, 43.3, 33.3, 31.0. HRMS Calculated for $C_{15}H_{18}N$ $[M+H]^+$: 212.14338, Found: 212.14338.



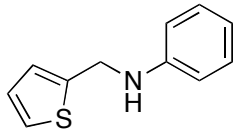
5m

***N*-((pyridin-4-yl)methyl)benzenamine (5m). 5m** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 1:1) as yellow solid, yield: 99%. m.p. 128.1-130.2 ^{o}C.^{1}H NMR (600 MHz, $CDCl_3$): δ 8.63 (s, 1H), 8.53 (d, *J* = 4.8 Hz, 1H), 7.70-7.69 (m, 1H), 7.27-7.25 (m, 1H), 7.18-7.16 (m, 2H), 6.76-6.73 (m, 1H), 6.64-6.62 (m, 2H), 4.36 (s, 2H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 149.0, 148.6, 147.6, 129.3, 123.5, 118.0, 112.9, 45.80. HRMS Calculated for $C_{12}H_{13}N_2$ $[M+H]^+$: 185.10732, Found: 185.10743.



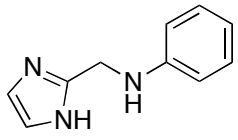
5n

***N*-((furan-2-yl)methyl)benzenamine (5n). 5n** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v=30:1) as yellow oil, yield: 99%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.41 (t, *J* = 1.2 Hz, 1H), 7.25-7.22 (m, 2H), 6.81-6.78 (m, 1H), 6.73-6.71 (m, 2H), 6.37-6.36 (m, 1H), 6.28-6.27 (m, 1H), 4.35 (s, 2H), 4.02 (br, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 152.7, 147.6, 141.8, 129.2, 118.0, 113.1, 110.3, 106.9, 41.4. HRMS Calculated for $C_{11}H_{12}NO$ $[M+H]^+$: 174.09134, Found: 174.09147.



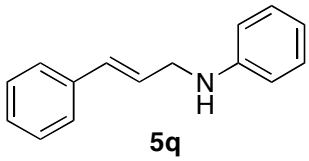
5o

***N*-((thiophen-2-yl)methyl)benzenamine (5o). 5o** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 30:1) as colorless oil, yield: 99%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.24-7.21 (m, 3H), 7.05-7.04 (m, 1H), 7.00-6.99 (m, 1H), 6.80-6.77 (m, 1H), 6.71-6.70 (m, 2H), 4.53 (s, 2H), 4.14 (br, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 147.5, 142.8, 129.2, 126.8, 125.0, 124.6, 118.1, 113.2, 43.5. HRMS Calculated for $C_{11}H_{12}NS$ $[M+H]^+$: 190.06850, Found: 190.06860.



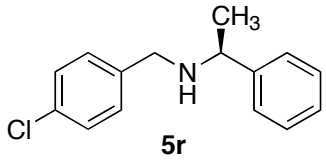
5p

***N*-((1H-imidazol-2-yl)methyl)benzenamine (5p). 5p** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 4:1) as white solid, yield: 93%. m.p. 195.0-197.2 ^{o}C ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.13-7.11 (m, 2H), 6.97 (s, 2H), 6.74-6.71 (m, 1H), 6.54-6.52 (m, 2H), 4.35 (s, 2H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 147.5, 146.6, 129.3, 121.9, 118.4, 113.1, 42.3. HRMS Calculated for $C_{10}H_{12}N_3$ $[M+H]^+$: 174.10257, Found: 174.10256.



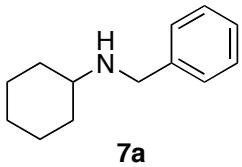
5q

***N*-cinnamylbenzenamine (5q). 5q** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 50:1) as yellow oil, yield: 95%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.42-7.41 (m, 2H), 7.37-7.34 (m, 2H), 7.29-7.22 (m, 3H), 6.80-6.77 (m, 1H), 6.73-6.71 (m, 2H), 6.66 (d, J = 15.6 Hz, 1H), 6.37 (dt, J = 15.6 Hz; 6.0 Hz, 1H), 3.97 (dd, J = 6.0 Hz; 1.8 Hz, 2H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 147.9, 136.8, 131.5, 129.2, 128.5, 127.5, 127.0, 126.3, 117.6, 113.1, 46.2. HRMS Calculated for $C_{15}H_{16}N$ $[M+H]^+$: 210.12773, Found: 210.12785.



5r

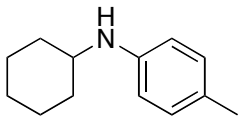
(*S*)-N-(4-chlorobenzyl)-1-phenylethanamine (5r). 5r was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 20:1) as colorless oil, yield: 95%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.29-7.28 (m, 4H), 7.21-7.16 (m, 5H), 3.74 (q, J = 6.6 Hz, 1H), 3.57 (d, J = 13.2 Hz, 1H), 3.50 (d, J = 13.2 Hz, 1H), 1.33 (d, J = 6.6 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 132.9, 129.9, 129.7, 128.6, 128.5, 127.2, 126.8, 123.0, 57.5, 50.6, 24.1. HRMS Calculated for $C_{15}H_{17}ClN$ $[M+H]^+$: 246.10440, Found: 246.10456.



7a

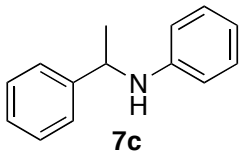
***N*-benzylcyclohexanamine (7a). 7a** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 8:1) as yellow oil, yield: 95%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.33-7.30 (m, 4H), 7.24-7.22 (m, 1H), 3.81 (s, 2H), 2.52-2.47 (m, 1H), 1.93-1.91 (m, 2H), 1.76-1.72 (m, 2H), 1.63-1.60 (m, 1H), 1.30-1.10 (m, 5H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 141.3, 128.6, 128.3, 127.0, 56.4, 33.8, 26.5, 25.2. HRMS Calculated for

$C_{13}H_{20}N$ $[M+H]^+$: 190.15903, Found: 190.15904.



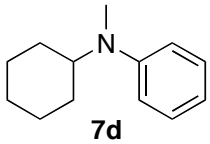
7b

***N*-cyclohexyl-4-methylbenzenamine (7b). 7b** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 50:1) as white solid, yield: 99%. m.p. 62.1-64.6 ^oC. ^1H NMR (600 MHz, $CDCl_3$): δ 6.99-6.98 (m, 2H), 6.55-6.53 (m, 2H), 3.37 (br, 1H), 3.26-3.22 (m, 1H), 2.25 (s, 3H), 2.08-2.06 (m, 2H), 1.79-1.76 (m, 2H), 1.68-1.65 (m, 1H), 1.41-1.35 (m, 2H), 1.27-1.21 (m, 1H), 1.18-1.12 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 145.4, 130.0, 126.3, 113.7, 52.3, 33.8, 26.2, 25.3, 20.6. HRMS Calculated for $C_{13}H_{20}N$ $[M+H]^+$: 190.15903, Found: 190.15902.



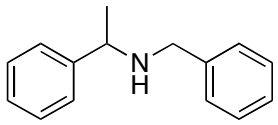
7c

***N*-(1-phenylethyl)benzenamine (7c). 7c** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 30:1) as colorless oil, yield: 99%. ^1H NMR (600 MHz, $CDCl_3$): δ 7.40-7.39 (m, 2H), 7.36-7.33 (m, 2H), 7.26-7.24 (m, 1H), 7.13-7.10 (m, 2H), 6.69-6.66 (m, 1H), 6.55-6.54 (m, 2H), 4.53-4.50 (m, 1H), 4.14 (br, 1H), 1.55 (d, J = 6.9 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 147.2, 145.1, 129.1, 128.6, 126.8, 125.8, 117.3, 113.4, 53.5, 24.9. HRMS Calculated for $C_{14}H_{16}N$ $[M+H]^+$: 198.12773, Found: 198.12788.



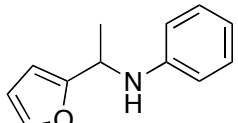
7d

***N*-cyclohexyl-*N*-methylbenzenamine (7d). 7d** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 25:1) as colorless oil, yield: 99%. ^1H NMR (600 MHz, $CDCl_3$): δ 7.25-7.22 (m, 2H), 6.80-6.78 (m, 2H), 6.70-6.68 (m, 1H), 3.60-3.55 (m, 1H), 2.78 (s, 3H), 1.86-1.79 (m, 4H), 1.71-1.68 (m, 1H), 1.55 (br, 1H), 1.50-1.43 (m, 2H), 1.41-1.33 (m, 2H), 1.18-1.11 (m, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 150.0, 129.1, 116.2, 113.2, 58.2, 31.1, 30.0, 26.2, 25.9. HRMS Calculated for $C_{13}H_{20}N$ $[M+H]^+$: 190.15903, Found: 190.15902.



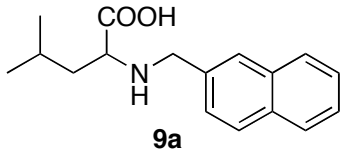
7e

***N*-benzyl-1-phenylethanamine (7e). 7e** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 8:1) as colorless oil, yield: 87%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.40-7.25 (m, 10H), 3.84 (q, *J* = 6.6 Hz, 1H), 3.79 (d, *J* = 13.2 Hz, 1H), 3.62 (d, *J* = 13.2 Hz, 1H), 1.73 (br, 1H), 1.40 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 145.5, 140.6, 128.4, 128.3, 128.1, 126.9, 126.8, 126.7, 57.5, 51.6, 24.4. HRMS Calculated for $C_{15}H_{18}N$ $[M+H]^+$: 212.14338, Found: 212.14339.



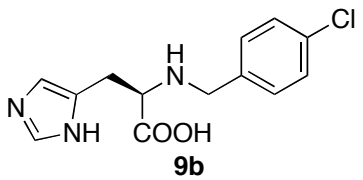
7f

***N*-(1-(furan-2-yl)ethyl)benzenamine (7f). 7f** was purified by flash silica gel chromatography (Hexane-EtOAc, v/v = 25:1) as yellow oil, yield: 96%. ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.31 (d, *J* = 1.2 Hz, 1H), 7.14 (m, 2H), 6.69 (t, *J* = 7.2 Hz, 1H), 6.61 (d, *J* = 7.8 Hz, 2H), 6.27-6.26 (m, 1H), 6.14 (d, *J* = 3.0 Hz, 1H), 4.62 (q, *J* = 6.6 Hz, 1H), 3.84 (br, 1H), 1.53 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$): δ 157.2, 147.0, 141.4, 129.1, 117.7, 113.4, 110.0, 105.0, 47.3, 20.8. HRMS Calculated for $C_{12}H_{14}NO$ $[M+H]^+$: 188.10699, Found: 188.10702.



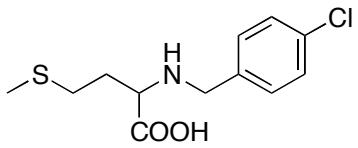
9a

2-((naphthalene-3-yl)methylamino)-4-methylpentanoic acid (9a). 9a was purified by recrystalization as white solid, yield: 65%. ^{1}H NMR (600 MHz, CD_3OD): δ 8.33 (d, *J* = 8.4 Hz, 1H), 7.97 (dd, *J* = 16.2 Hz; 8.4 Hz, 2H), 7.70-7.65 (m, 2H), 7.60-7.53 (m, 2H), 4.76 (d, *J* = 13.2 Hz, 1H), 4.54 (d, *J* = 13.2 Hz, 1H), 3.66 (dd, *J* = 8.4 Hz; 6.0 Hz, 1H), 1.87-1.77 (m, 2H), 1.63-1.58 (m, 1H), 1.00 (d, *J* = 6.6 Hz, 3H), 0.91 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR (150 MHz, CD_3OD): δ 135.4, 133.1, 131.4, 130.7, 129.9, 128.4, 127.5, 126.4, 124.4, 63.2, 41.2, 26.1, 23.2, 22.5. HRMS Calculated for $C_{17}H_{22}NO_2$ $[M+H]^+$: 272.16451, Found: 272.16461.



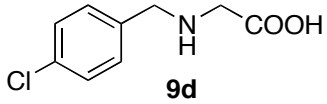
9b

(*S*)-2-(4-chlorobenzylamino)-3-(1*H*-imidazol-5-yl) propanoic acid (9b). 9b was purified by recrystalization as white solid, yield: 65%. ^{1}H NMR (600 MHz, CD_3OD): δ 7.69 (d, *J* = 1.2 Hz, 1H), 7.48-7.46 (m, 2H), 7.44-7.42 (m, 2H), 6.98 (d, *J* = 1.2 Hz, 1H), 4.23 (d, *J* = 13.2 Hz, 1H), 4.16 (d, *J* = 13.2 Hz, 1H), 3.73 (dd, *J* = 7.8 Hz; 4.8 Hz, 1H), 3.23 (dd, *J* = 15.6, 4.8 Hz, 1H), 3.08 (dd, *J* = 15.6, 4.8 Hz, 1H). ^{13}C NMR (150 MHz, CD_3OD): δ 172.8, 136.4, 136.3, 135.5, 132.6, 132.3, 130.2, 116.7, 63.6, 50.6, 49.6, 28.3. HRMS Calculated for $C_{13}H_{15}ClN_3O_2$ $[M+H]^+$: 280.08473, Found: 280.08487.



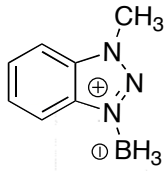
9c

2-(4-chlorobenzylamino)-4-(methylthio)butanoic acid (9d). 9d was purified by recrystalization as white solid, yield: 65%. ^{1}H NMR (600 MHz, $CDCl_3$ with CF_3COOH): δ 7.43 (d, *J* = 8.4 Hz, 2H), 7.34 (d, *J* = 8.4 Hz, 2H), 4.40 (d, *J* = 12.6, 1H), 4.32 (d, *J* = 12.6, 1H), 4.27 (br, 1H), 2.70 (br, 2H), 2.36(br, 3H), 2.12 (br, 2H). ^{13}C NMR (150 MHz, $CDCl_3$ with CF_3COOH): δ 137.6, 131.5, 130.3, 126.9, 59.2, 51.4, 30.0, 27.6, 15.1. HRMS Calculated for $C_{12}H_{17}ClNO_2S$ $[M+H]^+$: 274.06630, Found: 274.06636.

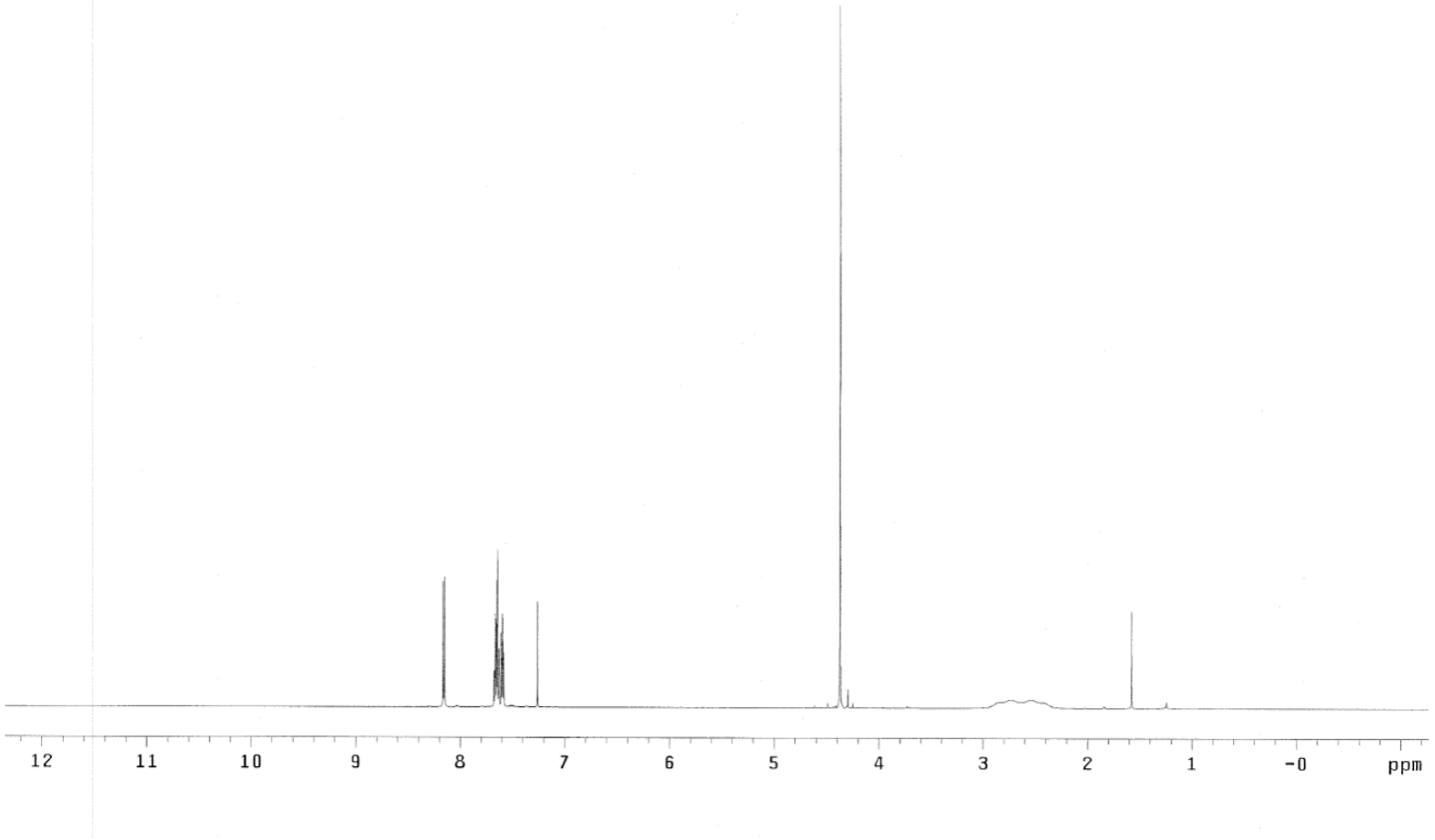


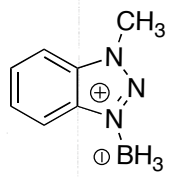
9d

2-(4-chlorobenzylamino)acetic acid (9d). 9d was purified by recrystalization as white solid, yield: 55%. ^{1}H NMR (600 MHz, CD_3OD): δ 7.42-7.40 (m, 2H), 7.36-7.35 (m, 2H), 3.96 (s, 2H), 3.29 (s, 2H). ^{13}C NMR (150 MHz, CD_3OD): δ 136.2, 135.2, 132.5, 129.9, 58.4, 54.9. HRMS Calculated for $C_9H_{11}ClNO_2$ $[M+H]^+$: 200.04728, Found: 200.04723.

