

Supporting Information

Tuning Selectivity in Aliphatic C–H Bond Oxidation of *N*- Alkylamides and Phthalimides Catalyzed by Manganese Complexes

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1. Experimental Section

1.1 Materials

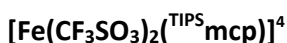
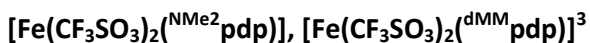
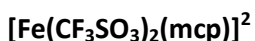
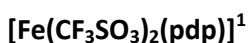
Reagents and solvents used were of commercially available reagent quality unless stated otherwise. Solvents were purchased from SDS and Scharlab. Solvents were purified and dried by passing through an activated alumina purification system (M-Braun SPS-800) or by conventional distillation techniques.

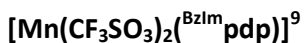
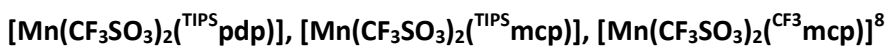
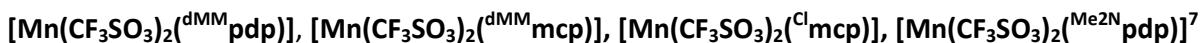
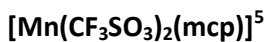
1.2 Instrumentation

Oxidation products were identified by comparison of their GC retention times and GC/MS with those of authentic compounds, and/or by ^1H and $^{13}\text{C}\{^1\text{H}\}$ -NMR analyses. Elemental analyses were performed using a CHNS-O EA-1108 elemental analyzer from Fisons. NMR spectra were taken on BrukerDPX300 and DPX400 spectrometers using standard conditions. High resolution mass spectra (HRMS) were recorded on a Bruker MicroTOF-Q IITM instrument with an ESI source at Serveis Tècnics of the University of Girona. Samples were introduced into the mass spectrometer ion source by direct infusion through a syringe pump and were externally calibrated using sodium formate.

2. Synthesis of the complexes

The manganese complexes were prepared according to the reported procedures:

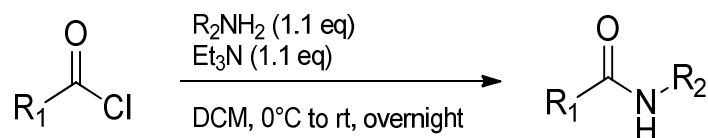




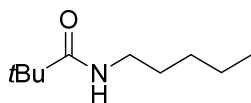
3. Synthesis of the substrates

The following substrates were prepared according to the reported procedures.

S16¹⁰

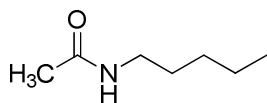


A round-bottom flask capped with a rubber septum and kept under nitrogen was charged with a 0.20 M solution of the amine (1.1 equiv) in dichloromethane and cooled to 0 °C. Triethylamine (1.1 equiv) was added to the reaction flask. The acyl chloride (1.0 equiv) was added dropwise and the reaction was stirred overnight at room temperature. At this point, a saturated aqueous Na₂CO₃ solution was added until pH~10-11 and then diluted with dichloromethane. The organic layer was separated from the basic aqueous layer. The aqueous layer was extracted with dichloromethane (2x) and the organic layers were combined. The organic layer was washed with 1N HCl and dried over anhydrous sodium sulfate (Na₂SO₄). The organic layer was evaporated to dryness and the crude amide was purified by flash chromatography over silica gel.



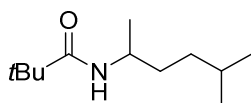
N-pentylpivalamide (S1): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.65 g, 88% yield). ¹H-NMR (CDCl₃, 400 MHz, 300K) δ, ppm: 5.74 (s, 1H), 3.19 (td, *J* = 7.2, 5.7 Hz, 2H), 1.55 – 1.40 (m, 2H), 1.36 – 1.22 (m, 4H), 1.16 (s, 9H), 0.93 – 0.80 (m, 3H). ¹³C-NMR 178.3, 39.5, 38.6, 29.3,

29.0, 27.6, 22.3, 14.0. HRMS(ESI+) m/z calculated for $C_{10}H_{21}NO$ $[M+Na]^+$ 194.1515, found 194.1515.

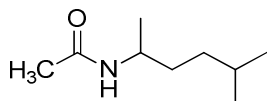


N-pentylacetamide (S2): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.53 g, 60% yield).

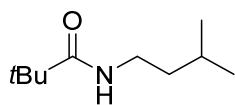
1H -NMR ($CDCl_3$, 400 MHz, 300K) δ , ppm: 6.16 (s, 1H), 3.17 (td, $J = 7.2, 5.7$ Hz, 2H), 1.93 (s, 3H), 1.55 – 1.38 (m, 2H), 1.37 – 1.14 (m, 4H), 0.91 – 0.78 (m, 3H). ^{13}C -NMR 170.2, 39.6, 29.2, 29.0, 23.2, 22.3, 13.9. HRMS(ESI+) m/z calculated for $C_7H_{15}NO$ $[M+Na]^+$ 152.1046, found 152.1047.



N-(2-(5-methylhexyl)pivalamide (S5): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.48 g, 85% yield). 1H -NMR ($CDCl_3$, 400 MHz, 300K) δ , ppm: 5.37 (s, 1H), 3.91 (dq, $J = 8.3, 6.7$ Hz, 1H), 1.51 (dq, $J = 13.3, 6.6$ Hz, 1H), 1.45 – 1.33 (m, 2H), 1.16 (s, 9H), 1.08 (d, $J = 6.6$ Hz, 3H), 0.85 (d, $J = 6.6$ Hz, 6H). ^{13}C -NMR 177.5, 45.0, 38.5, 35.1, 34.7, 27.9, 27.6, 22.5, 20.9. HRMS(ESI+) m/z calculated for $C_{12}H_{25}NO$ $[M+Na]^+$ 222.1828, found 222.1832.

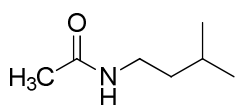


N-(2-(5-methylhexyl)acetamide (S6): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.43 g, 72% yield). 1H -NMR ($CDCl_3$, 400 MHz, 300K) δ , ppm: 5.90 (s, 1H), 3.87 (d, $J = 41.8$ Hz, 1H), 1.92 (s, 3H), 1.48 (dq, $J = 13.3, 6.6$ Hz, 1H), 1.42 – 1.31 (m, 2H), 1.20 – 1.10 (m, 2H), 1.07 (d, $J = 6.6$ Hz, 3H), 0.82 (d, $J = 6.7$ Hz, 6H). ^{13}C -NMR 169.4, 45.4, 35.1, 34.6, 27.9, 23.4, 22.52, 22.50, 20.9. HRMS(ESI+) m/z calculated for $C_9H_{19}NO$ $[M+Na]^+$ 180.1359, found 180.1360.



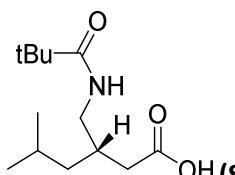
N-1-(3-methylbutyl)pivalamide (S9): Following the general conditions, the

crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.44 g, 64% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 5.71 (s, 1H), 3.29 – 3.16 (m, 2H), 1.57 (dp, $J = 13.3$, 6.7 Hz, 1H), 1.43 – 1.27 (m, 2H), 1.15 (s, 9H), 0.88 (d, $J = 6.6$ Hz, 6H). $^{13}\text{C-NMR}$ 178.3, 38.54, 38.49, 37.9, 27.6, 25.9, 22.5. HRMS(ESI+) m/z calculated for $\text{C}_{10}\text{H}_{21}\text{NO}$ $[\text{M}+\text{Na}]^+$ 194.1515, found 194.1518.



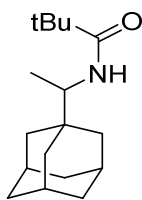
N-1-(3-methylbutyl)acetamide (S10): Following the general conditions, the

crude mixture was concentrated to dryness without further purification. The product was isolated as a white solid (0.65 g, 57% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 6.33 (s, 1H), 3.25 – 3.08 (m, 2H), 1.91 (s, 3H), 1.56 (dp, $J = 13.3$, 6.7 Hz, 1H), 1.33 (q, $J = 7.1$ Hz, 2H), 0.85 (d, $J = 6.6$ Hz, 6H). $^{13}\text{C-NMR}$ 170.3, 38.3, 37.9, 25.8, 23.1, 22.4. HRMS(ESI+) m/z calculated for $\text{C}_7\text{H}_{15}\text{NO}$ $[\text{M}+\text{Na}]^+$ 152.1046, found 152.1047.

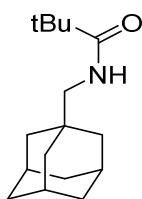


N-1-(3-methylbutyl)-2-(3-methylbutyl)acetamide (S13): Following the general conditions, the crude mixture was purified by flash

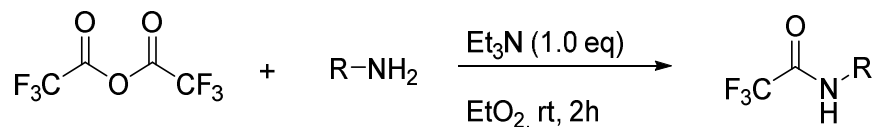
chromatography over silica with hexane:ethyl acetate 5:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.19 g, 72% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 6.22 (s, 1H), 3.44 – 3.10 (m, 2H), 2.37 (dd, $J = 15.0$, 4.4 Hz, 1H), 2.27 (dd, $J = 15.0$, 7.8 Hz, 1H), 2.20 – 2.08 (m, 1H), 1.70 (dt, $J = 13.4$, 6.7 Hz, 1H), 1.22 (s, 9H), 1.18 (dd, $J = 7.2$, 1.2 Hz, 2H), 0.92 (dd, $J = 9.3$, 6.6 Hz, 6H). $^{13}\text{C-NMR}$ 179.8, 176.8, 43.4, 41.7, 38.8, 37.6, 33.4, 27.5, 25.2, 22.7, 22.6. HRMS(ESI+) m/z calculated for $\text{C}_{13}\text{H}_{25}\text{NO}_3$ $[\text{M}+\text{Na}]^+$ 266.1727, found 266.1734.



(S15): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.99 g, 98% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 5.46 (d, $J = 9.6$ Hz, 1H), 3.69 (dq, $J = 9.6, 6.9$ Hz, 1H), 1.97 (p, $J = 3.2$ Hz, 3H), 1.77 – 1.56 (m, 6H), 1.55 – 1.39 (m, 6H), 1.19 (s, 9H), 0.99 (d, $J = 6.9$ Hz, 3H). $^{13}\text{C-NMR}$ 177.4, 52.3, 38.8, 38.4, 37.1, 35.9, 28.3, 27.7, 14.5. HRMS(ESI+) m/z calculated for $\text{C}_{17}\text{H}_{29}\text{NO}$ $[\text{M}+\text{Na}]^+$ 286.2141, found 286.4144.

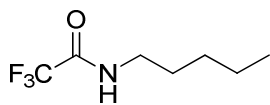


(S17): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 2:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.42 g, 98% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 5.68 (s, 1H), 2.95 (d, $J = 6.3$ Hz, 2H), 1.98 (q, $J = 3.2$ Hz, 3H), 1.80 – 1.57 (m, 6H), 1.48 (d, $J = 2.8$ Hz, 6H), 1.22 (s, 9H). $^{13}\text{C-NMR}$ 178.3, 50.7, 40.3, 38.9, 37.0, 33.8, 28.2, 27.8. HRMS(ESI+) m/z calculated for $\text{C}_{16}\text{H}_{27}\text{NO}$ $[\text{M}+\text{Na}]^+$ 272.1985, found 272.1988.



A round-bottom flask equipped with a septum and kept under nitrogen was charged with the amine (1.0 equiv) and solubilized in diethylether (1.4 M). Triethylamine (1.0 equiv) was added to the reaction flask. Trifluoroacetic anhydride (1.0 equiv) in diethylether (1.4 M) was added dropwise and the reaction was stirred for 2 hours at room temperature. At this point H_2O was added and the basic aqueous layer was separated. The organic layer was extracted with NaHCO_3 , saturated with NH_4Cl and dried over anhydrous sodium sulfate (Na_2SO_4). The organic layer was

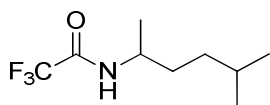
evaporated to dryness and the crude amine was purified by flash chromatography over silica gel and the product was concentrated to dryness.



N-pentyltrifluoroacetamide (S3): Following the general conditions, the

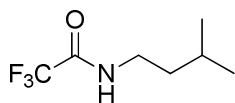
crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.37 g, 73% yield).

$^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 6.73 (s, 1H), 3.47 – 3.22 (m, 2H), 1.67 – 1.51 (m, 2H), 1.44 – 1.20 (m, 4H), 0.99 – 0.80 (m, 3H). $^{13}\text{C-NMR}$ 157.5, 121.6, 117.8, 114.0, 40.0, 28.7, 28.5, 22.2, 13.8. HRMS(ESI+) m/z calculated for $\text{C}_7\text{H}_{12}\text{F}_3\text{NO}$ $[\text{M}+\text{Na}]^+$ 206.0763, found 206.0769.



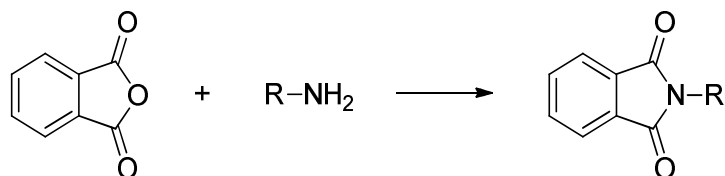
N-(2-(5-methylhexyl)trifluoroacetamide (S7): Following the general

conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.55 g, 64% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 6.44 (s, 1H), 4.09 – 3.87 (m, 1H), 1.53 (td, $J = 12.7, 11.7, 7.0$ Hz, 3H), 1.22 (d, $J = 6.6$ Hz, 4H), 1.17 (d, $J = 6.7$ Hz, 1H), 0.88 (d, $J = 6.8$ Hz, 6H). $^{13}\text{C-NMR}$ 156.8, 121.6, 117.8, 114.0, 46.8, 34.9, 34.0, 27.8, 22.4, 20.2. HRMS(ESI+) m/z calculated for $\text{C}_9\text{H}_{16}\text{F}_3\text{NO}$ $[\text{M}+\text{Na}]^+$ 234.1076, found 234.1075.

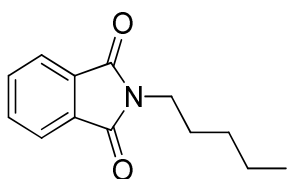


N-1-(3-methylbutyl)trifluoroacetamide (S11): Following the general

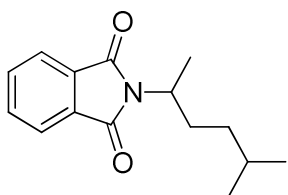
conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.56 g, 71% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 6.68 (s, 1H), 3.45 – 3.31 (m, 2H), 1.75 – 1.56 (m, 1H), 1.56 – 1.42 (m, 2H), 0.94 (d, $J = 6.6$ Hz, 6H). $^{13}\text{C-NMR}$ 157.5, 121.6, 117.8, 114.0, 38.3, 37.6, 25.7, 22.2. HRMS(ESI+) m/z calculated for $\text{C}_7\text{H}_{12}\text{F}_3\text{NO}$ $[\text{M}+\text{Na}]^+$ 206.0763, found 206.0762.



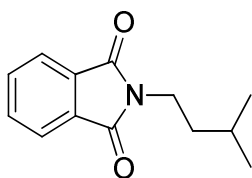
Phthalic anhydride (1.5 equiv) was added to a solution of the amine (1.0 equiv) in DMF and refluxed overnight at 155° C for 12 hours. The reaction was cooled to room temperature and poured into 50 mL of 1M HCl and extracted with Et₂O. The organic layer was then dried with magnesium sulfate and concentrated under reduced pressure. The crude phthalimide was purified by flash chromatography over silica gel.



N-pentylphthalimide (S4): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 5:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.67 g, 90% yield). ¹H-NMR (CDCl₃, 400 MHz, 300K) δ , ppm: 7.86 – 7.73 (m, 2H), 7.72 – 7.59 (m, 2H), 3.72 – 3.54 (m, 2H), 1.74 – 1.54 (m, 2H), 1.37 – 1.20 (m, 4H), 0.93 – 0.73 (m, 3H). ¹³C-NMR 168.4, 133.8, 132.1, 123.1, 38.0, 28.9, 28.2, 22.2, 13.9. HRMS(ESI+) *m/z* calculated for C₁₃H₁₅NO₂ [M+Na]⁺ 240.0995, found 240.0995.

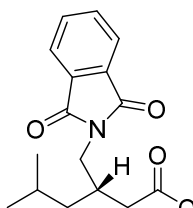


N-(2-(5-methylhexyl)phthalimide (S8): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 5:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.43 g, 95% yield). ¹H-NMR (CDCl₃, 400 MHz, 300K) δ , ppm: 7.87 – 7.73 (m, 2H), 7.76 – 7.62 (m, 2H), 4.29 (ddt, *J* = 13.0, 9.3, 6.9 Hz, 1H), 2.03 (dddd, *J* = 13.5, 11.1, 9.3, 5.1 Hz, 1H), 1.71 (dddd, *J* = 13.6, 11.3, 6.0, 5.3 Hz, 1H), 1.58 – 1.48 (m, 1H), 1.45 (d, *J* = 7.0 Hz, 3H), 1.28 – 0.96 (m, 2H), 0.82 (dd, *J* = 6.6, 3.4 Hz, 6H). ¹³C-NMR 168.5, 133.7, 132.0, 123.0, 47.7, 35.9, 31.6, 27.8, 22.6, 22.4, 18.7. HRMS(ESI+) *m/z* calculated for C₁₅H₁₉NO₂ [M+Na]⁺ 268.1308, found 268.1309.



N-1-(3-methylbutyl)phthalimide (S12): Following the general conditions, the

crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 5:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.54 g, 96% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 7.85 – 7.73 (m, 2H), 7.72 – 7.59 (m, 2H), 3.74 – 3.55 (m, 2H), 1.66 – 1.44 (m, 3H), 0.92 (d, $J = 6.3$ Hz, 6H). $^{13}\text{C-NMR}$ 168.3, 133.8, 132.1, 123.0, 35.3, 36.4, 25.8, 22.3. HRMS(ESI+) m/z calculated for $\text{C}_{13}\text{H}_{15}\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 240.0995, found 240.1003.