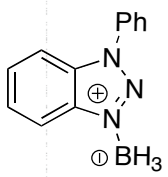


2a

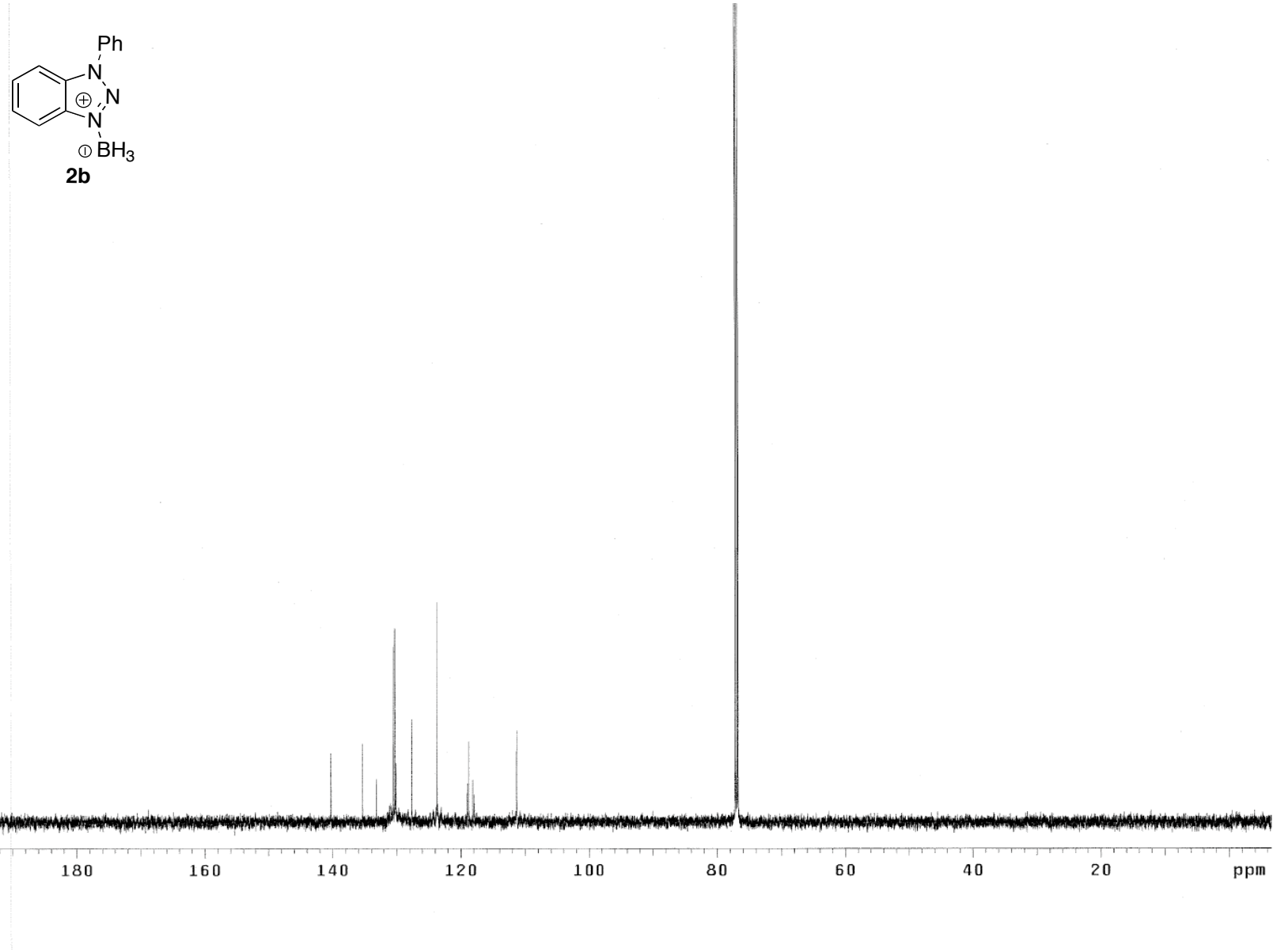




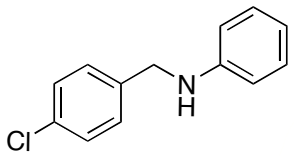
2a



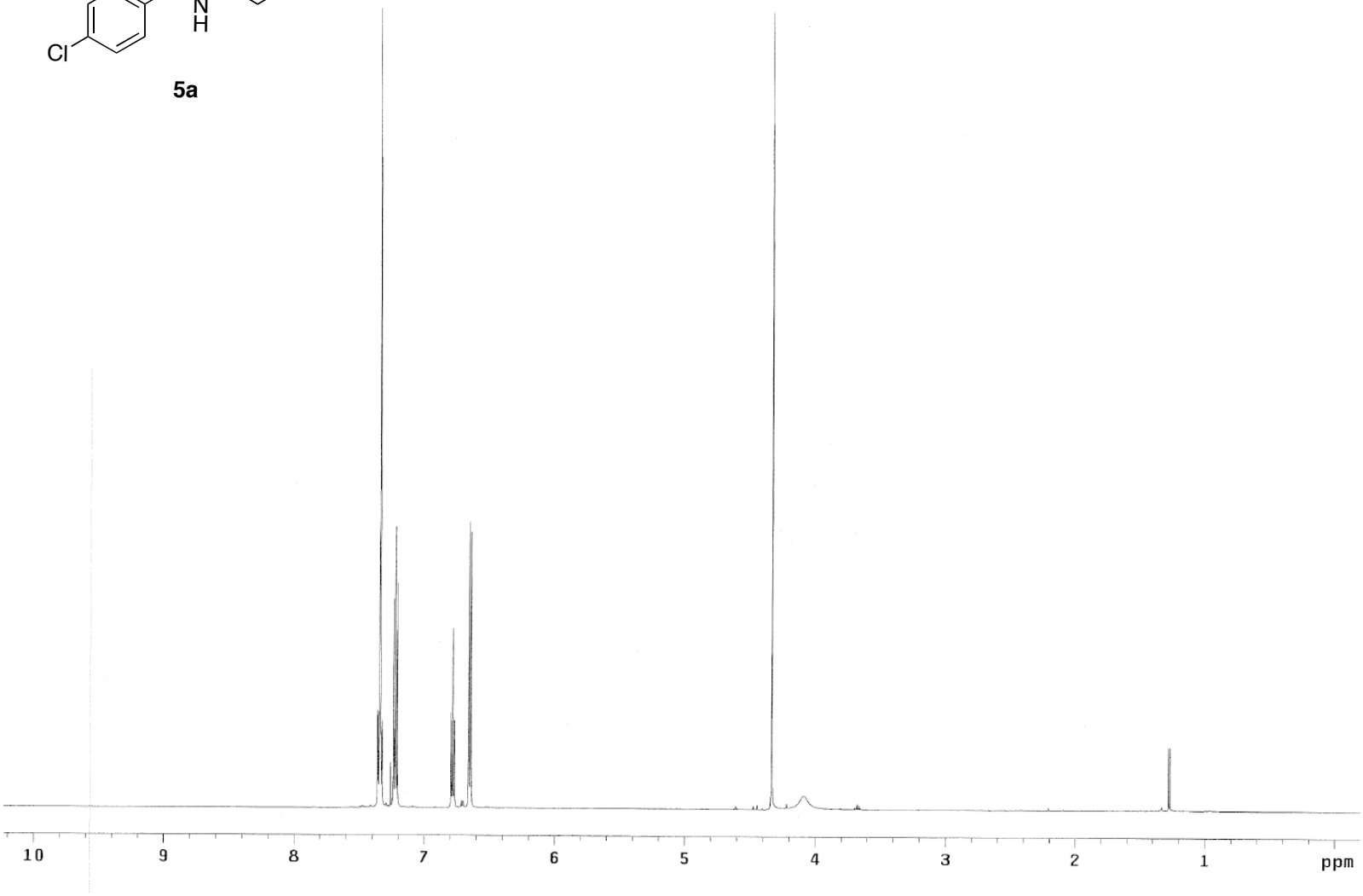
2b

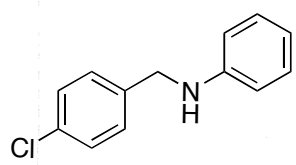


2b

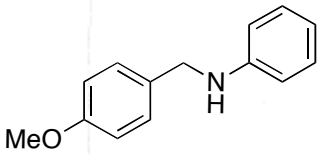


5a

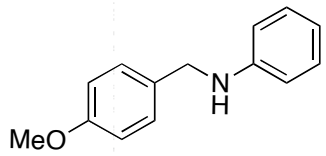




5a



5b



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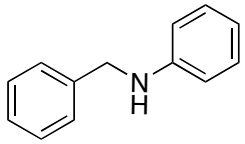
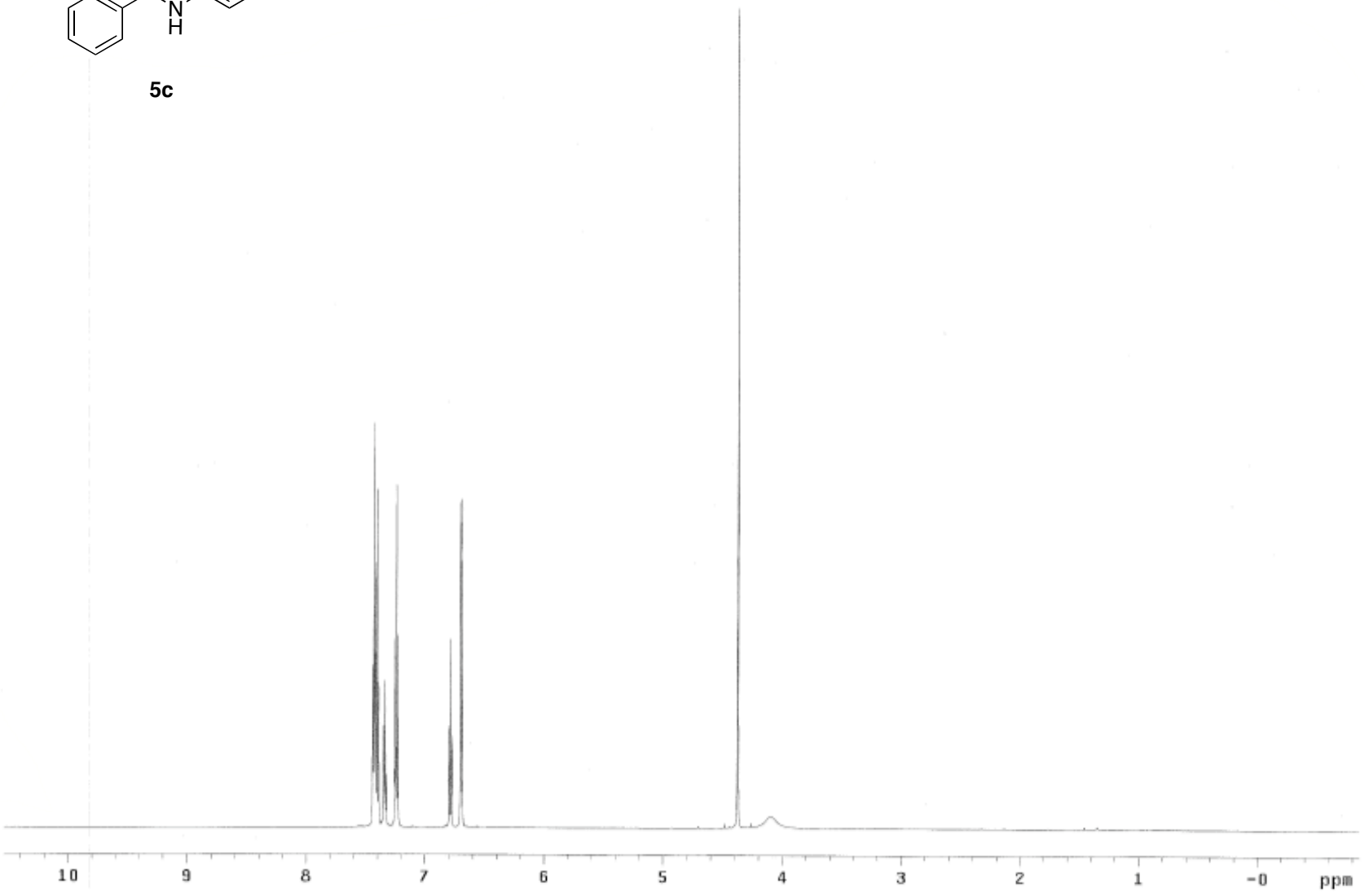
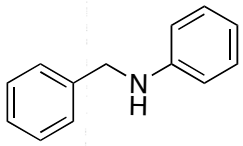


5c





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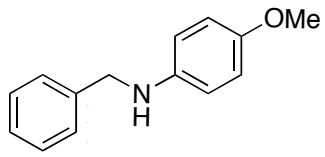

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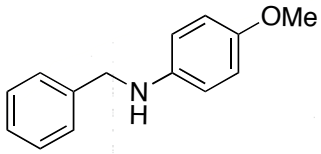

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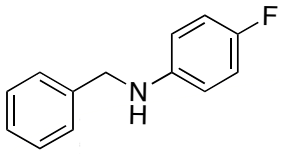

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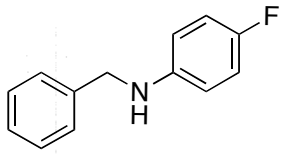

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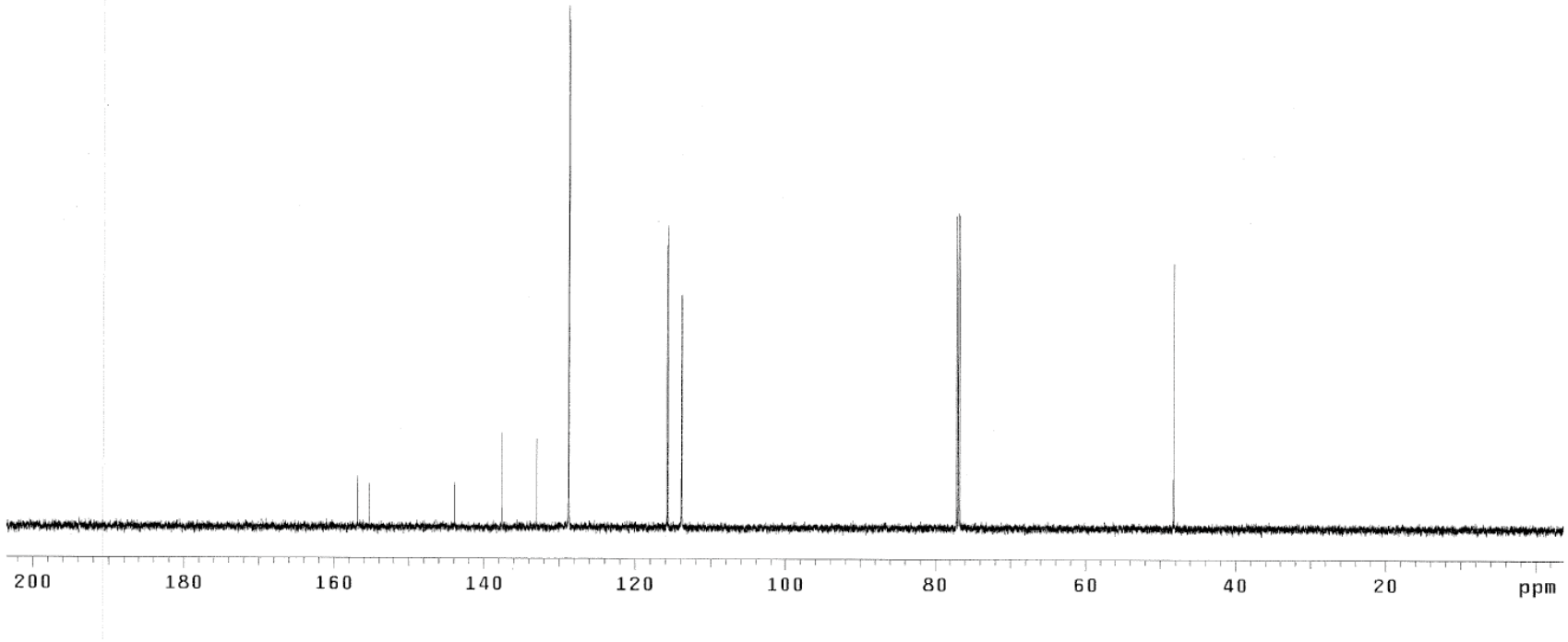

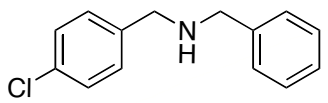

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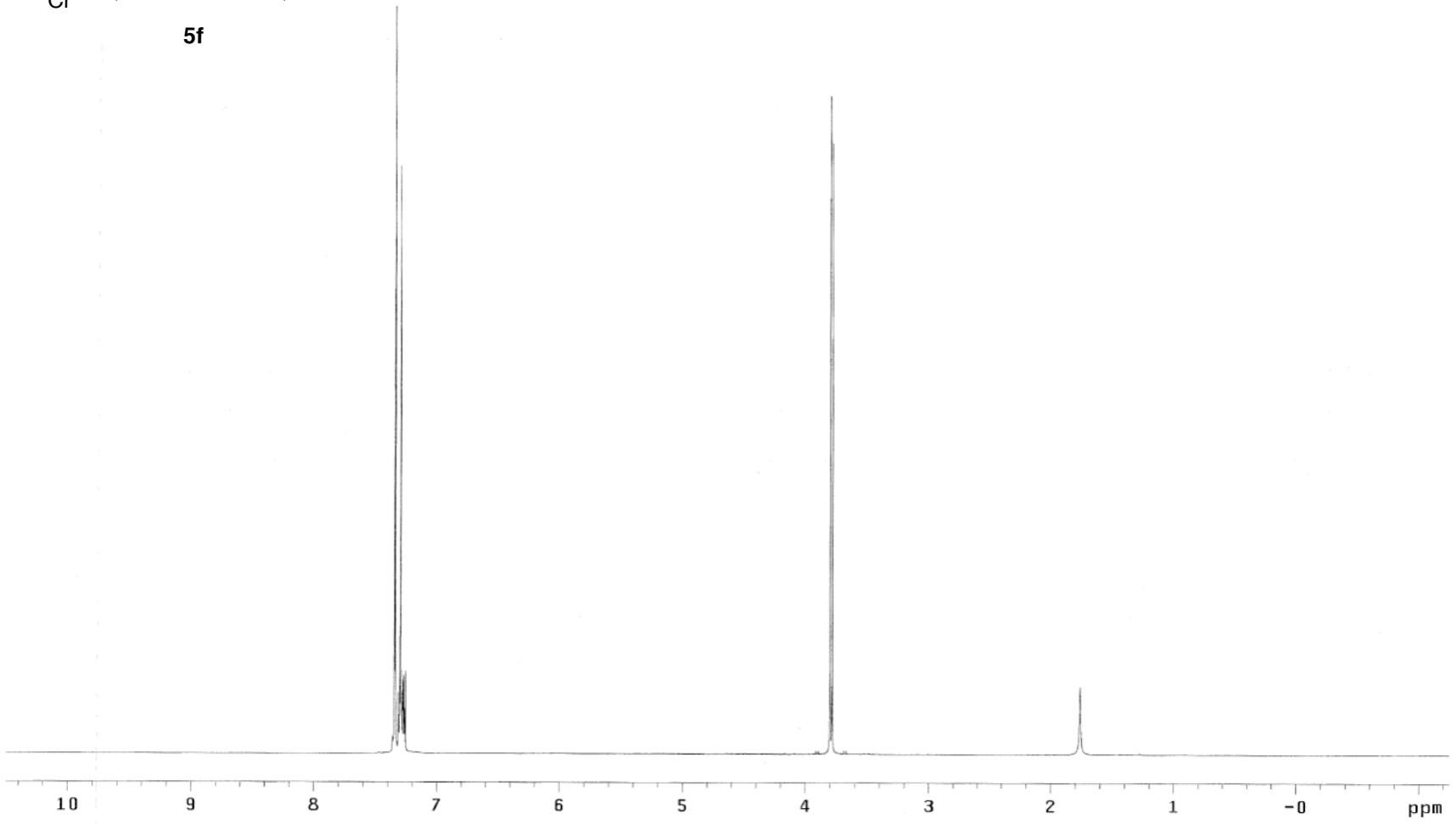