(S14): Following the general conditions, the crude mixture was purified by flash

chromatography over silica with hexane:ethyl acetate 5:1 and the product was concentrated to dryness. The product was isolated as a white solid (0.29 g, 70% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 7.95 – 7.79 (m, 2H), 7.79 – 7.59 (m, 2H), 3.79 – 3.53 (m, 2H), 2.45 (dtd, $J = 8.2, 6.6, 4.9$ Hz, 1H), 2.40 – 2.25 (m, 2H), 1.78 (dq, $J = 13.5, 6.7$ Hz, 1H), 1.33 – 1.20 (m, 2H), 0.95 (dd, $J = 20.5, 6.6$ Hz, 6H). $^{13}\text{C-NMR}$ 177.2, 168.7, 134.0, 131.9, 123.3, 41.8, 41.6, 37.2, 32.7, 25.3, 22.7, 22.5. HRMS(ESI+) m/z calculated for $\text{C}_{16}\text{H}_{19}\text{NO}_4$ $[\text{M}+\text{Na}]^+$ 312.1206, found 312.1213.

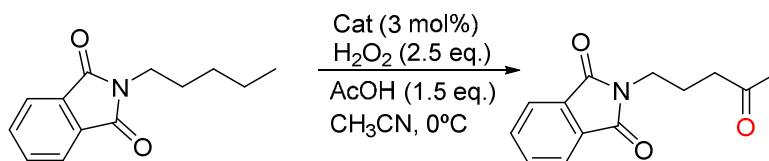
4. Oxidation reactions

Hydrogen peroxide solutions employed in the oxidation reactions were prepared by diluting commercially available hydrogen peroxide (30% H_2O_2 solution in water, Aldrich) in acetonitrile to achieve a 1.5 M final concentration. Commercially available glacial acetic acid (99-100%) purchased from Riedel-de-Haën was employed. The purity of the amide substrates synthesized as described above was in all cases >99%. Acetic acid was purchased from Aldrich.

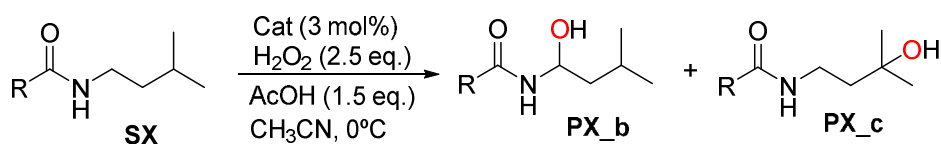
4.1 Reaction protocol for catalysis

An acetonitrile solution (400 μ L) of the substrate (0.25 M) and the pertinent complex (2.5 mM) was prepared in a vial (10 mL) equipped with a stirring bar and cooled at $-40\text{ }^{\circ}\text{C}$, in a $\text{CH}_3\text{CN}/\text{N}_2(\text{liq})$ bath. Acetic acid (13 equiv.) was added directly to the solution. Then hydrogen peroxide in CH_3CN (3.5 equiv.) was added by syringe pump over a period of 30 min. At this point, an internal standard was added and the solution was quickly filtered through a basic alumina plug, which was subsequently rinsed with 2 x 1 mL AcOEt. GC or ^1H -NMR analysis of the solution provided substrate conversions and product yields relative to the internal standard integration.

4.1.1 Oxidation Reactions with Fe(pdp) complex



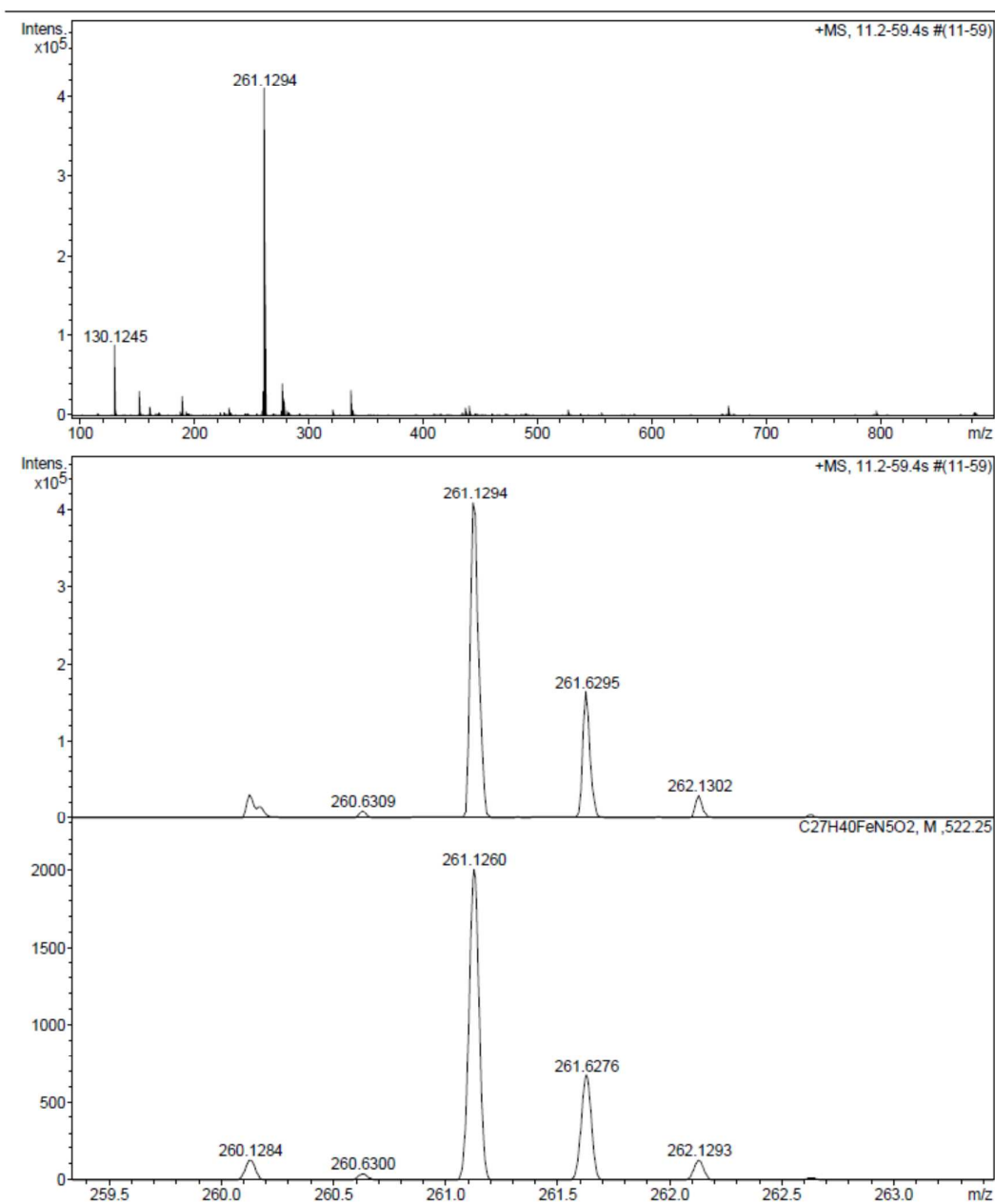
Entry	Substrate	Conv (%) ^a	Yield (%) ^a
1	S4	10	8



Entry	Substrate	Conv (%) ^a	Yield (%) ^a PX_b	Yield (%) ^a PX_c
1	S9	<2	-	-
2	S10	<2	-	-
3	S11	55	11	36

^aConversions and yields determined from crude reaction mixtures by GC and ¹H-NMR.

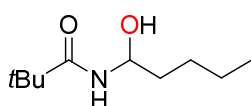
4.1.2 ESI-MS spectrum of $\{[\text{Fe}(\text{pdp})(\text{S10})+\text{O-H}]\}^{2+}$



4.2 General Procedure for product isolation

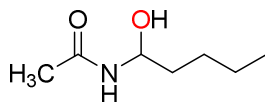
A 25 mL round bottom flask was charged with: catalyst (6 μmol , 1.0 mol%), substrate (1.0 equiv.), CH_3CN (3.3 mL) and a magnetic stirring bar. Acetic acid was then added (13 equiv.) and the mixture was cooled at $-40\text{ }^\circ\text{C}$ in an $\text{CH}_3\text{CN}/\text{N}_2(\text{liq})$ bath under magnetic stirring. Then, 1.4 mL of hydrogen peroxide solution in CH_3CN (3.5 equiv.) were added by syringe pump over a period of 30 min at $-40\text{ }^\circ\text{C}$. At this point, 15 mL of an aqueous NaHCO_3 saturated solution were added to the mixture. The resultant solution was extracted with CH_2Cl_2 (3 x 10 mL). The organic fractions were combined, dried over MgSO_4 , and the solvent was removed under reduced pressure to afford the oxidized product. This residue was filtered by silica gel column to obtain the pure product.

5. Characterization of the isolated products



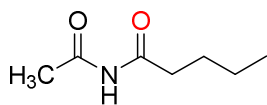
N-(1-hydroxy)pentylpivalamide (P1): Following the general conditions, the

crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (61 mg, 48% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 6.26 (d, $J = 5.2$ Hz, 1H), 5.28 (q, $J = 6.7$ Hz, 1H), 4.37 (s, 1H), 1.73 – 1.61 (m, 1H), 1.55 (tdt, $J = 11.7, 9.4, 6.2$ Hz, 1H), 1.36 (tddd, $J = 11.2, 9.4, 5.6, 2.0$ Hz, 4H), 1.18 (s, 9H), 0.90 (td, $J = 6.2, 5.5, 1.8$ Hz, 3H). $^{13}\text{C-NMR}$ 179.7, 74.4, 38.6, 34.9, 27.3, 27.0, 22.3, 13.9. HRMS(ESI+) m/z calculated for $\text{C}_{10}\text{H}_{21}\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 210.1465, found 210.1468.