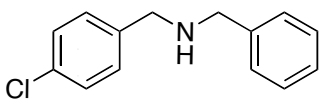

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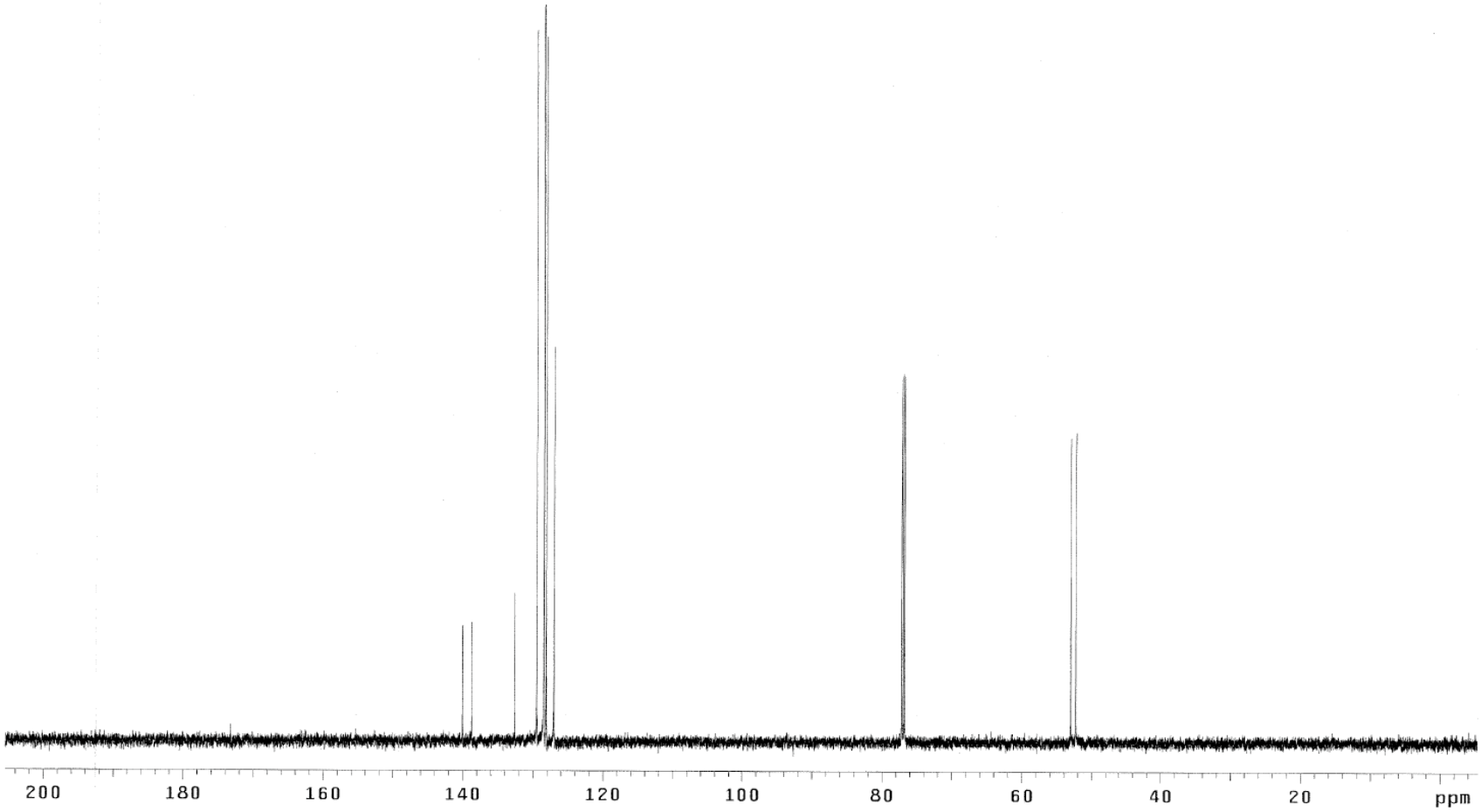

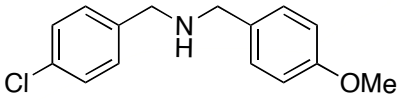

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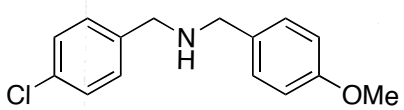

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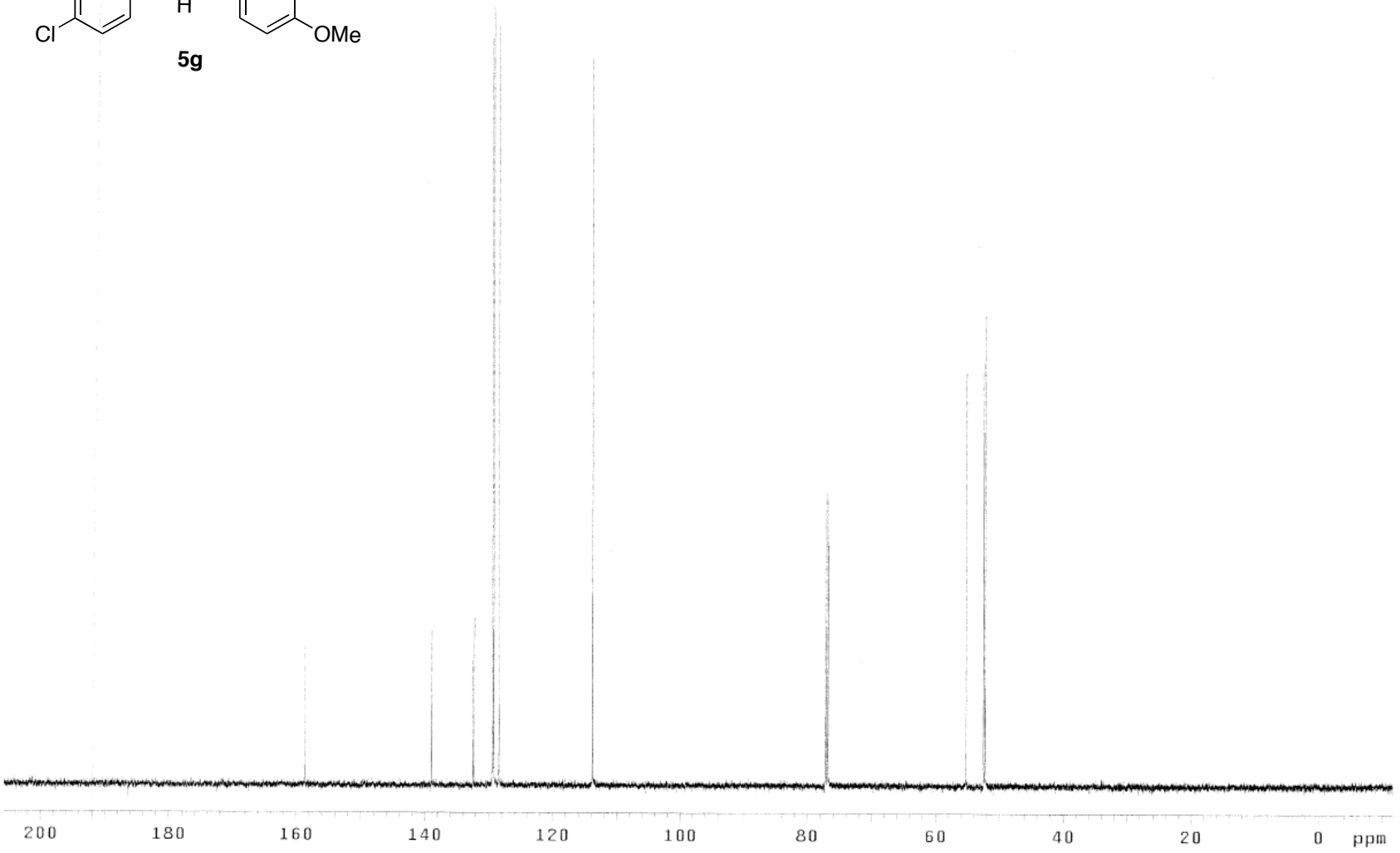

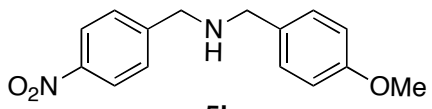

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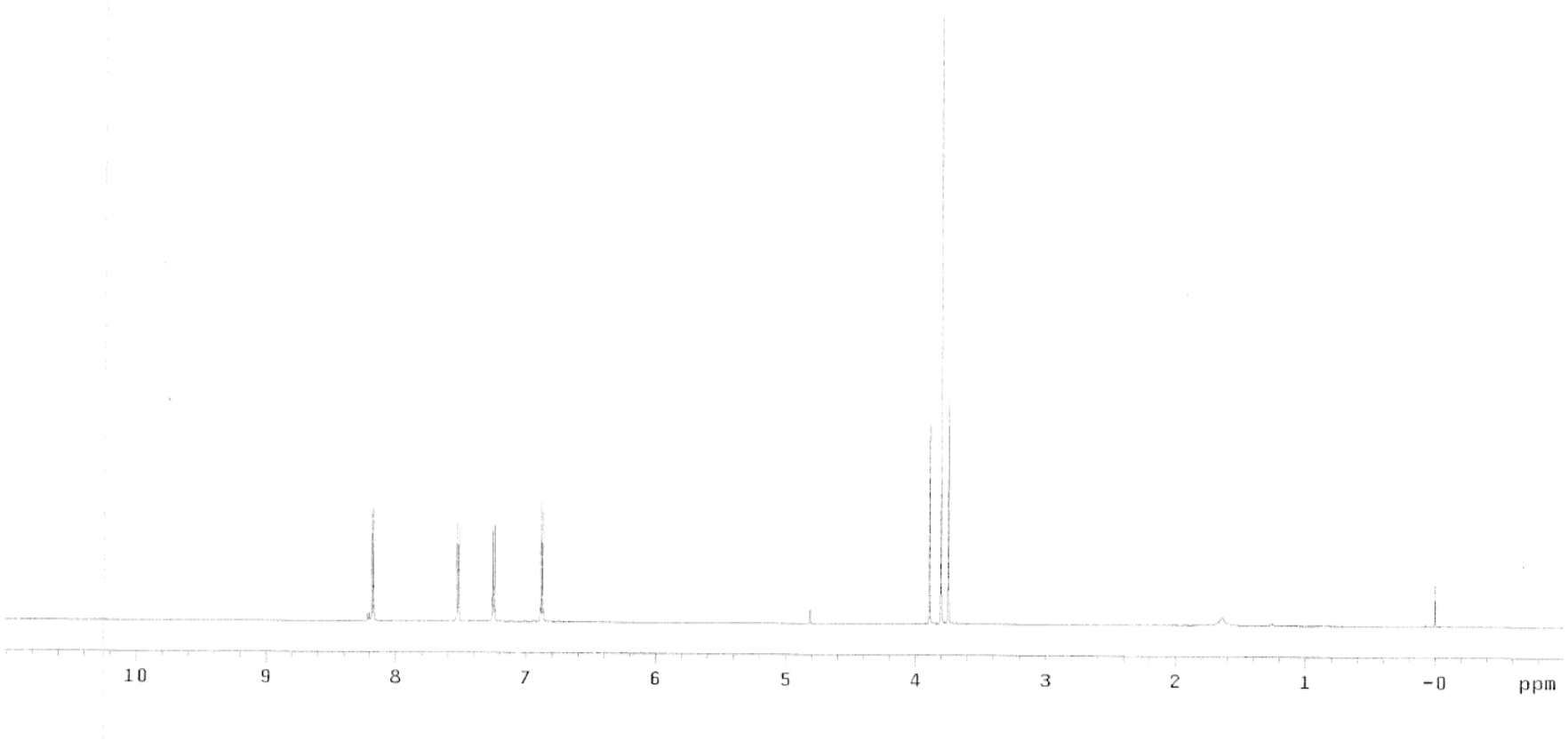

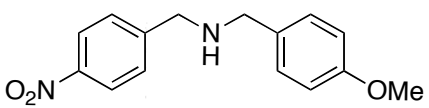

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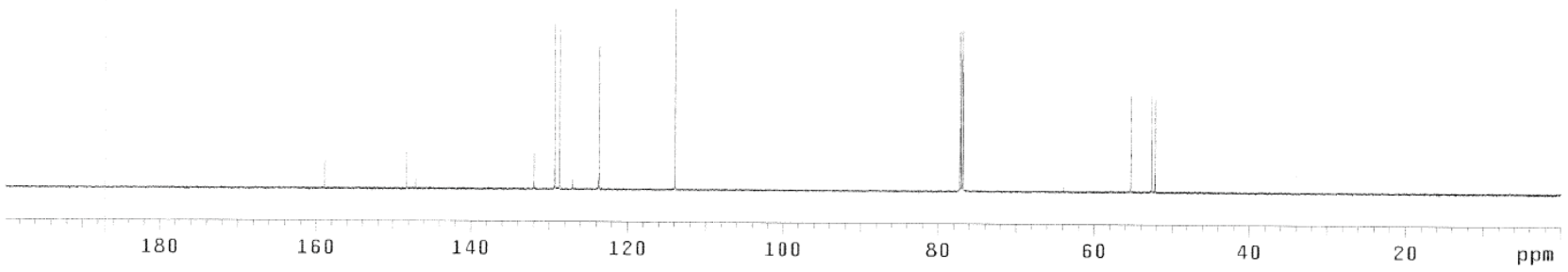

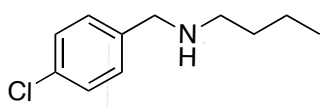
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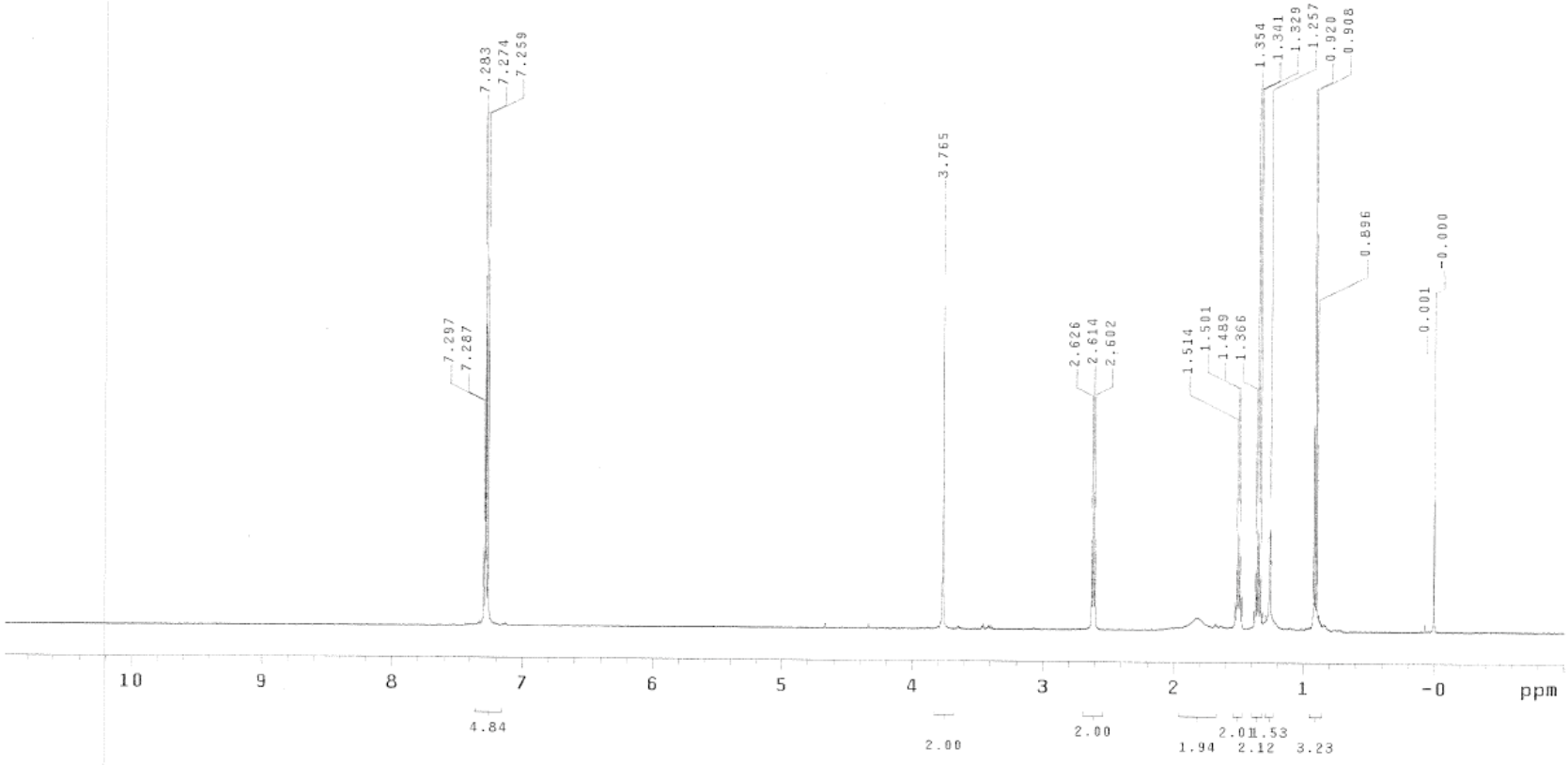
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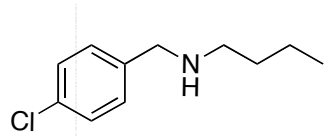