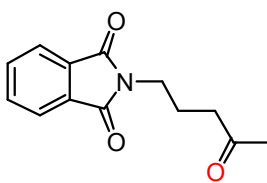


N-(1-hydroxy)pentylacetamide (P2): Following the general conditions, the

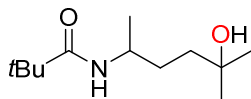
crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (40 mg, 36% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 6.46 (d, $J = 7.8$ Hz, 1H), 5.29 (td, $J = 8.6, 4.5$ Hz, 1H), 4.34 (d, $J = 3.5$ Hz, 1H), 2.00 (s, 3H), 1.74 – 1.62 (m, 1H), 1.62 – 1.50 (m, 1H), 1.46 – 1.26 (m, 4H), 0.97 – 0.85 (m, 3H). $^{13}\text{C-NMR}$ 171.6, 74.3, 34.9, 27.0, 23.3, 22.3, 13.9. HRMS(ESI+) m/z calculated for $\text{C}_7\text{H}_{15}\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 168.0995, found 168.0991.



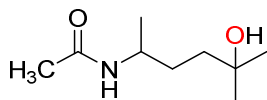
N-(1-oxo)pentylacetamide (P2_i): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (39 mg, 36% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 9.24 (s, 1H), 2.51 (t, $J = 7.5$ Hz, 2H), 2.34 (d, $J = 23.9$ Hz, 3H), 1.61 (p, $J = 7.5$ Hz, 2H), 1.35 (h, $J = 7.3$ Hz, 2H), 0.91 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C-NMR}$ 174.3, 172.7, 37.0, 26.5, 25.1, 22.2, 13.7. HRMS(ESI+) m/z calculated for $\text{C}_7\text{H}_{13}\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 166.0838, found 166.0843.



N-(4-oxo)pentylphthalimide (P4) Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 2:1 and the product was concentrated to dryness. The product was isolated as a white solid (53 mg, 41% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 7.78 (s, 2H), 7.70 (s, 2H), 3.66 (s, 2H), 2.47 (s, 2H), 2.11 (s, 3H), 1.89 (s, 2H). $^{13}\text{C-NMR}$ 208.1, 168.8, 134.1, 131.9, 123.3, 40.5, 37.1, 30.2, 22.6. HRMS(ESI+) m/z calculated for $\text{C}_{13}\text{H}_{13}\text{NO}_3$ $[\text{M}+\text{Na}]^+$ 254.0785, found 254.0785.

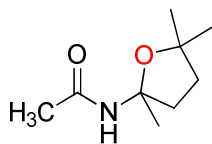


N-(2-(5-hydroxy-5-methylhexyl)-pivalamide (P5): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (69.3 mg, 52% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 5.55 (s, 1H), 4.04 – 3.87 (m, 1H), 2.26 (s, 1H), 1.59 - 1.42 (m, 4H), 1.19 (s, 6H), 1.17 (s, 9H), 1.11 (d, $J = 6.6$ Hz, 3H). $^{13}\text{C-NMR}$ 177.9, 70.4, 45.3, 39.4, 38.6, 31.6, 29.5, 29.3, 27.6, 21.1. HRMS(ESI+) m/z calculated for $\text{C}_{12}\text{H}_{25}\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 238.1778, found 238.1779.

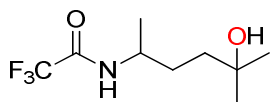


N-(2-(5-hydroxy-5-methylhexyl) acetamide (P6): Following the general conditions, the crude mixture was purified by flash chromatography over silica with ethyl acetate

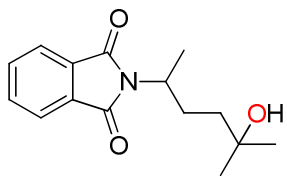
and 8% of methanol the product was concentrated to dryness. The product was isolated as a white solid (61.4 mg, 34% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 5.55 (d, $J = 8.3$ Hz, 1H), 4.10 – 3.89 (m, 1H), 1.98 (s, 3H), 1.59 – 1.46 (m, 4H), 1.22 (s, 6H), 1.15 (d, $J = 6.6$ Hz, 3H). $^{13}\text{C-NMR}$ 169.6, 70.6, 45.6, 39.5, 31.6, 29.5, 29.4, 23.5, 21.2. HRMS(ESI+) m/z calculated for $\text{C}_9\text{H}_{19}\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 196.1308, found 196.1316.



(P6_a): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 \rightarrow ethyl acetate and the product was concentrated to dryness. The product was isolated as a white solid with 11% yield of an impurity that could not be separated (38 mg, 33% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 5.71 (d, $J = 8.3$ Hz, 1H), 2.73 – 2.68 (m, 1H), 2.06 – 1.99 (m, 2H), 1.93 (s, 3H), 1.82 – 1.77 (m, 1H), 1.33 (s, 3H), 1.22 (s, 1H). $^{13}\text{C-NMR}$ 168.5, 93.5, 82.9, 37.8, 36.8, 29.7, 28.8, 26.4, 24.2. HRMS(ESI+) m/z calculated for $\text{C}_9\text{H}_{17}\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 194.1151, found 194.1157.

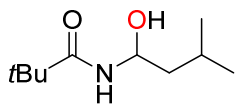


N-(2-(5-hydroxy-5-methylhexyl)trifluoroacetamide (P7): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (76.1 mg, 58% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 7.23 (s, 1H), 3.97 (s, 1H), 2.25 – 2.10 (m, 1H), 1.73 – 1.59 (m, 2H), 1.57 – 1.42 (m, 2H), 1.23 (s, 3H), 1.21 (s, 7H). $^{13}\text{C-NMR}$ 157.0, 120.2, 117.4, 114.5, 70.6, 46.8, 38.9, 30.4, 29.4, 29.3, 20.1. HRMS(ESI+) m/z calculated for $\text{C}_9\text{H}_{16}\text{F}_3\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 250.1025, found 250.1026.



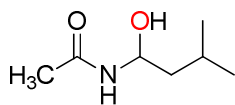
N-(2-(5-hydroxy-5-methylhexyl)phthalimide (P8): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (54.9 mg, 83% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 7.81 (dd, $J = 5.4, 3.0$ Hz, 2H),

7.70 (dd, $J = 5.5, 3.1$ Hz, 2H), 4.40 – 4.27 (m, 1H), 2.17 (dddd, $J = 13.5, 12.2, 9.6, 4.7$ Hz, 1H), 1.83 (dddd, $J = 13.5, 12.3, 5.8, 4.6$ Hz, 1H), 1.56 – 1.50 (m, 1H), 1.49 (d, $J = 6.9$ Hz, 3H), 1.35 (ddd, $J = 13.4, 12.3, 4.7$ Hz, 1H), 1.19 (s, 6H). $^{13}\text{C-NMR}$ 168.5, 133.8, 131.9, 123.1, 70.6, 47.9, 40.8, 29.4, 29.0, 28.7, 18.9. HRMS(ESI+) m/z calculated for $\text{C}_{15}\text{H}_{19}\text{NO}_3$ $[\text{M}+\text{Na}]^+$ 284.1257, found 284.1257.



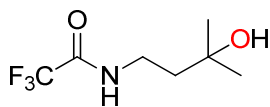
N-1-(1-hydroxy-3-methylbutyl)-pivalamide (P9_b): Following the general

conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (65.5 mg, 64% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 6.27 (d, $J = 7.8$ Hz, 1H), 5.37 (td, $J = 7.5, 5.8$ Hz, 1H), 4.55 (s, 1H), 1.73 (ddt, $J = 13.0, 7.6, 6.5$ Hz, 1H), 1.59 (ddd, $J = 13.8, 7.4, 6.5$ Hz, 1H), 1.36 (ddd, $J = 13.5, 7.7, 5.8$ Hz, 1H), 1.16 (s, 9H), 0.93 – 0.84 (m, 6H). $^{13}\text{C-NMR}$ 179.5, 72.9, 44.1, 38.5, 27.3, 24.5, 22.8, 22.2. HRMS(ESI+) m/z calculated for $\text{C}_{10}\text{H}_{21}\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 210.1465, found 210.1466.



N-1-(1-hydroxy-3-methylbutyl)acetamide (P10_b): Following the general

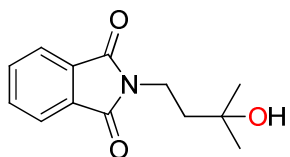
conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:4 and the product was concentrated to dryness. The product was isolated as a white solid (74.3 mg, 65% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 6.68 (d, $J = 8.2$ Hz, 1H), 5.38 (td, $J = 7.7, 5.9$ Hz, 1H), 4.64 (s, 1H), 1.97 (s, 3H), 1.81 – 1.66 (m, 1H), 1.57 (dt, $J = 13.8, 7.1$ Hz, 1H), 1.43 – 1.33 (m, 1H), 0.91 (dd, $J = 6.6, 2.8$ Hz, 6H). $^{13}\text{C-NMR}$ 171.4, 72.6, 44.1, 29.7, 24.4, 23.3, 22.2. HRMS(ESI+) m/z calculated for $\text{C}_7\text{H}_{15}\text{NO}_2$ $[\text{M}+\text{Na}]^+$ 168.0995, found 168.0992.