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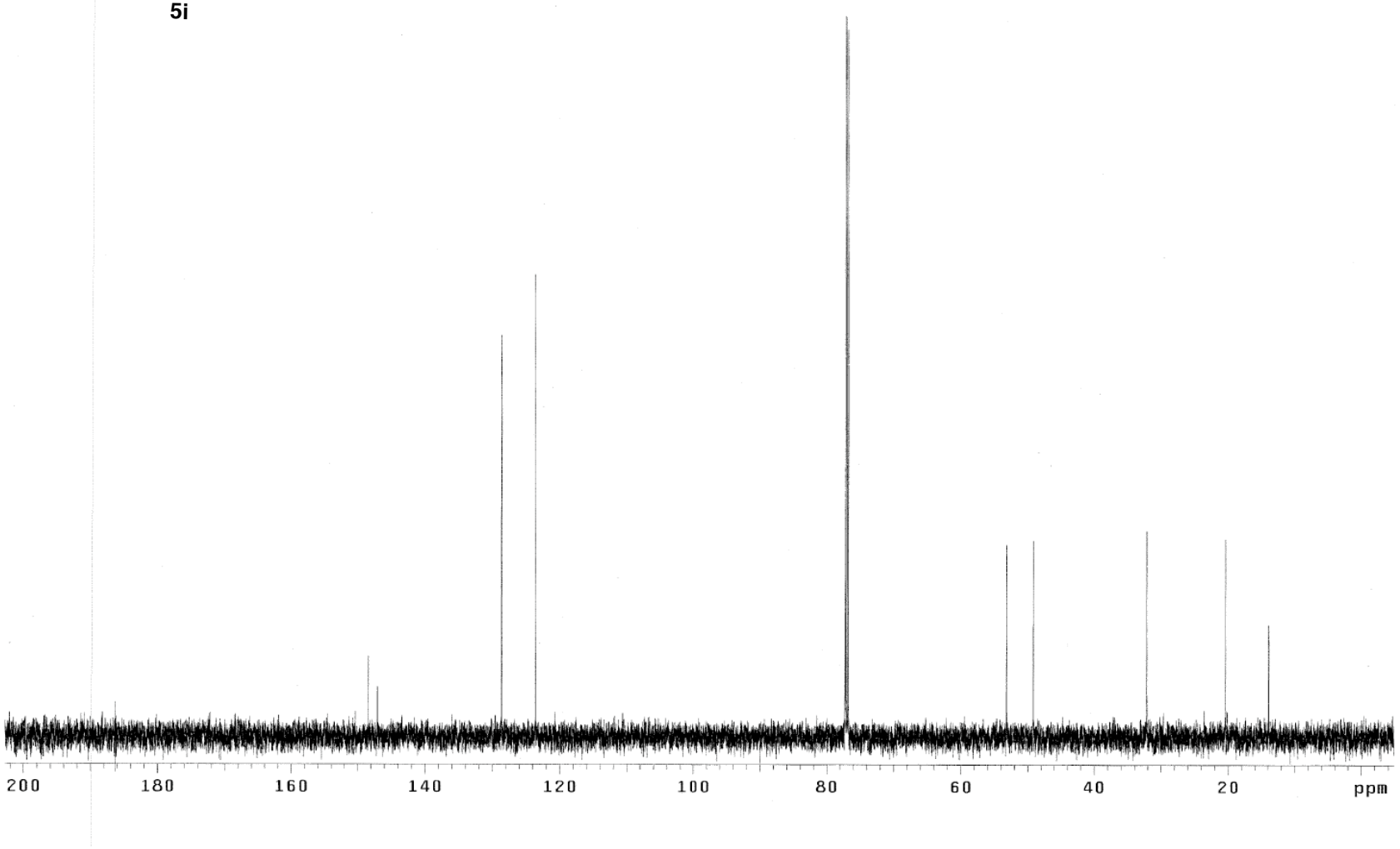

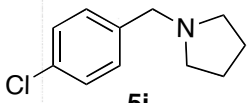

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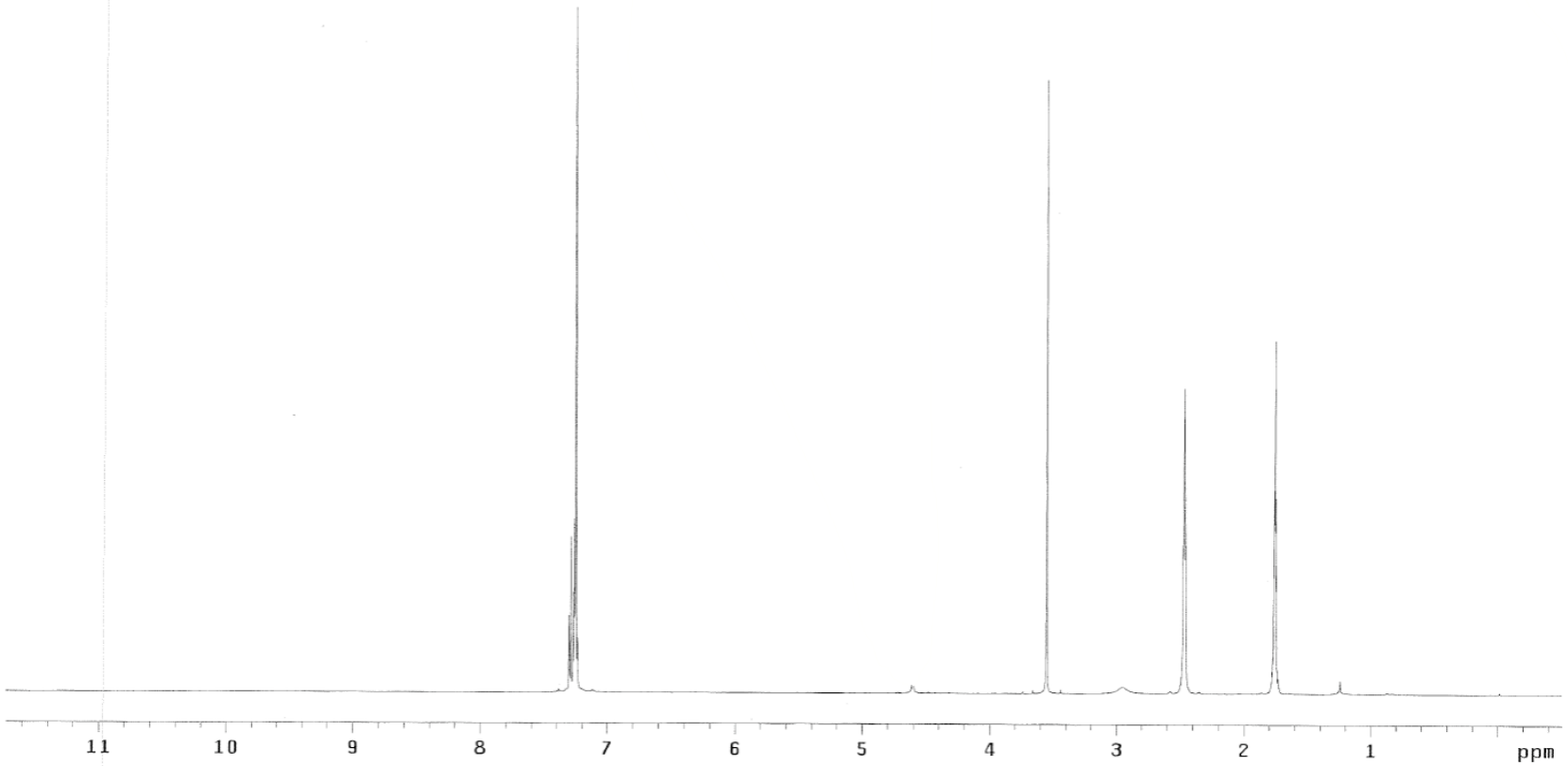

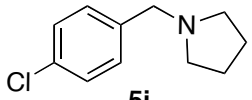

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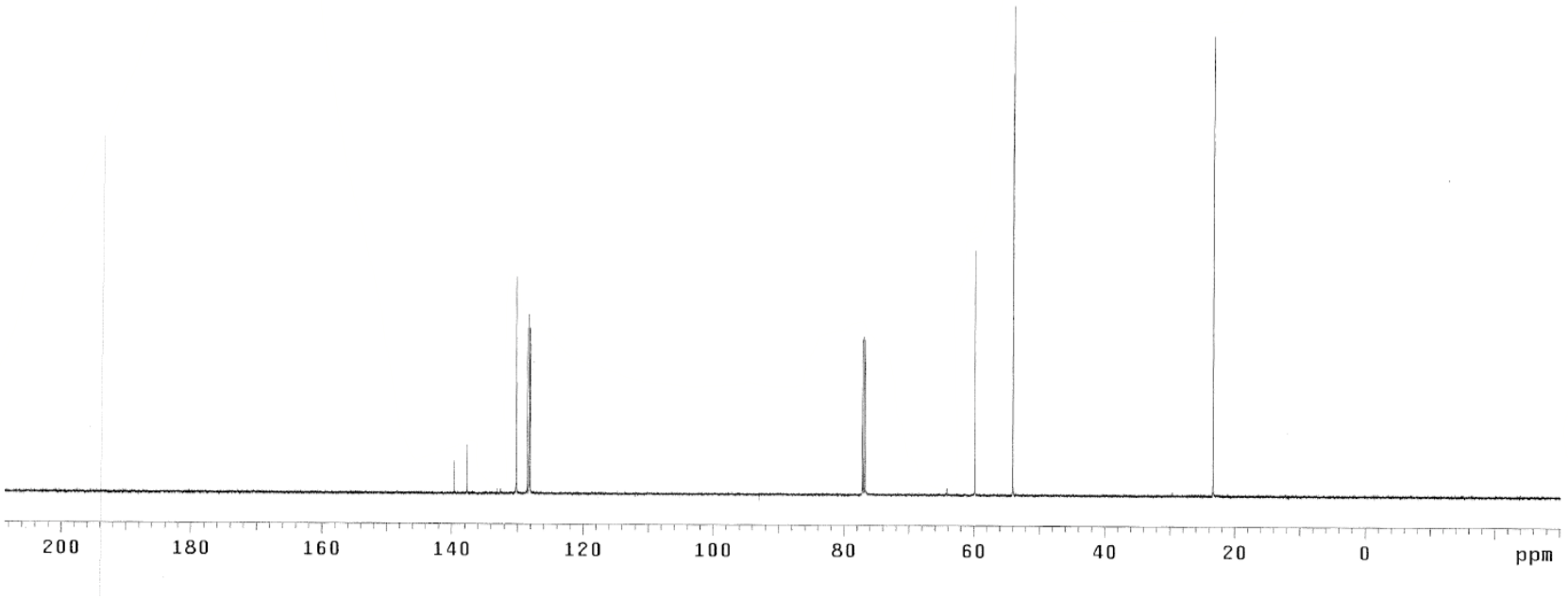

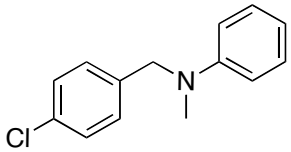

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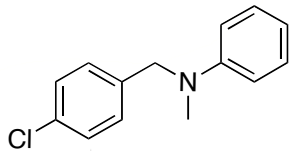

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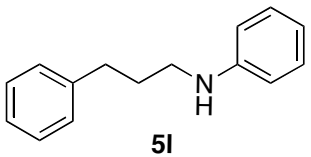

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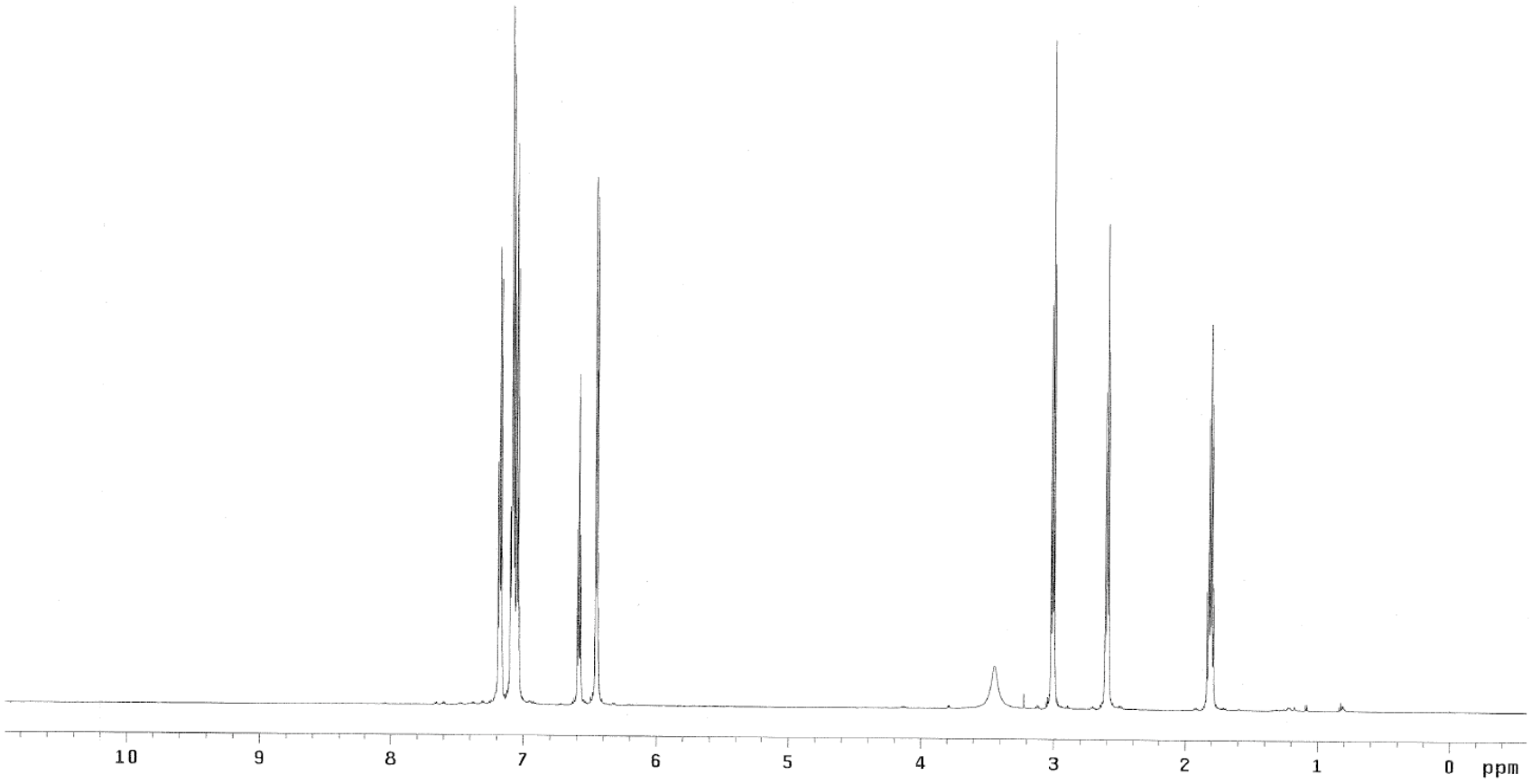

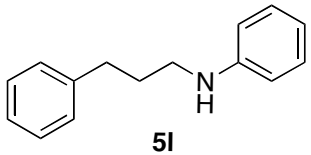

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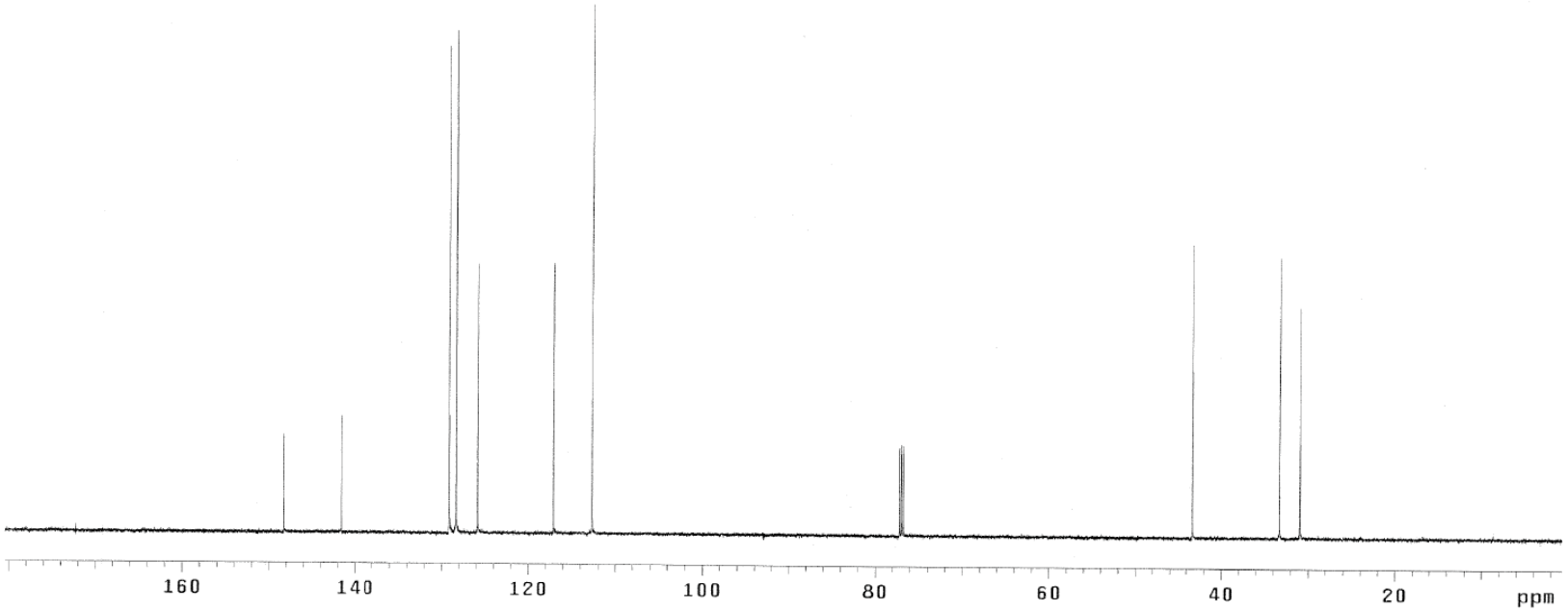

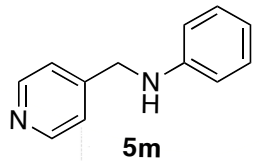

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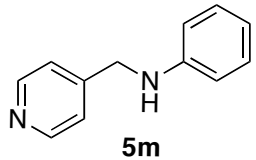

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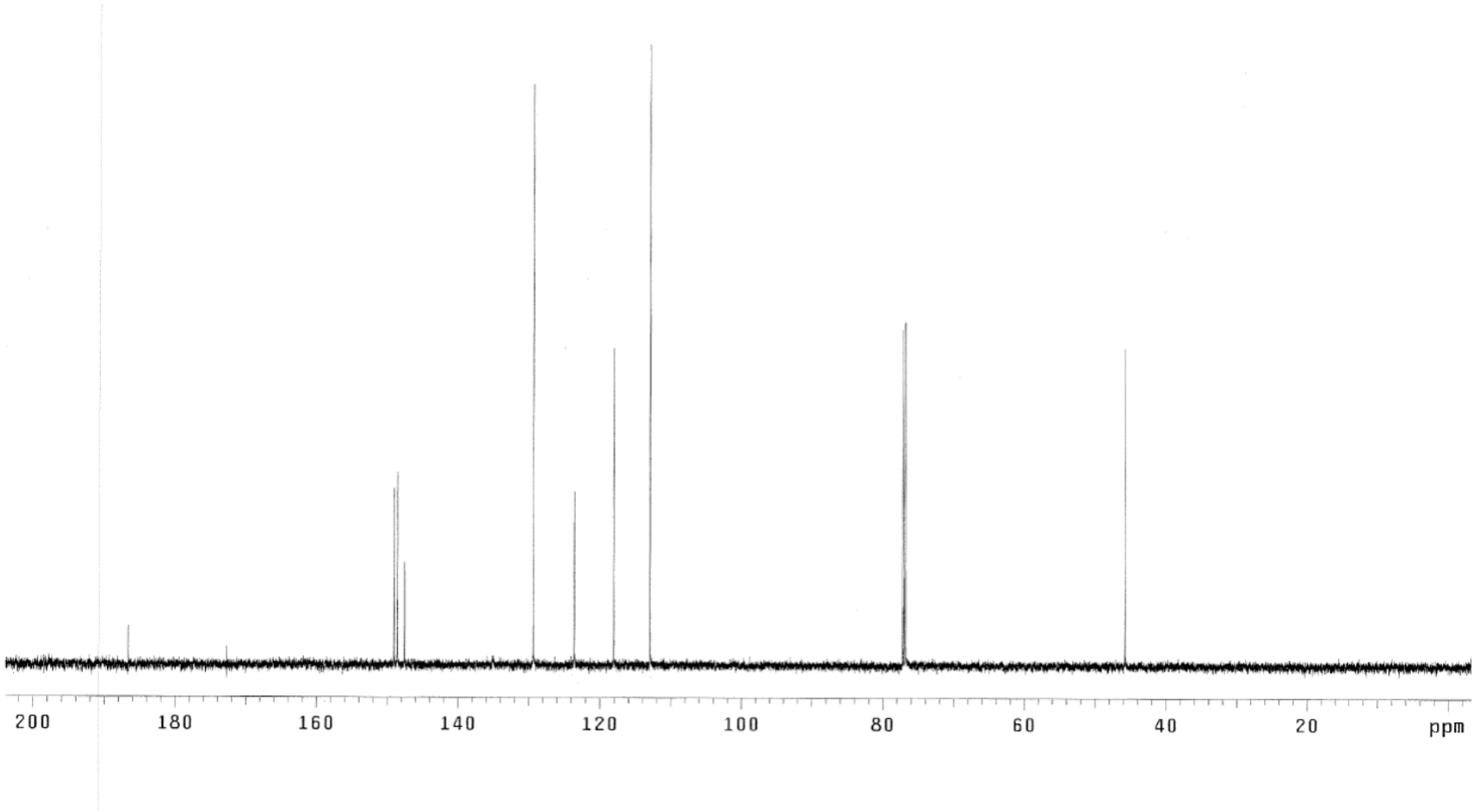

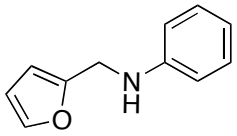

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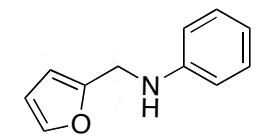

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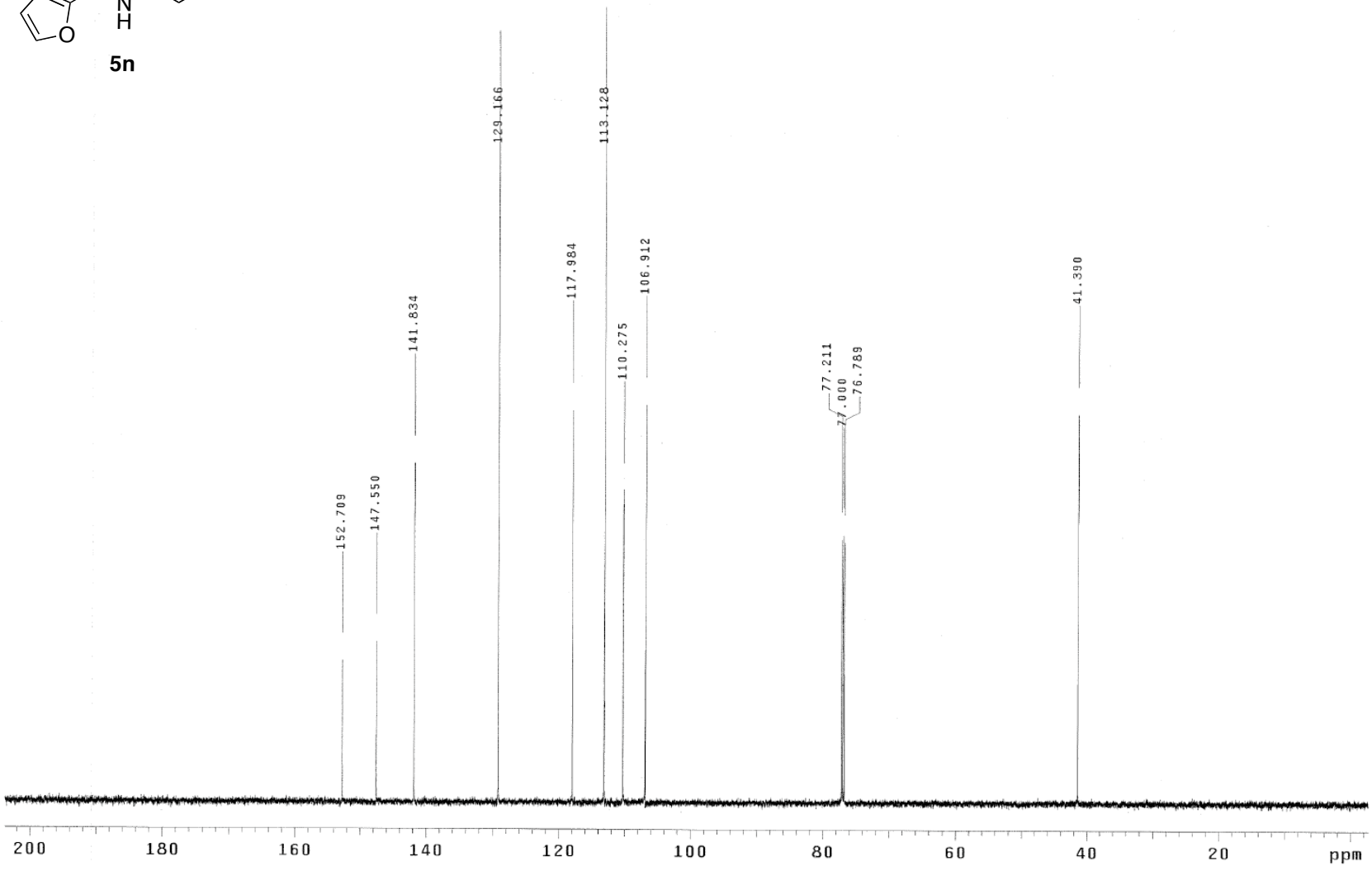

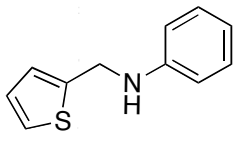

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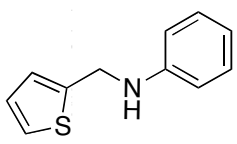

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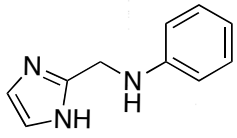

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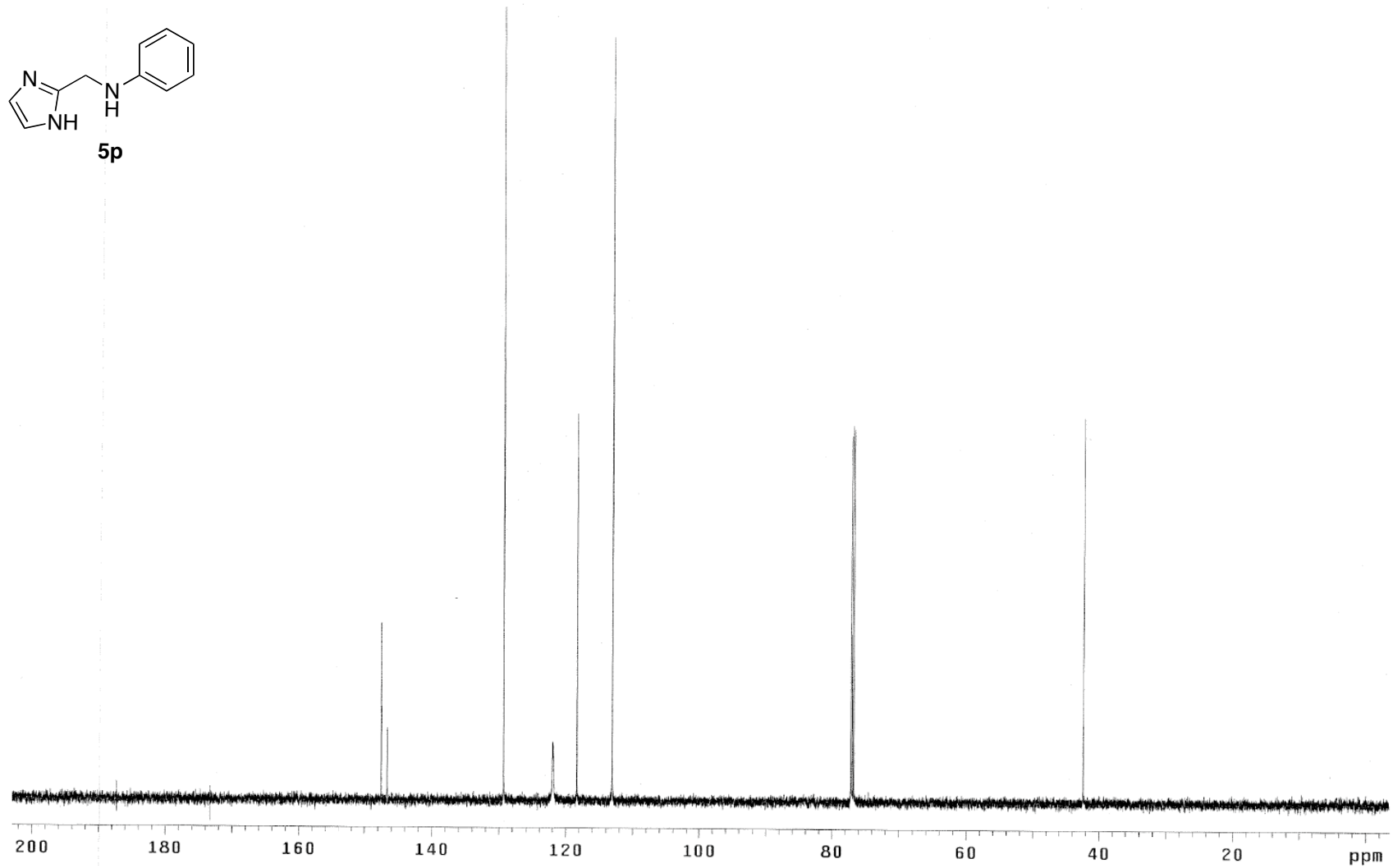

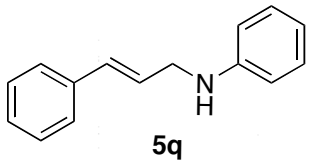

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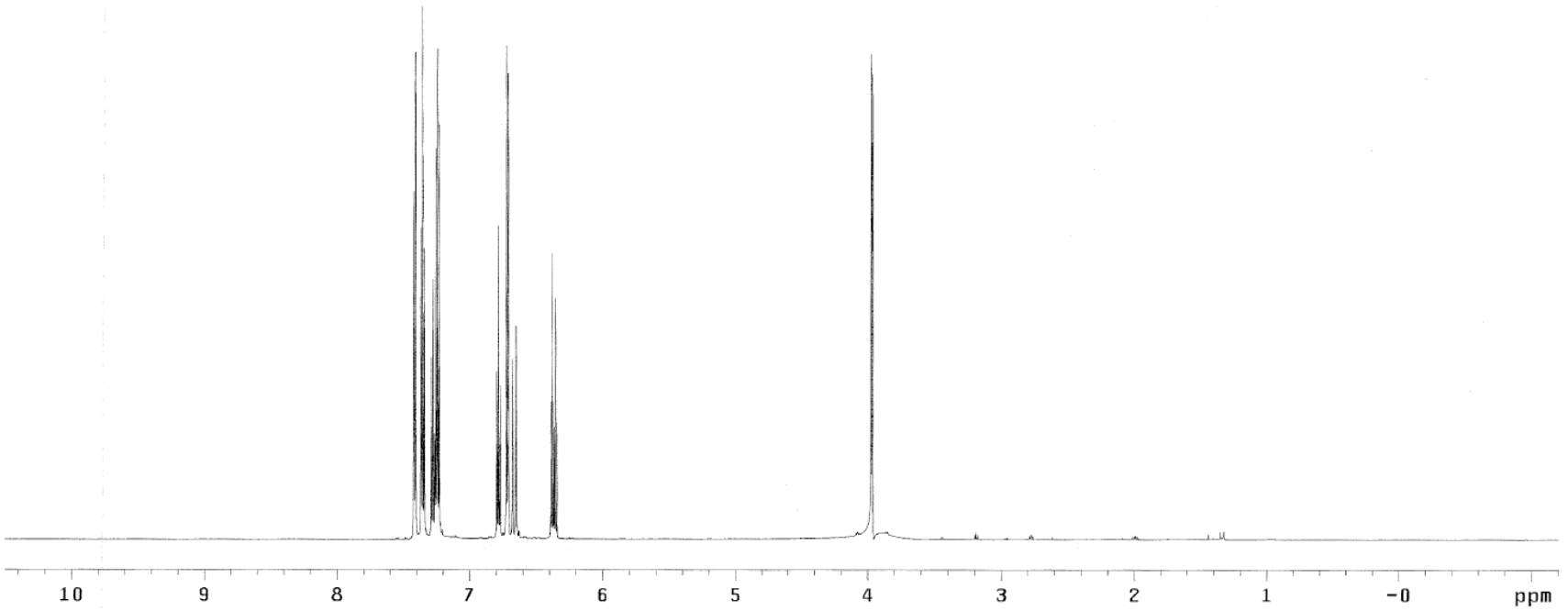

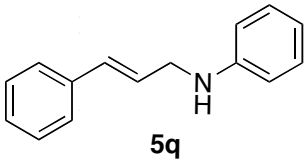

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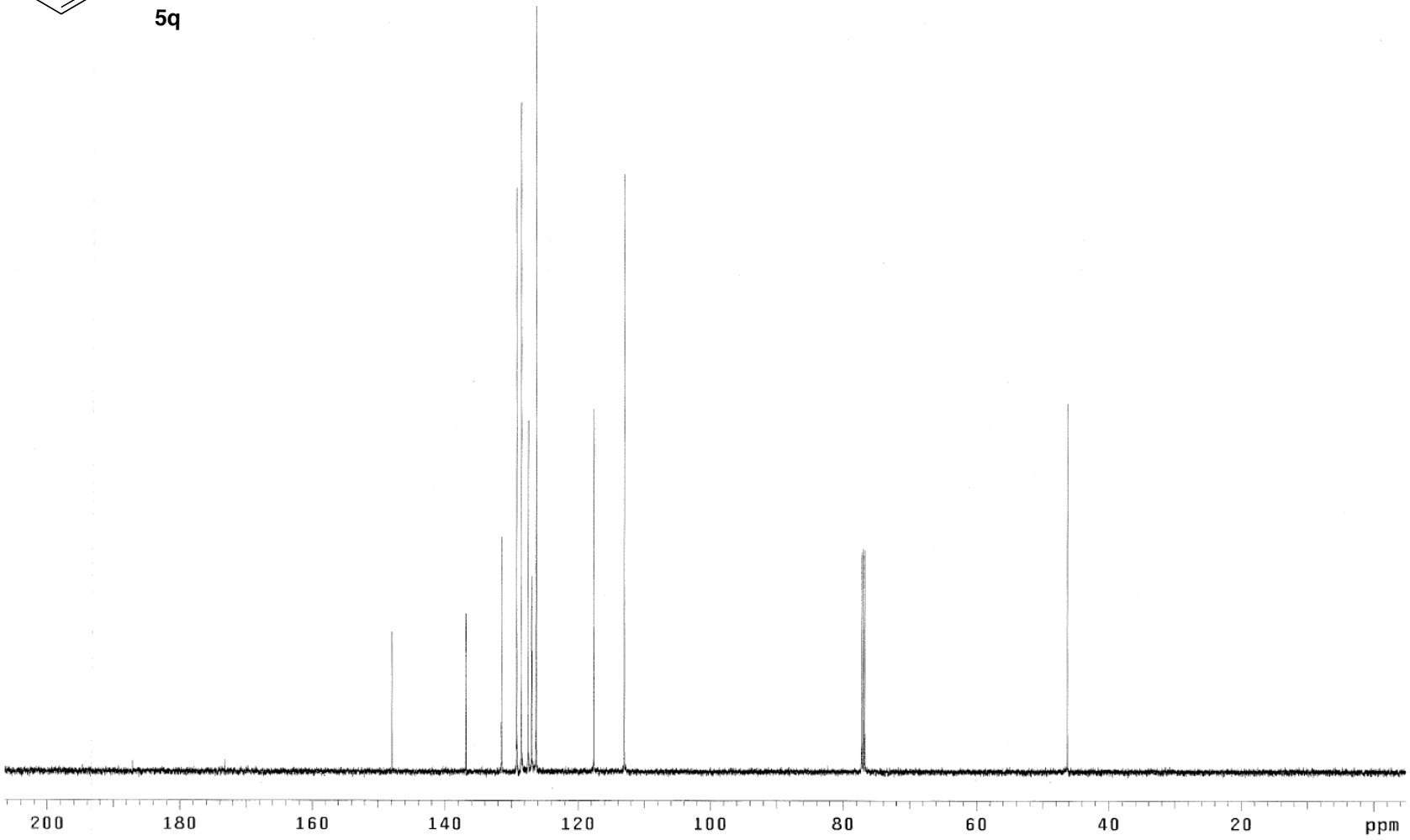