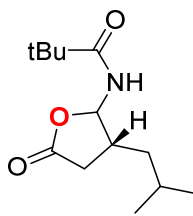
N-1-(3-hydroxy-3-methylbutyl)trifluoroacetamide (P11_c): Following the

general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 1:1 and the product was concentrated to dryness. The product was isolated as a white solid (46 mg, 48% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 7.98 (s, 1H), 3.61 – 3.42 (m, 2H), 2.28 (s, 1H), 1.84 – 1.63 (m, 2H), 1.30 (s, 6H). $^{13}\text{C-NMR}$ 157.2, 120.2, 117.4, 114.5,

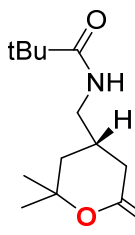
71.8, 39.5, 36.5, 29.6. HRMS(ESI+) m/z calculated for $C_7H_{12}F_3NO_2$ $[M+Na]^+$ 222.0712, found 222.0713.



N-1-(3-hydroxy-3-methylbutyl)phthalimide (P12): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 2:1 and the product was concentrated to dryness. The product was isolated as a white solid (57 mg, 65% yield). 1H -NMR ($CDCl_3$, 400 MHz, 300K) δ , ppm: 7.86 – 7.74 (m, 2H), 7.74 – 7.60 (m, 2H), 3.91 – 3.75 (m, 2H), 2.29 (s, 1H), 1.92 – 1.80 (m, 2H), 1.30 (s, 6H). ^{13}C -NMR 168.5, 133.9, 132.2, 123.2, 69.8, 41.4, 34.0, 29.3. HRMS(ESI+) m/z calculated for $C_{13}H_{15}NO_3$ $[M+Na]^+$ 256.0944, found 256.0948.

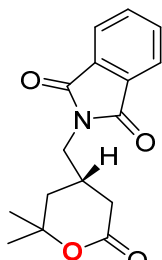


(P13_a): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 2:1 and the product was concentrated to dryness. The product was isolated as a white solid (24 mg, 26% yield). 1H -NMR ($CDCl_3$, 400 MHz, 300K) δ , ppm: 6.53 (d, $J = 9.7$ Hz, 1H), 5.89 (dd, $J = 9.7, 7.5$ Hz, 1H), 2.78 (dd, $J = 17.0, 8.1$ Hz, 1H), 2.46 – 2.36 (m, 1H), 2.29 (dd, $J = 17.0, 10.2$ Hz, 1H), 1.59 (dt, $J = 13.3, 6.7$ Hz, 1H), 1.54 – 1.38 (m, 2H), 1.23 (s, 9H), 0.93 (dd, $J = 11.0, 6.5$ Hz, 6H). ^{13}C -NMR 178.9, 174.4, 86.0, 41.4, 40.0, 40.1, 38.9, 35.8, 27.2, 26.1, 22.7, 22.3. HRMS(ESI+) m/z calculated for $C_{13}H_{23}NO_3$ $[M+Na]^+$ 264.1570, found 264.1588.

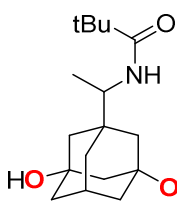


(P13_b): Following the general conditions, the crude mixture was purified by flash chromatography over silica with hexane:ethyl acetate 2:1 and the product was concentrated to

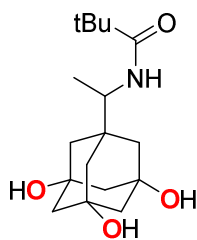
dryness. The product was isolated as a white solid (7 mg, 7% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 5.81 (s, 1H), 3.37 – 3.09 (m, 2H), 2.66 (ddd, $J = 17.7, 5.6, 2.1$ Hz, 1H), 2.38 – 2.32 (m, 1H), 2.06 (dd, $J = 17.7, 11.7$ Hz, 1H), 1.85 (ddd, $J = 13.7, 3.6, 2.1$ Hz, 1H), 1.47 (s, 3H), 1.39 (s, 3H), 1.23 (s, 9H). $^{13}\text{C-NMR}$ 178.9, 170.5, 81.9, 44.2, 38.8, 38.5, 33.6, 30.7, 29.8, 27.63, 27.58. HRMS(ESI+) m/z calculated for $\text{C}_{13}\text{H}_{23}\text{NO}_3$ $[\text{M}+\text{Na}]^+$ 264.1570, found 264.1555.



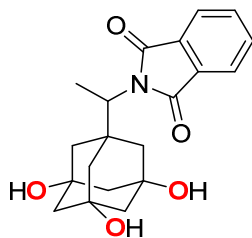
(P14) Following the general conditions, the crude mixture was purified by flash chromatography over silica with CH_2Cl_2 and 2% of MeOH and the product was concentrated to dryness. The product was isolated as a white solid (58 mg, 60% yield). $^1\text{H-NMR}$ (CDCl_3 , 400 MHz, 300K) δ , ppm: 8.00 – 7.84 (m, 2H), 7.84 – 7.65 (m, 2H), 3.68 (d, $J = 6.7$ Hz, 2H), 2.68 (ddd, $J = 17.4, 5.5, 2.2$ Hz, 1H), 2.60 (dddd, $J = 11.6, 10.4, 5.7, 3.6$ Hz, 1H), 2.24 – 2.09 (m, 1H), 1.88 (ddd, $J = 13.8, 3.6, 2.2$ Hz, 1H), 1.47 (s, 3H), 1.38 (s, 3H), 1.28 (s, 1H). $^{13}\text{C-NMR}$ 169.9, 168.4, 134.3, 131.7, 123.5, 81.7, 42.4, 38.5, 33.6, 30.7, 29.2, 27.6. HRMS(ESI+) m/z calculated for $\text{C}_{16}\text{H}_{17}\text{NO}_4$ $[\text{M}+\text{Na}]^+$ 310.1050, found 310.1061.



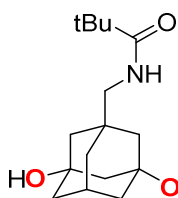
(P15_a): Following the general conditions, the crude mixture was purified by flash chromatography over silica with ethyl acetate and 10% of MeOH and the product was concentrated to dryness. The product was isolated as a white solid (47 mg, 25% yield). $^1\text{H-NMR}$ (MeOD, 400 MHz, 300K) δ , ppm: 6.87 (d, $J = 9.6$ Hz, 1H), 3.86 (dq, $J = 9.6, 7.0$ Hz, 1H), 2.32 (p, $J = 3.2$ Hz, 1H), 1.71 – 1.52 (m, 6H), 1.43 (s, 4H), 1.39 – 1.31 (m, 2H), 1.22 (s, 9H), 1.09 (d, $J = 7.0$ Hz, 3H). $^{13}\text{C-NMR}$ 179.2, 69.78, 69.72, 51.4, 44.8, 44.7, 42.8, 41.7, 38.4, 36.0, 30.6, 26.6, 13.4. HRMS(ESI+) m/z calculated for $\text{C}_{17}\text{H}_{29}\text{NO}_3$ $[\text{M}+\text{Na}]^+$ 318.2040, found 218.2049.



(P15_b): Following the general conditions, the crude mixture was purified by flash chromatography over silica with ethyl acetate and 10% of MeOH and the product was concentrated to dryness. The product was isolated as a white solid (109 mg, 55% yield). $^1\text{H-NMR}$ (MeOD, 400 MHz, 300K) δ , ppm: 6.94 (d, $J = 9.5$ Hz, 1H), 4.04 – 3.83 (m, 1H), 3.52 - 3.50 (m, 1H), 1.75 – 1.47 (m, 6H), 1.39 (s, 6H), 1.22 (s, 9H), 1.11 (d, $J = 7.0$ Hz, 3H). $^{13}\text{C-NMR}$ 179.3, 70.1, 50.9, 50.5, 43.9, 41.3, 38.4, 26.5, 13.5. HRMS(ESI+) m/z calculated for $\text{C}_{17}\text{H}_{29}\text{NO}_4$ $[\text{M}+\text{Na}]^+$ 334.1989, found 334.1989.

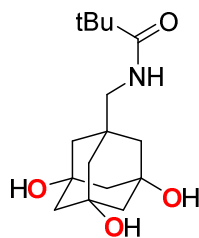


(P16): Following the general conditions, the crude mixture was purified by flash chromatography over silica with ethyl acetate and 10% of MeOH and the product was concentrated to dryness. The product was isolated as a white solid (55 mg, 41% yield). $^1\text{H-NMR}$ (MeOD, 400 MHz, 300K) δ , ppm: 7.85 – 7.69 (m, 4H), 4.22 (q, $J = 7.3$ Hz, 1H), 1.67 (s, 1H), 1.64 – 1.59 (m, 4H), 1.55 (d, $J = 1.5$ Hz, 4H), 1.53 (d, $J = 3.0$ Hz, 3H), 1.45 (t, $J = 2.2$ Hz, 2H), 1.42 (t, $J = 2.3$ Hz, 1H). $^{13}\text{C-NMR}$ 168.9, 134.6, 131.3, 122.3, 70.0, 55.2, 50.2, 44.9, 44.2, 42.4, 42.2. HRMS(ESI+) m/z calculated for $\text{C}_{20}\text{H}_{23}\text{NO}_5$ $[\text{M}+\text{Na}]^+$ 380.1468, found 380.1468.



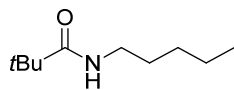
(P17_a) Following the general conditions, the crude mixture was purified by flash chromatography over silica with ethyl acetate and 10% of MeOH and the product was concentrated to dryness. The product was isolated as a white solid (82 mg, 42% yield). $^1\text{H-NMR}$ (MeOD, 400 MHz, 300K) δ , ppm: 7.44 (m, 1H), 3.05 (s, 2H), 1.68 – 1.54 (m, 7H), 1.40 (s, 4H), 1.32

(m, 2H), 1.22 (s, 9H). $^{13}\text{C-NMR}$ 180.1, 69.7, 51.4, 48.7, 46.3, 42.8, 39.6, 38.5, 37.8, 30.6, 26.6. HRMS(ESI+) m/z calculated for $\text{C}_{16}\text{H}_{27}\text{NO}_3$ $[\text{M}+\text{Na}]^+$ 304.1883, found 304.1876.

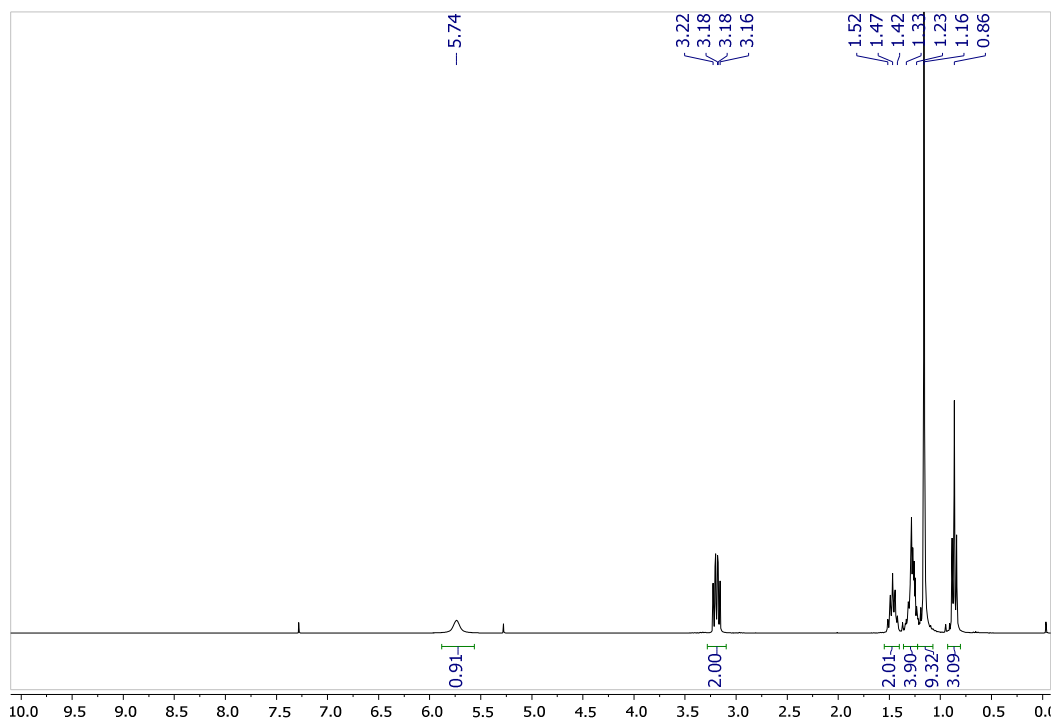


(P17_b) Following the general conditions, the crude mixture was purified by flash chromatography over silica with ethyl acetate and 10% of MeOH and the product was concentrated to dryness. The product was isolated as a white solid (37 mg, 18% yield). $^1\text{H-NMR}$ (MeOD, 400 MHz, 300K) δ , ppm: 7.49 (m, 1H), 3.10 (s, 2H), 1.67 – 1.57 (m, 6H), 1.46 (s, 6H), 1.32 (m, 2H), 1.22 (s, 9H). $^{13}\text{C-NMR}$ 180.2, 70.0, 50.4, 45.5, 39.1, 38.5, 26.6. HRMS(ESI+) m/z calculated for $\text{C}_{16}\text{H}_{27}\text{NO}_3$ $[\text{M}+\text{Na}]^+$ 304.1883, found 304.1876. HRMS(ESI+) m/z calculated for $\text{C}_{16}\text{H}_{27}\text{NO}_4$ $[\text{M}+\text{Na}]^+$ 320.1832, found 320.1819.

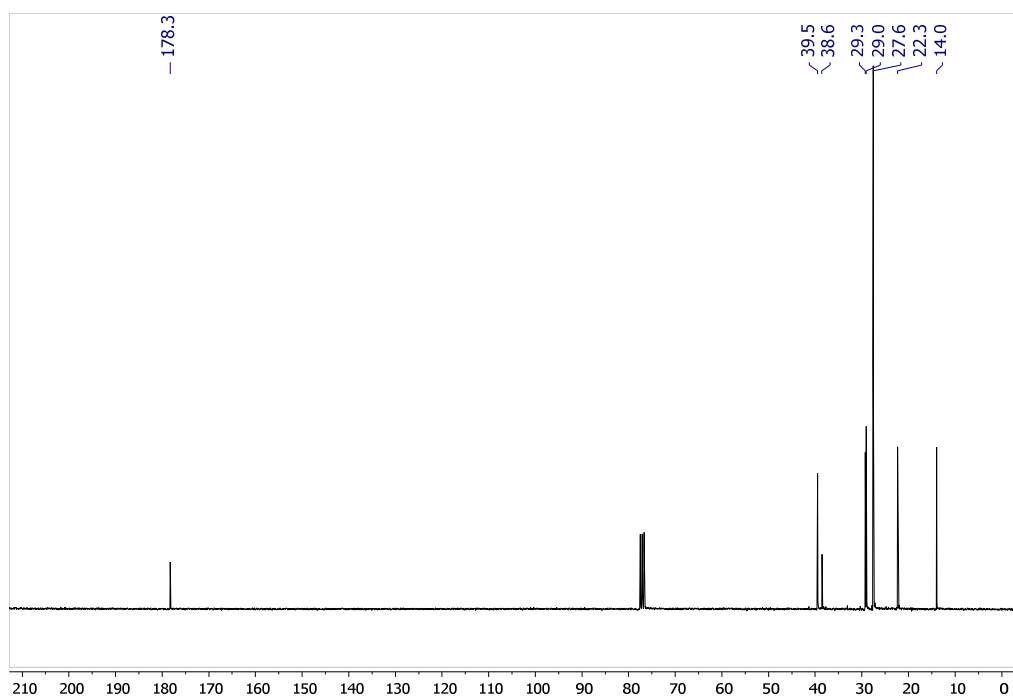
A1 ^1H and $^{13}\text{C}\{^1\text{H}\}$ NMR spectra of substrates