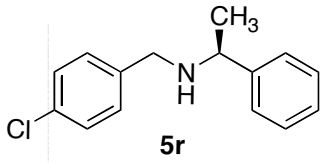

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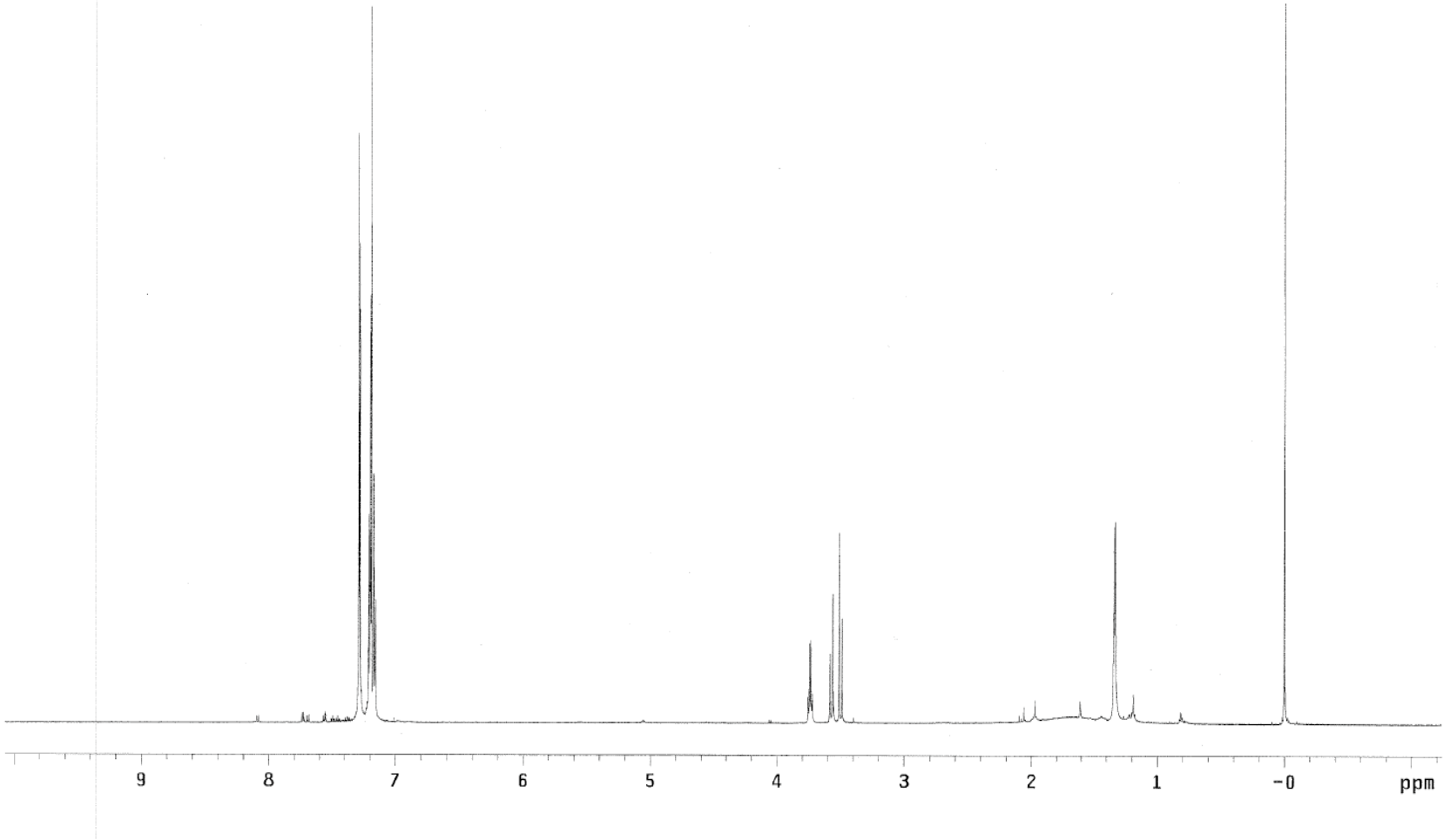

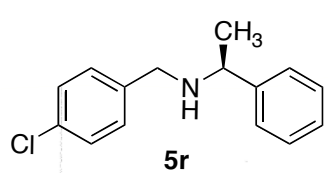

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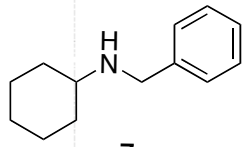

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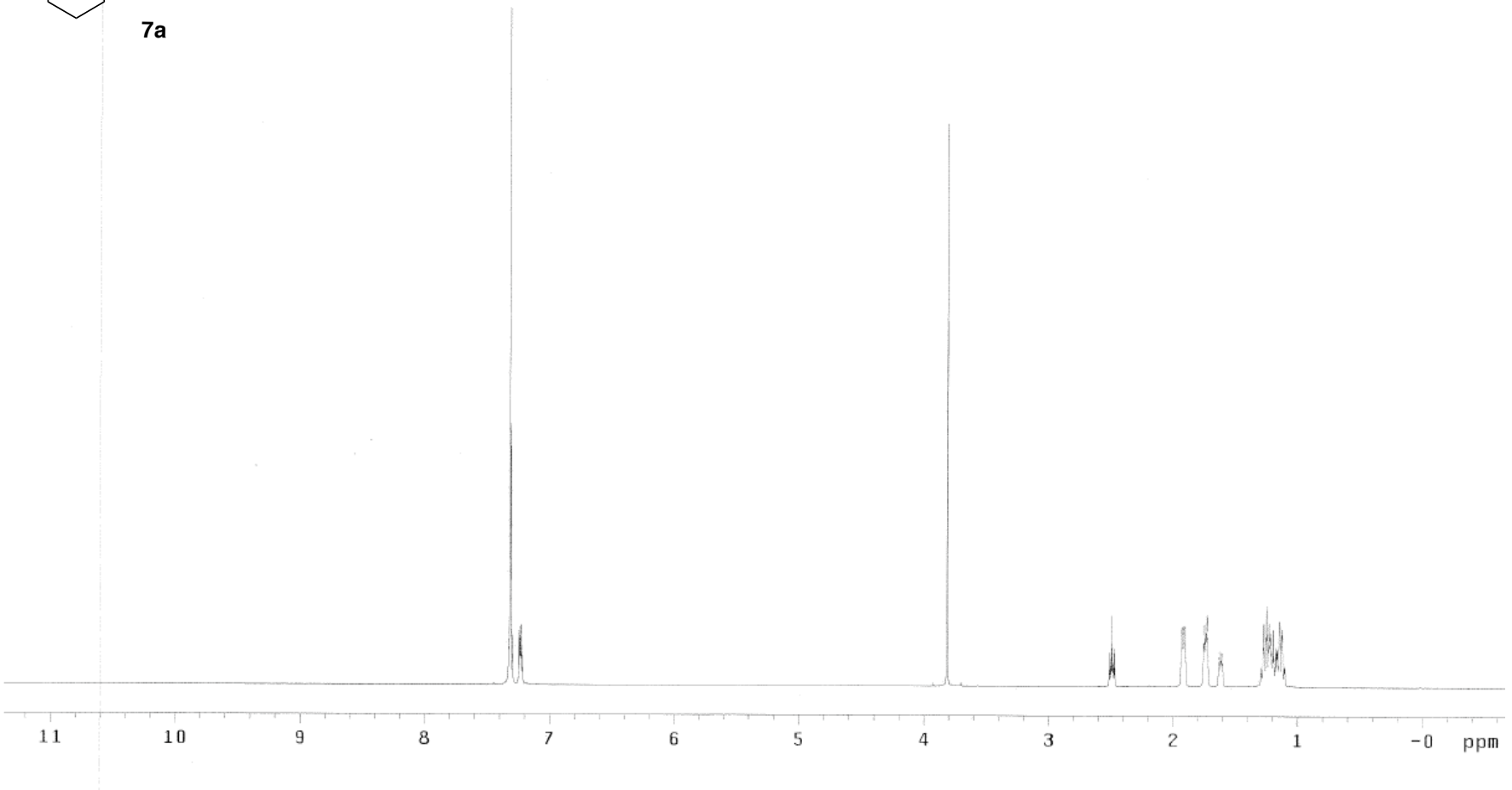

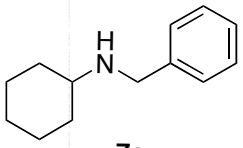

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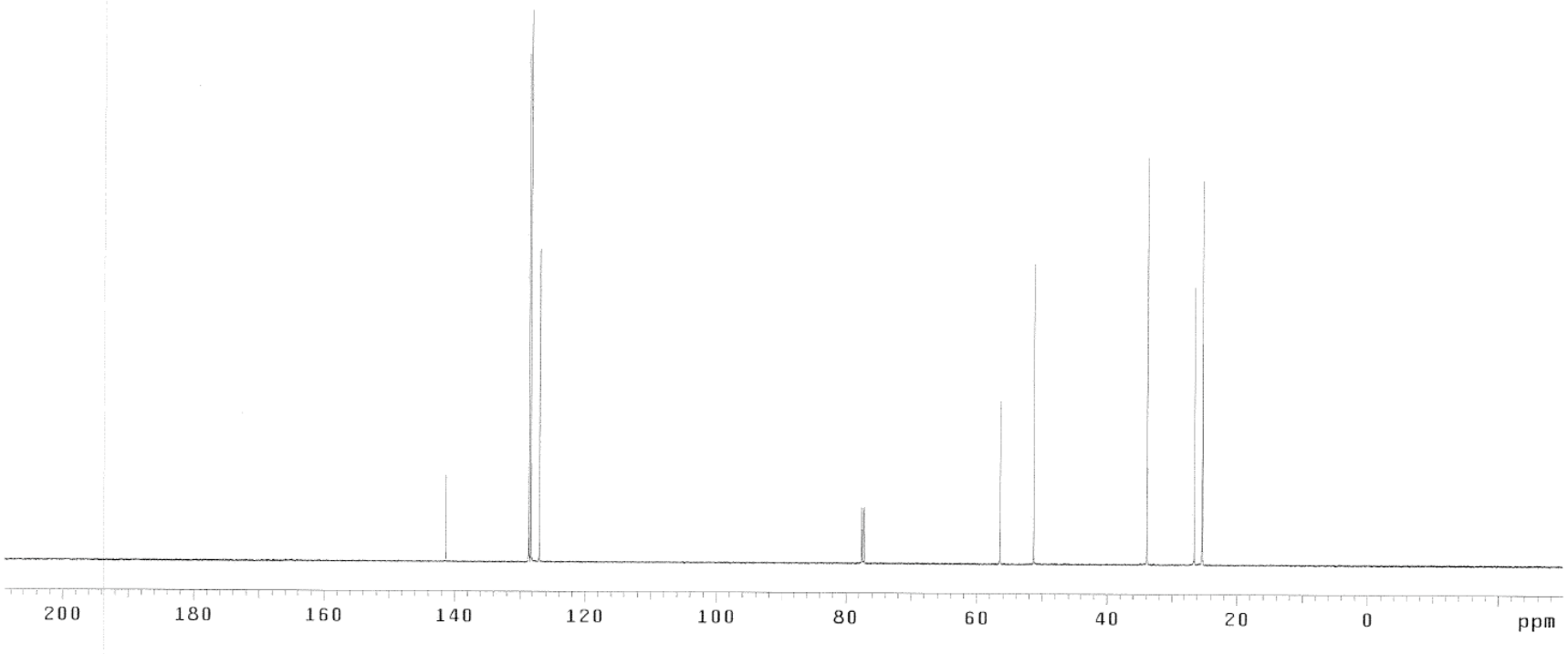

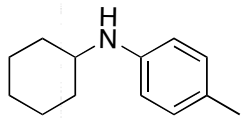

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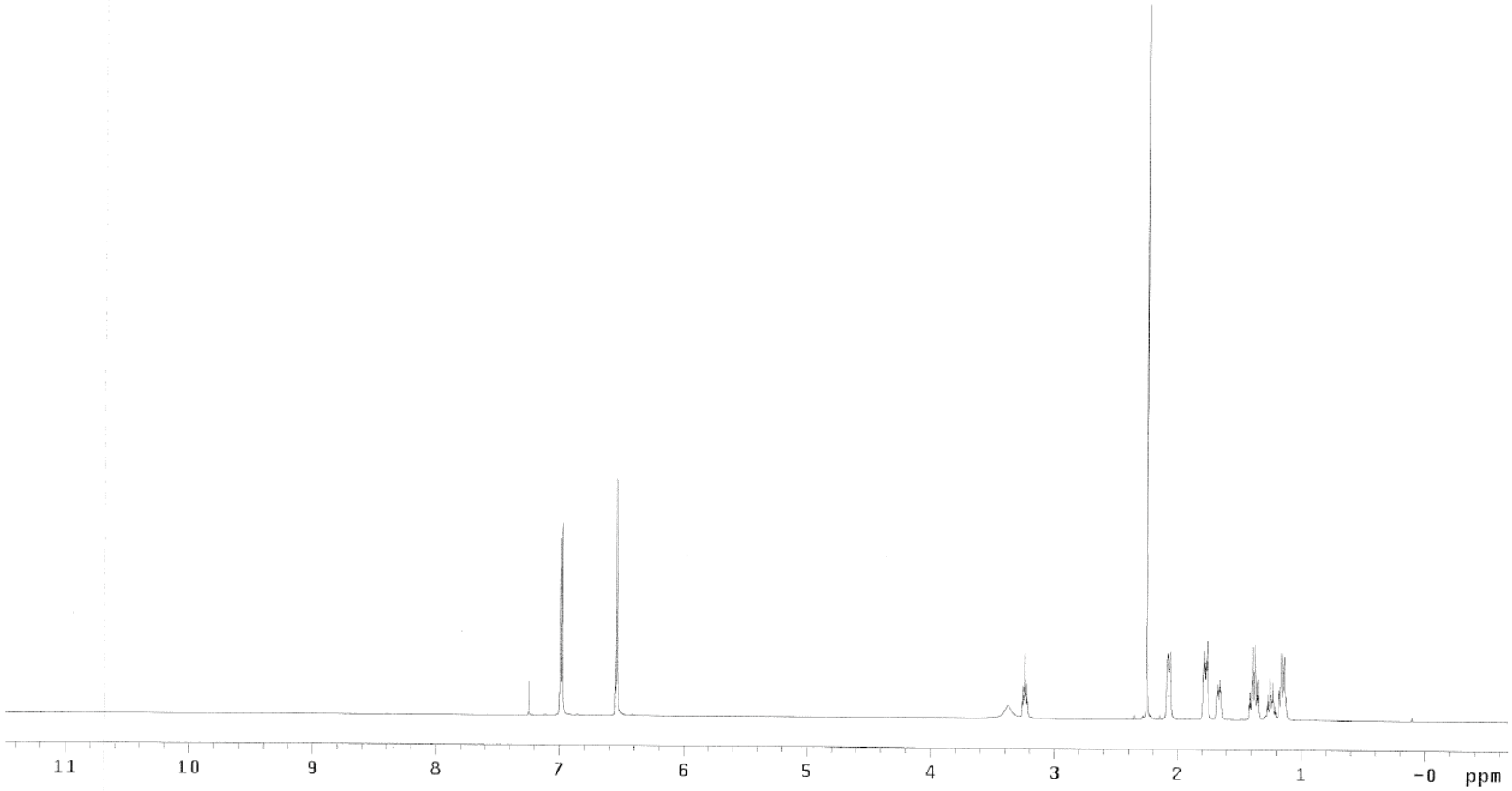