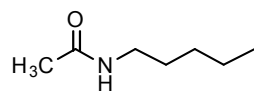


^1H -NMR of **S1** in CDCl_3

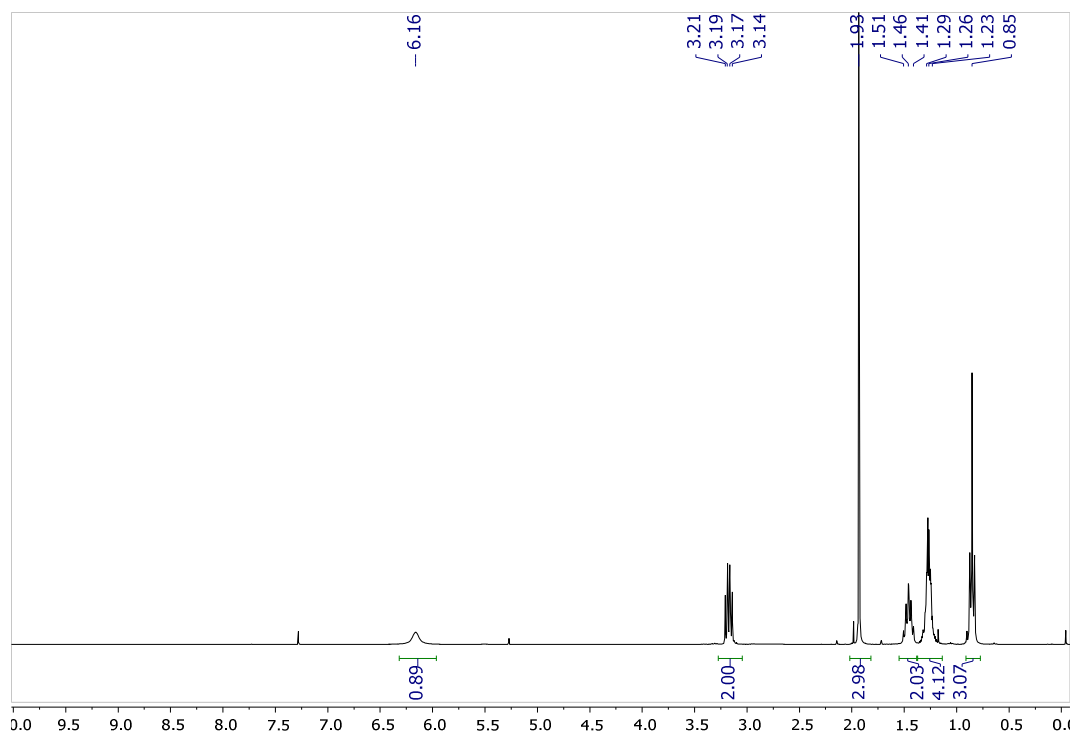


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S1** in CDCl_3

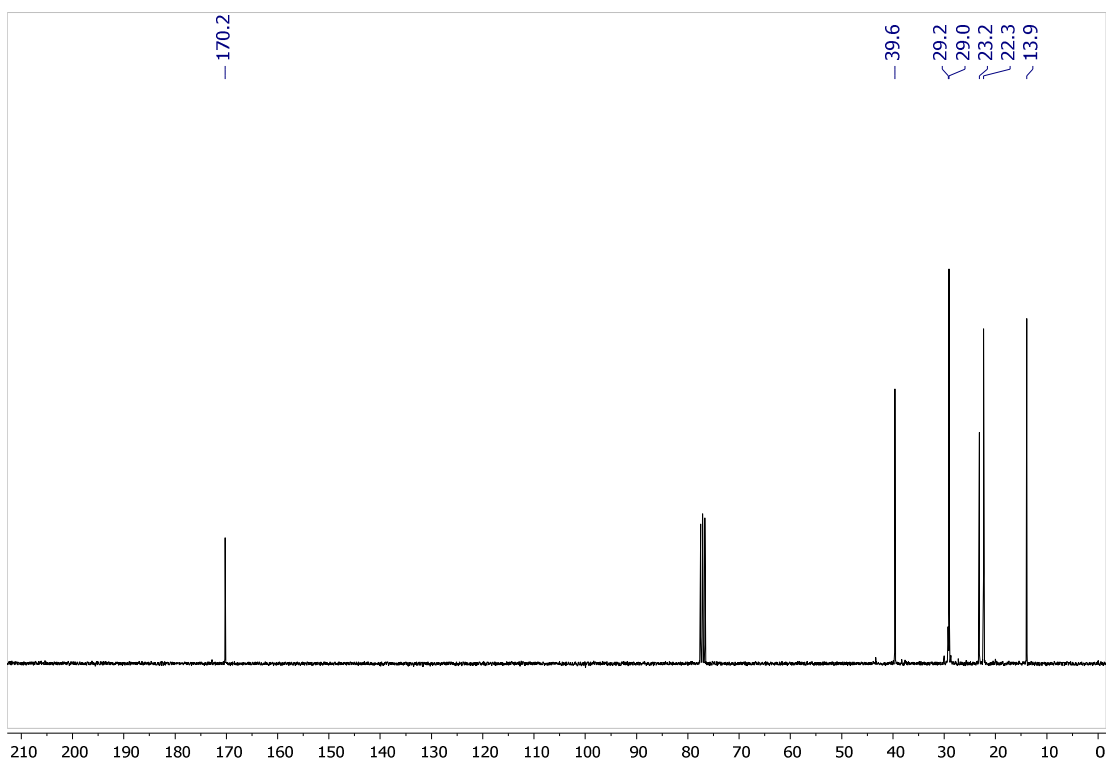


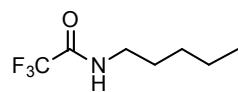


$^1\text{H-NMR}$ of **S2** in CDCl_3

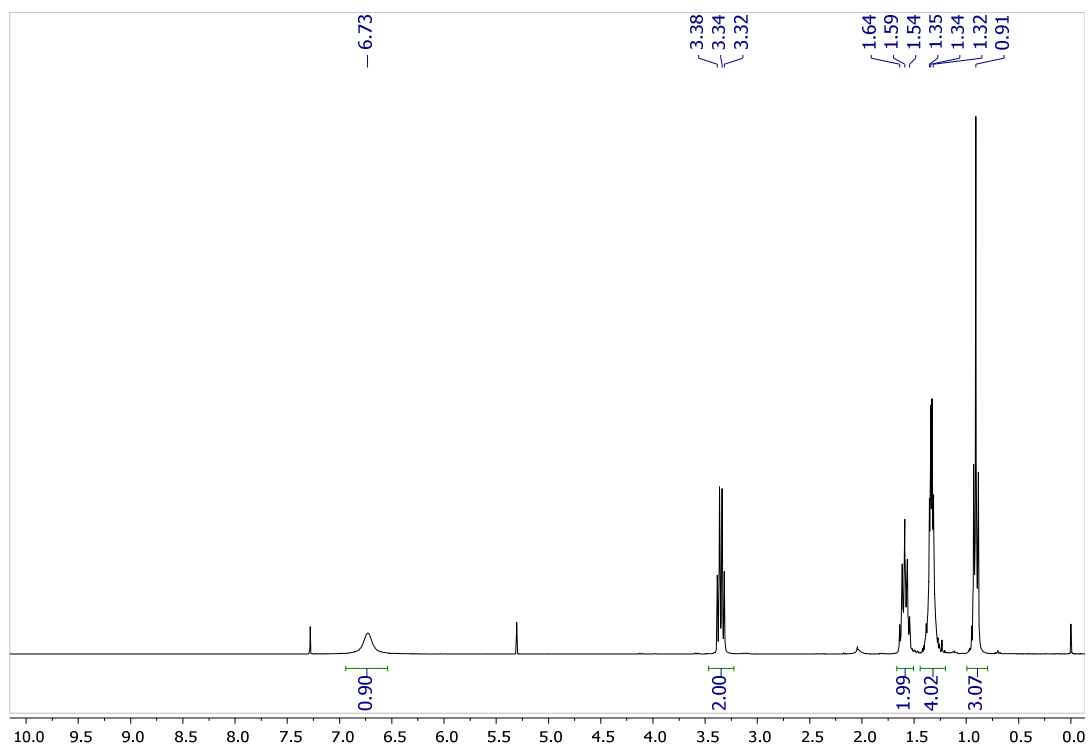


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S2** in CDCl_3

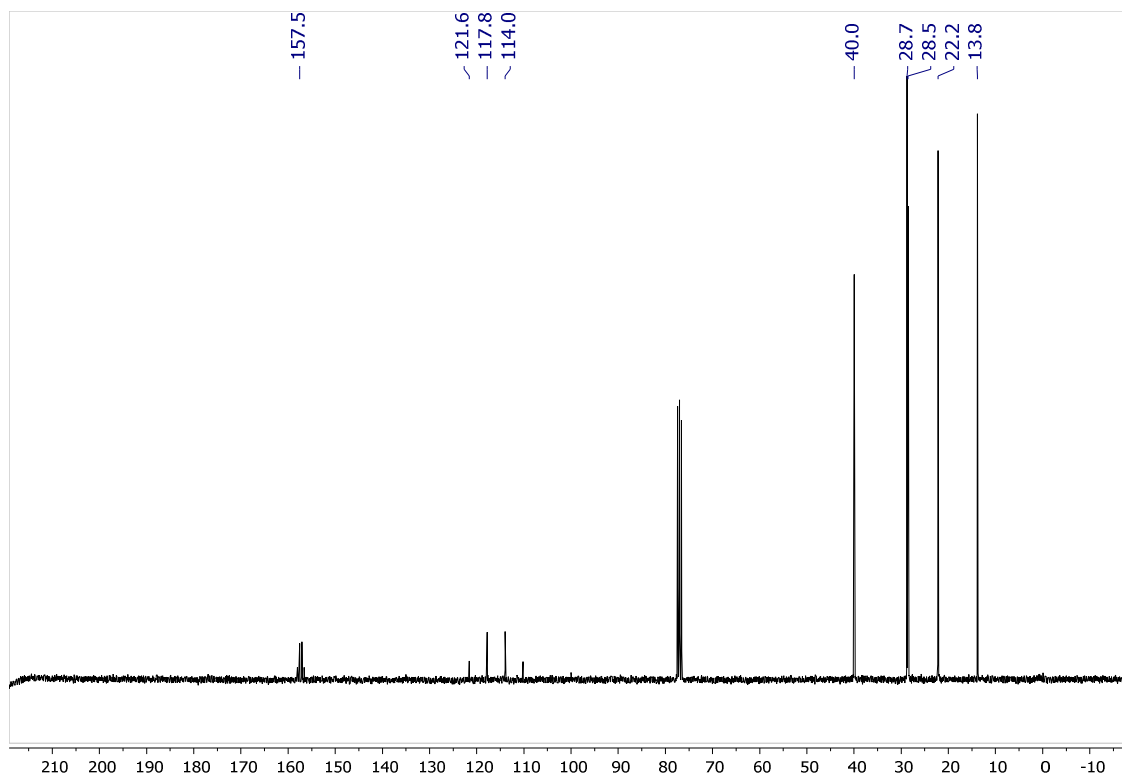


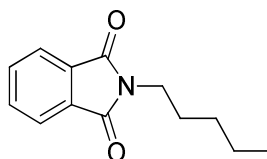