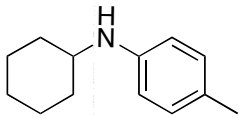

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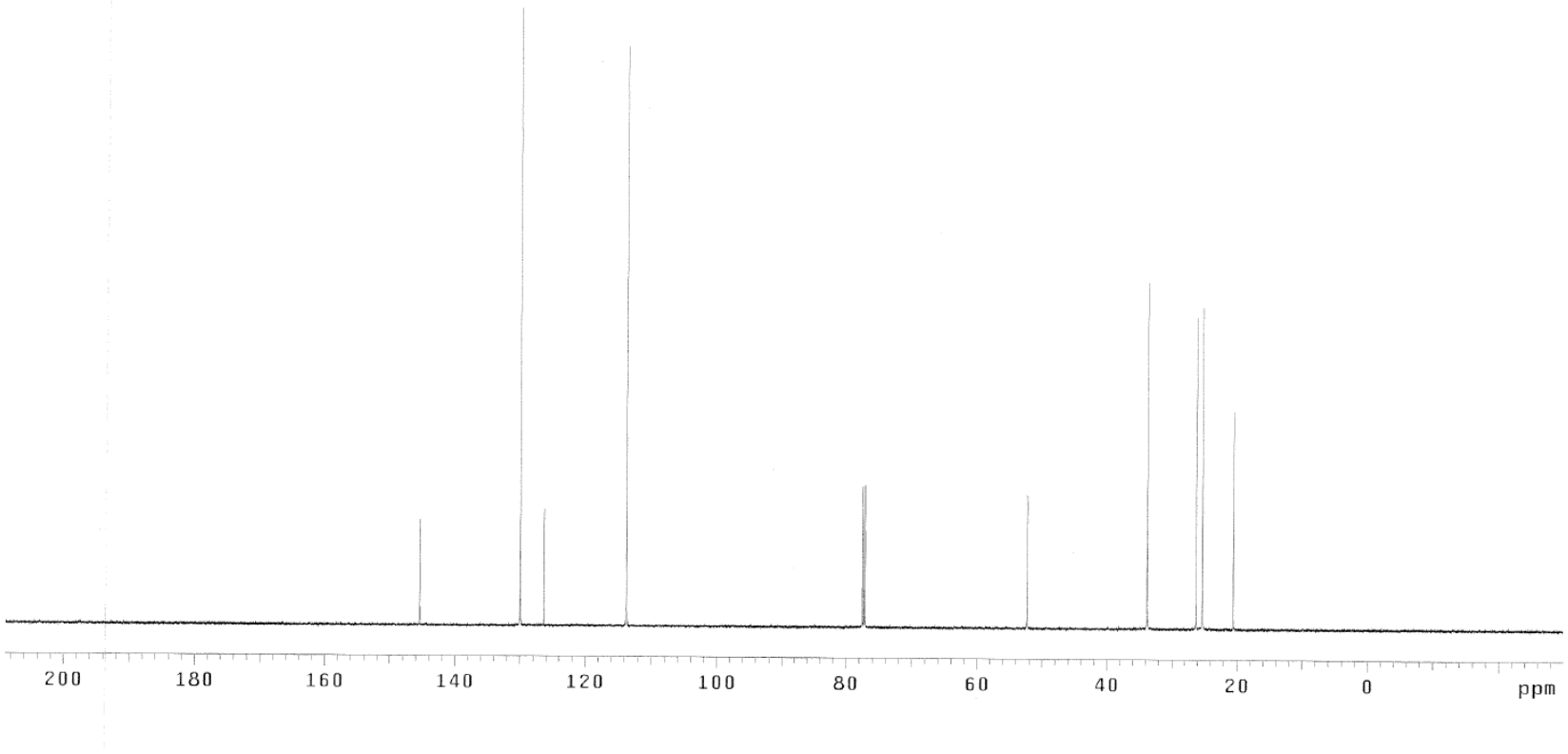

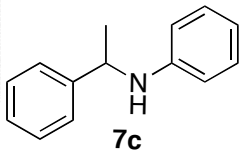

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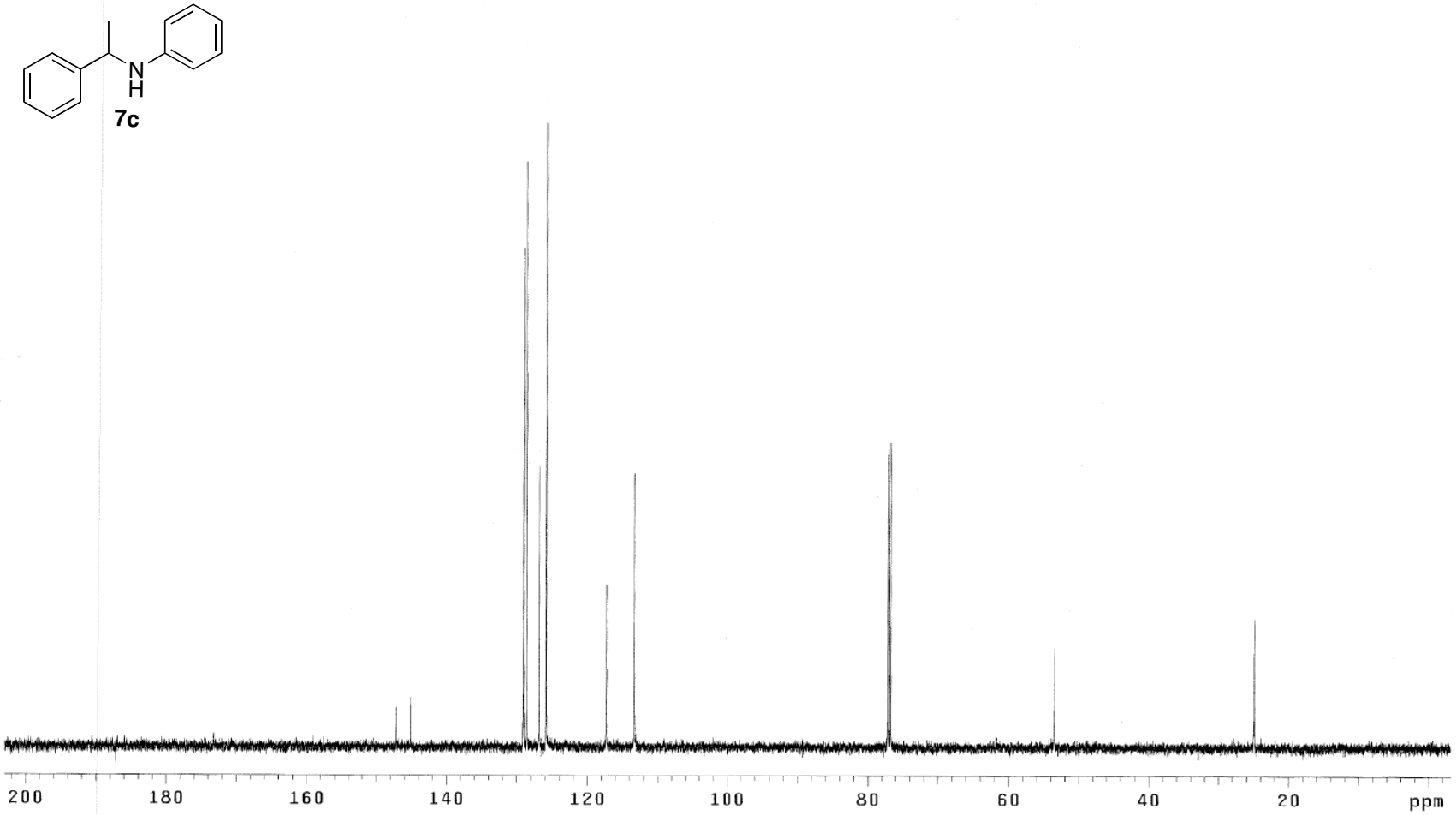

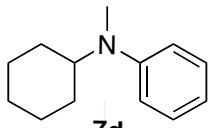

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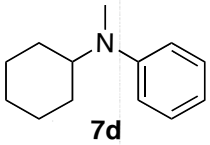

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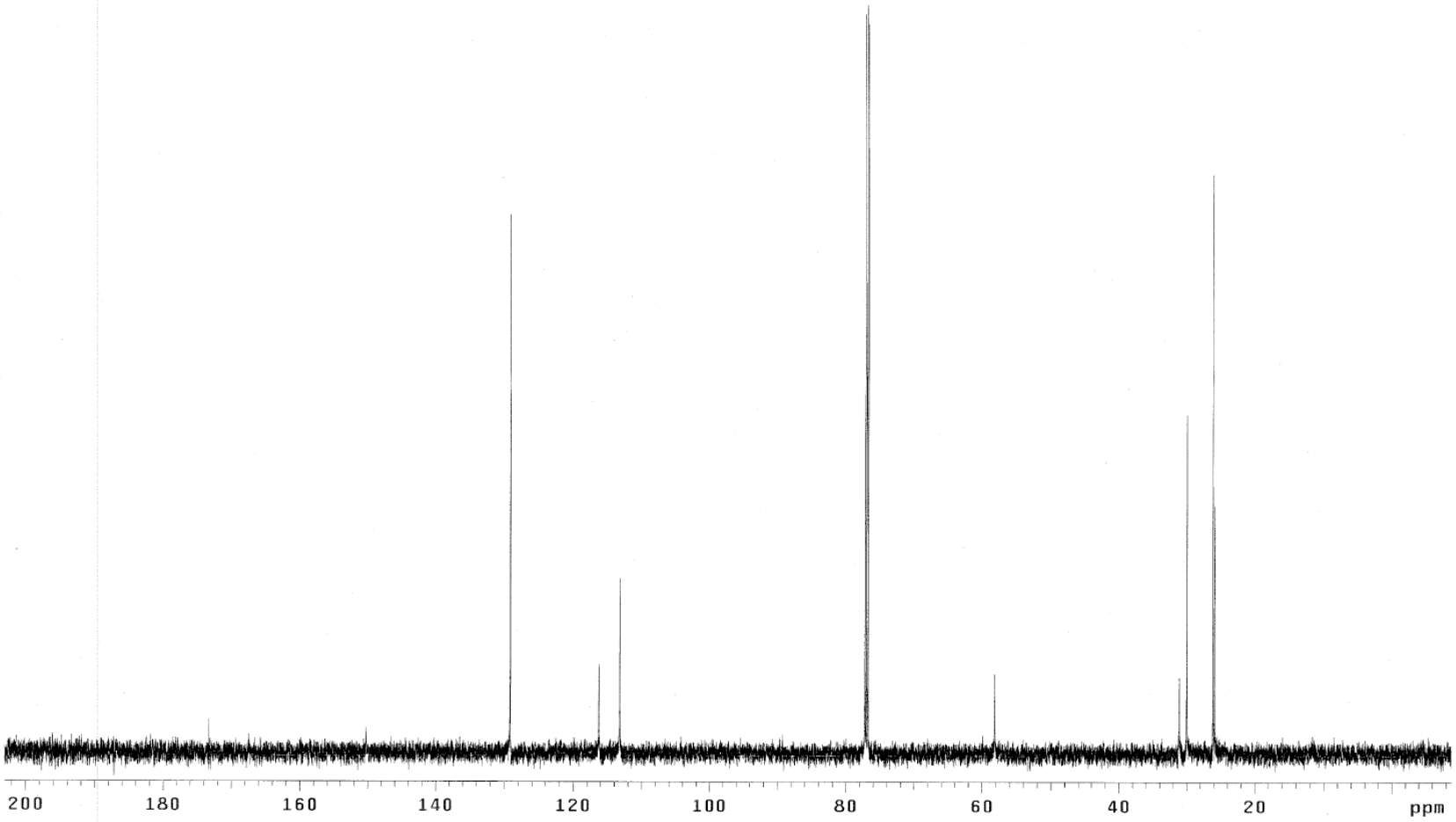

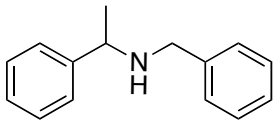

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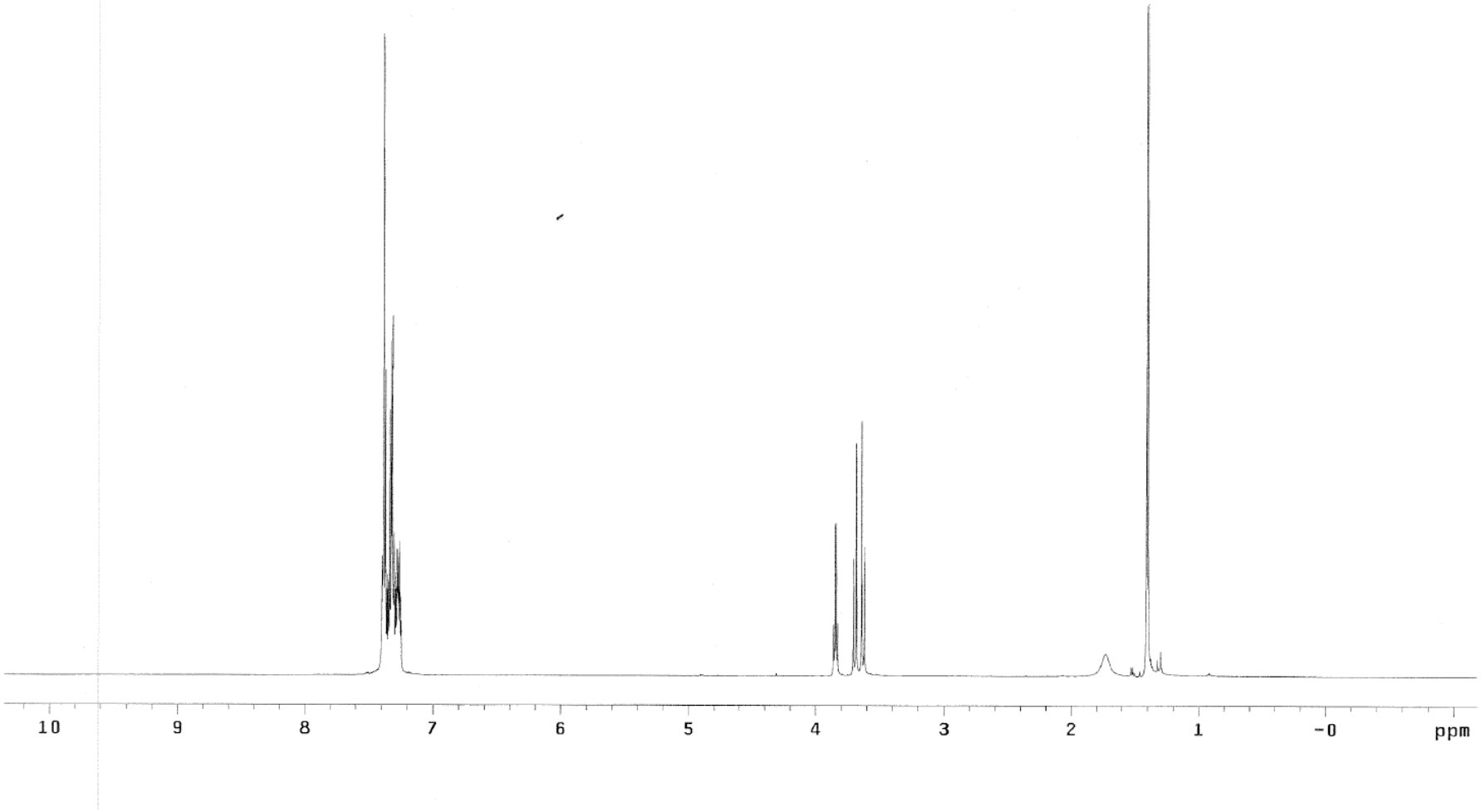

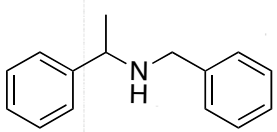

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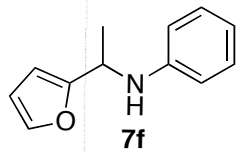

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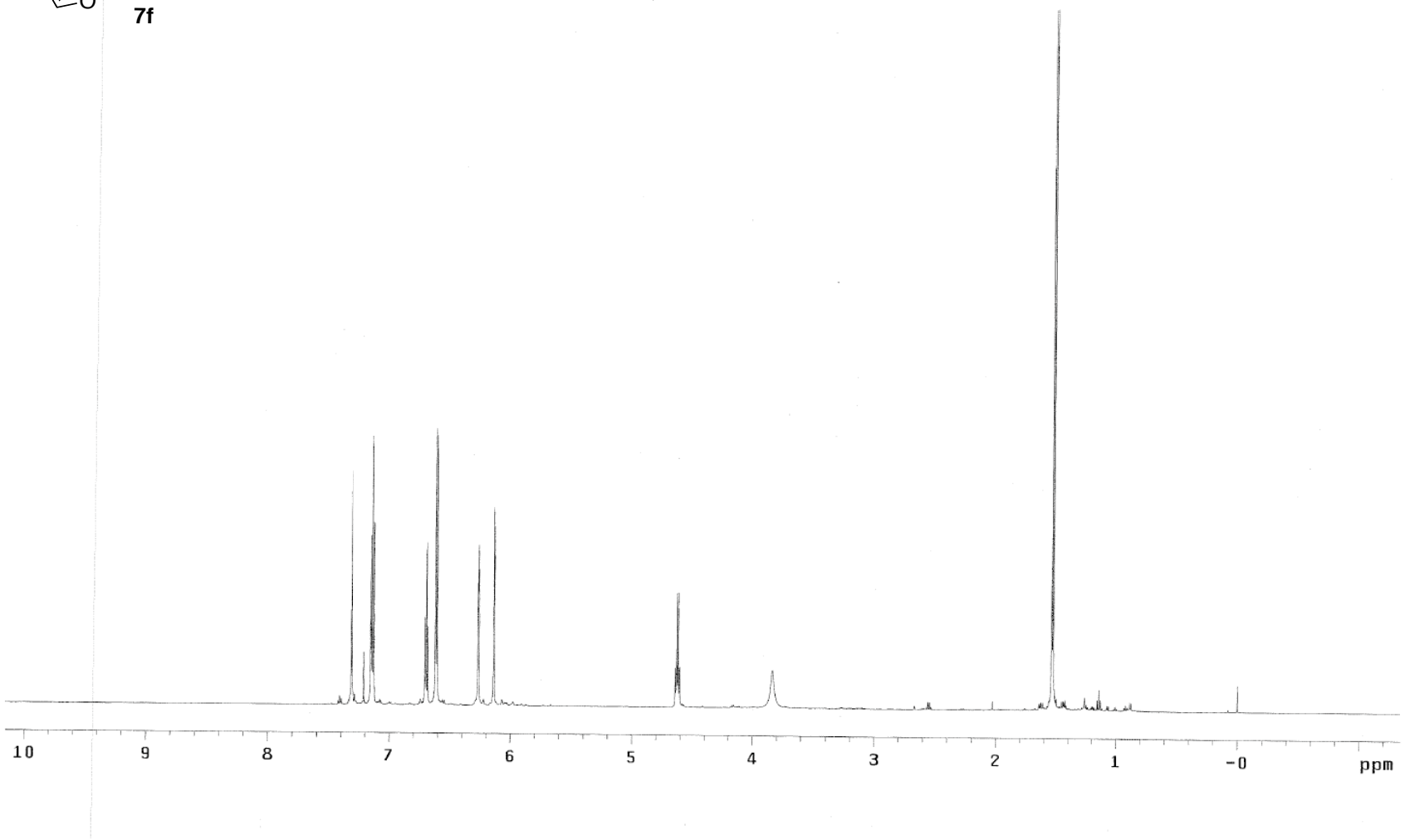

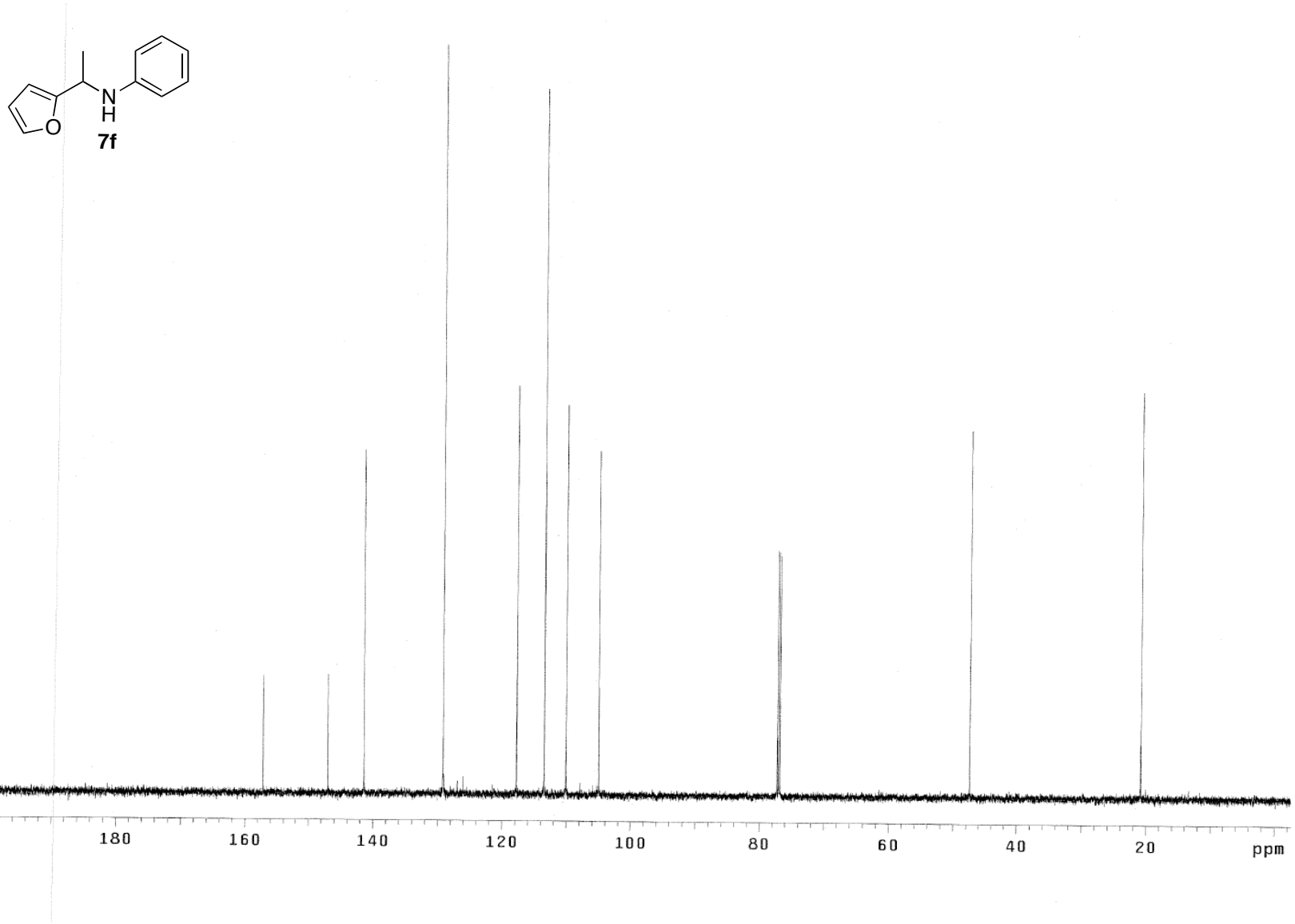

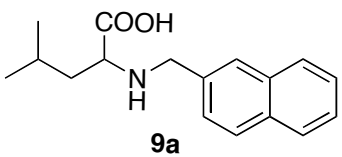

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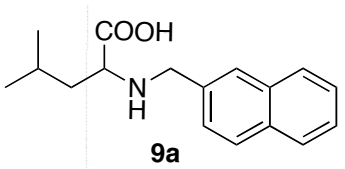

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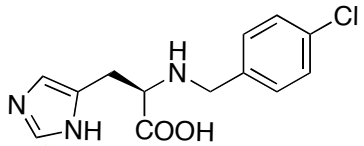

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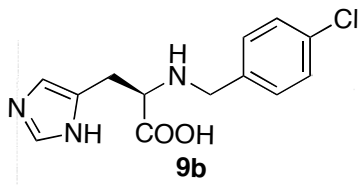

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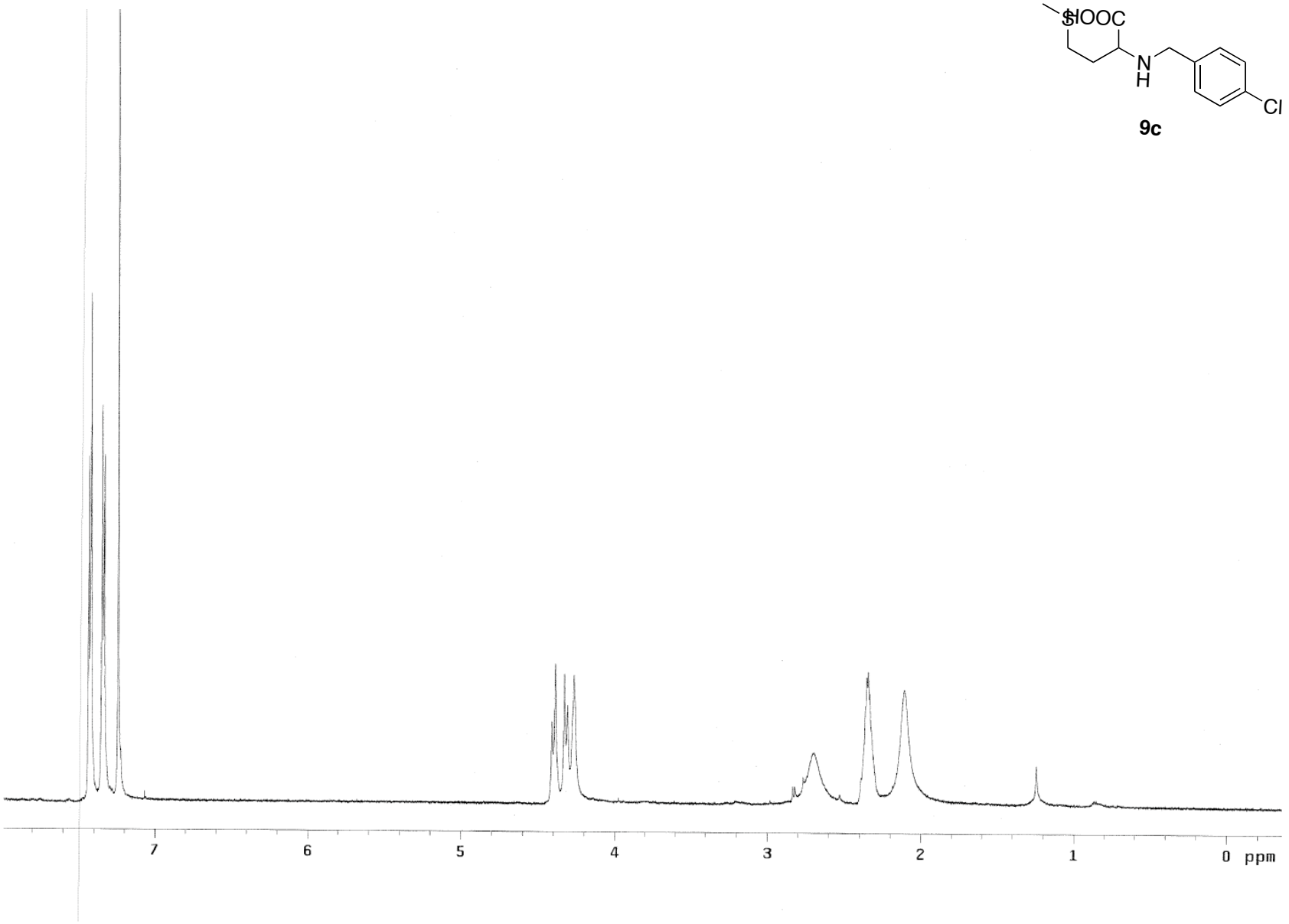

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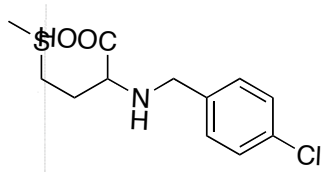

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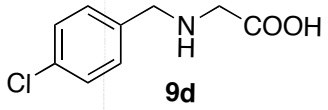

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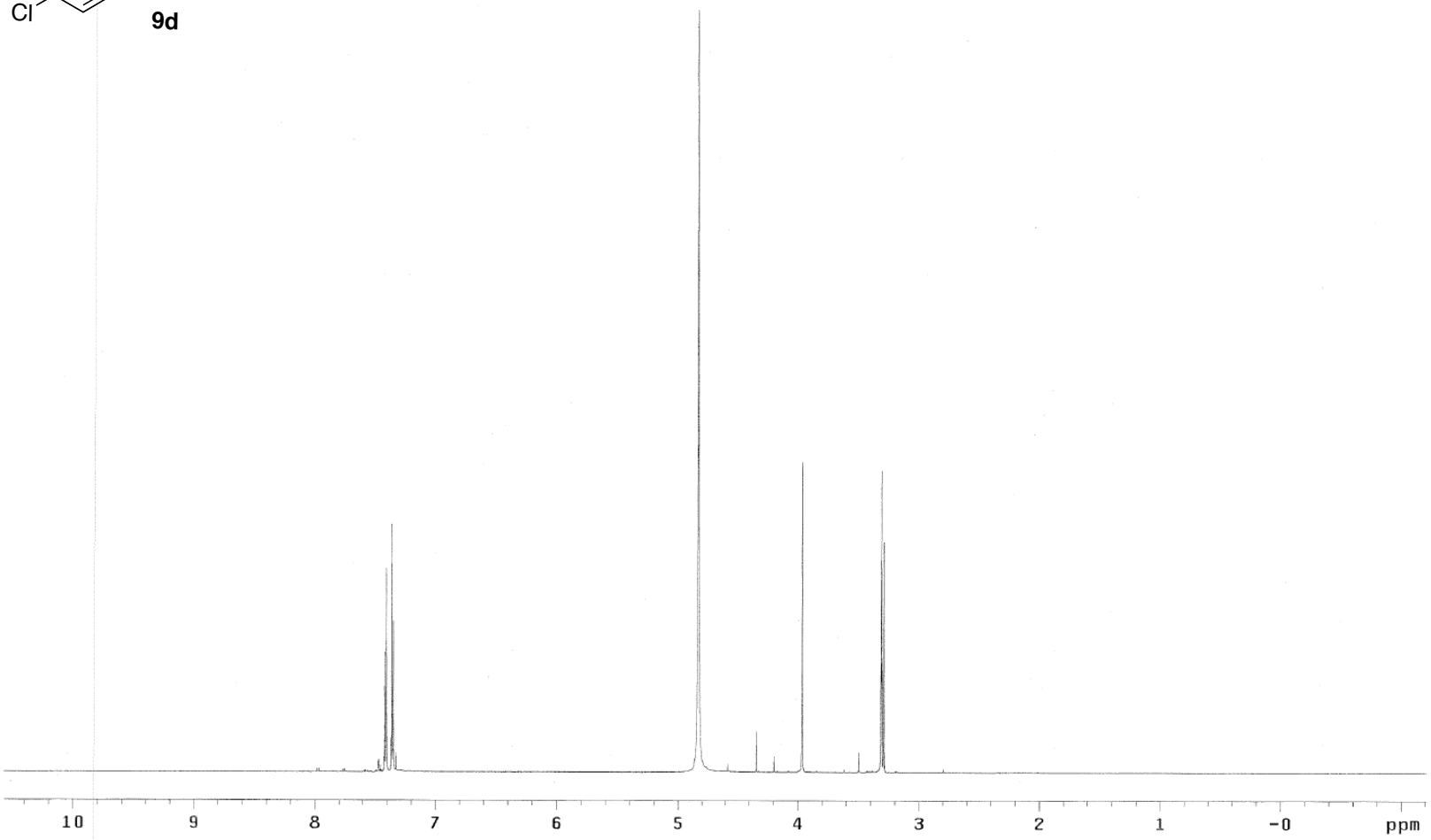

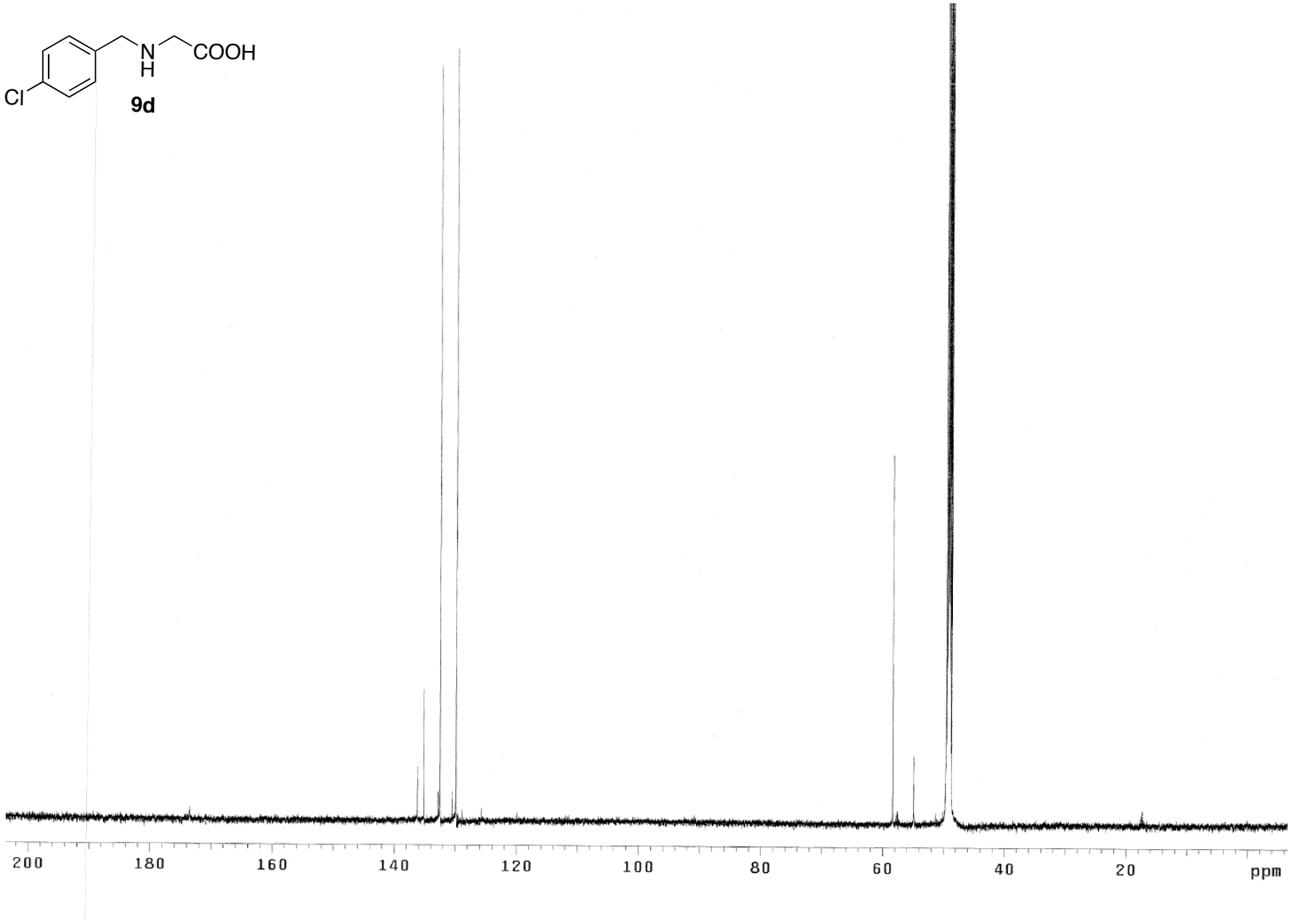

IV.ORTEP Drawing of the crystal structures

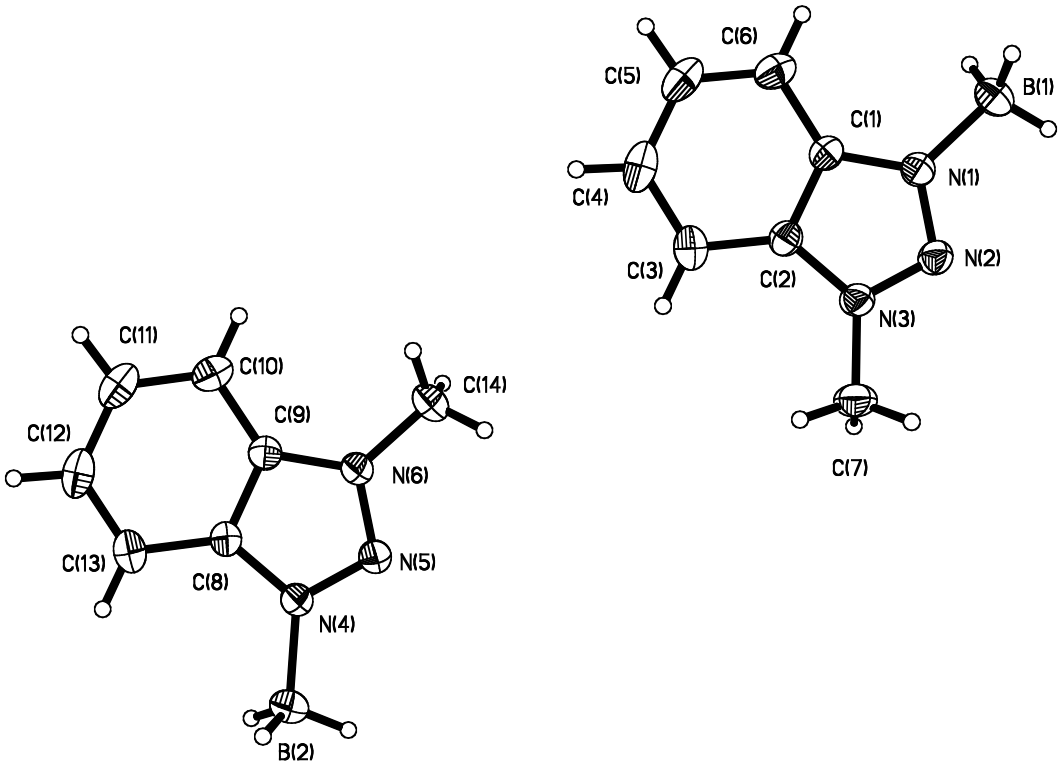

Figure 1. Perspective view of the molecular structures of the two independent molecules of **2a** with their respective atom labeling schemes. The thermal ellipsoids are scaled to enclose 30% probability. CCDC number: 741401.