$^1\text{H-NMR}$ of **S3** in CDCl_3

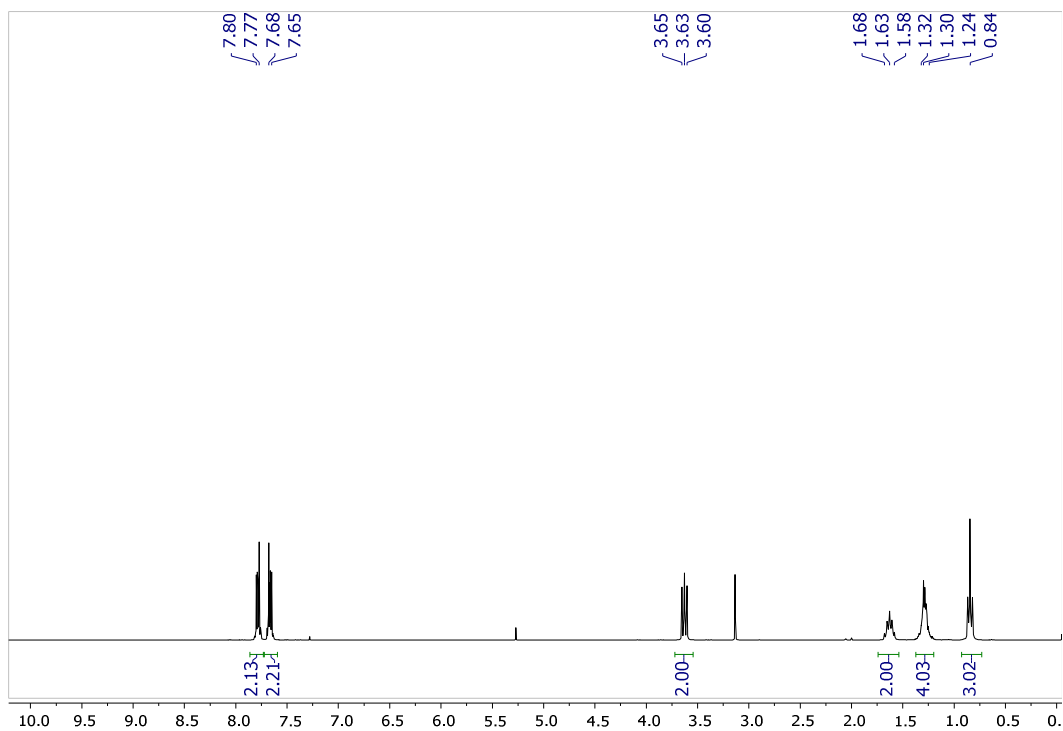


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S3** in CDCl_3

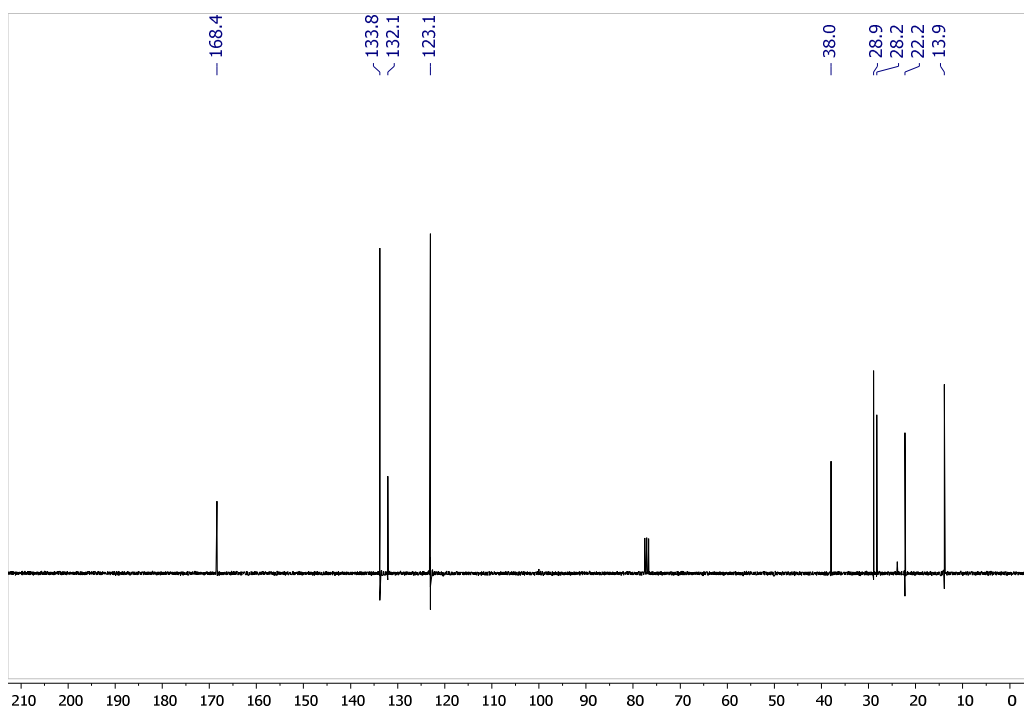


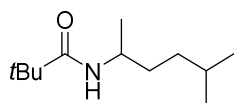


$^1\text{H-NMR}$ of **S4** in CDCl_3

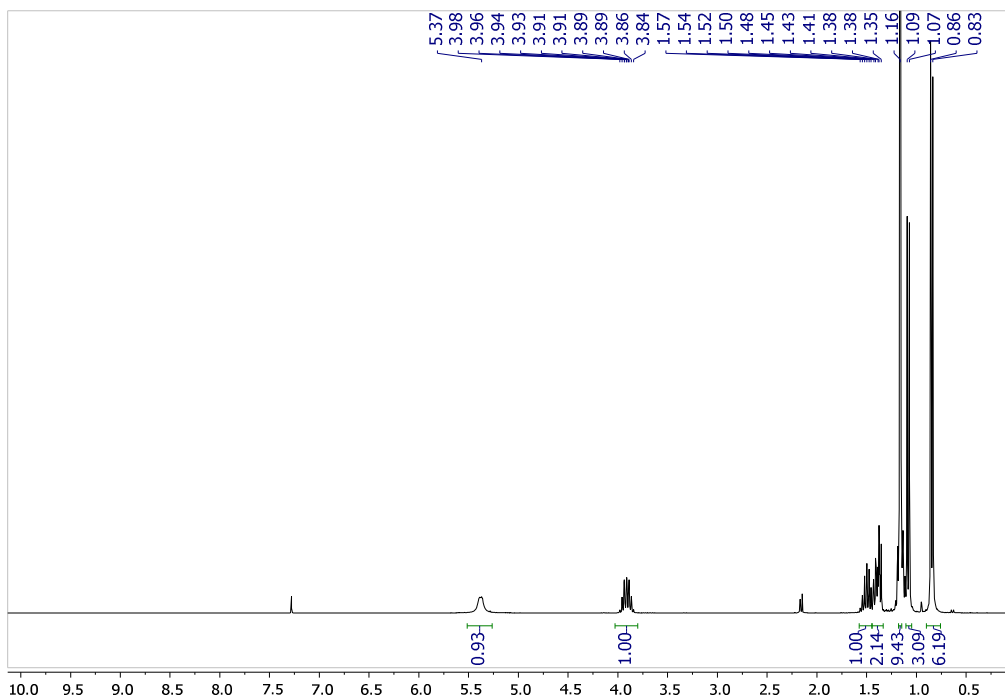


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S4** in CDCl_3

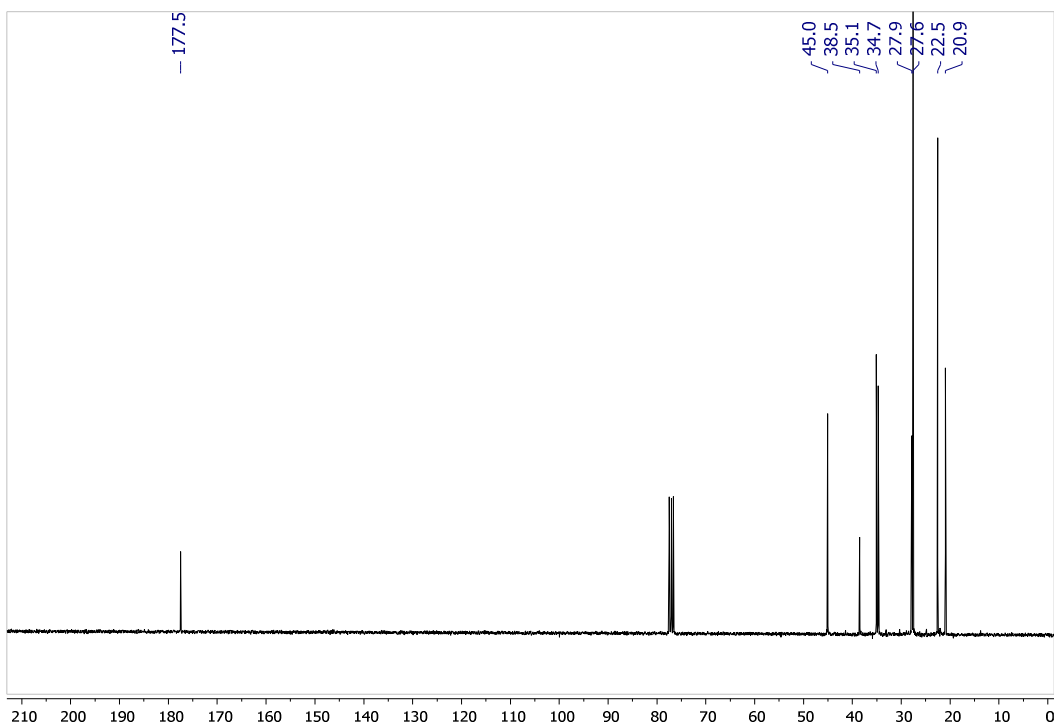


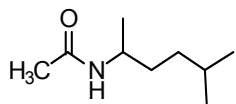


$^1\text{H-NMR}$ of **S5** in CDCl_3

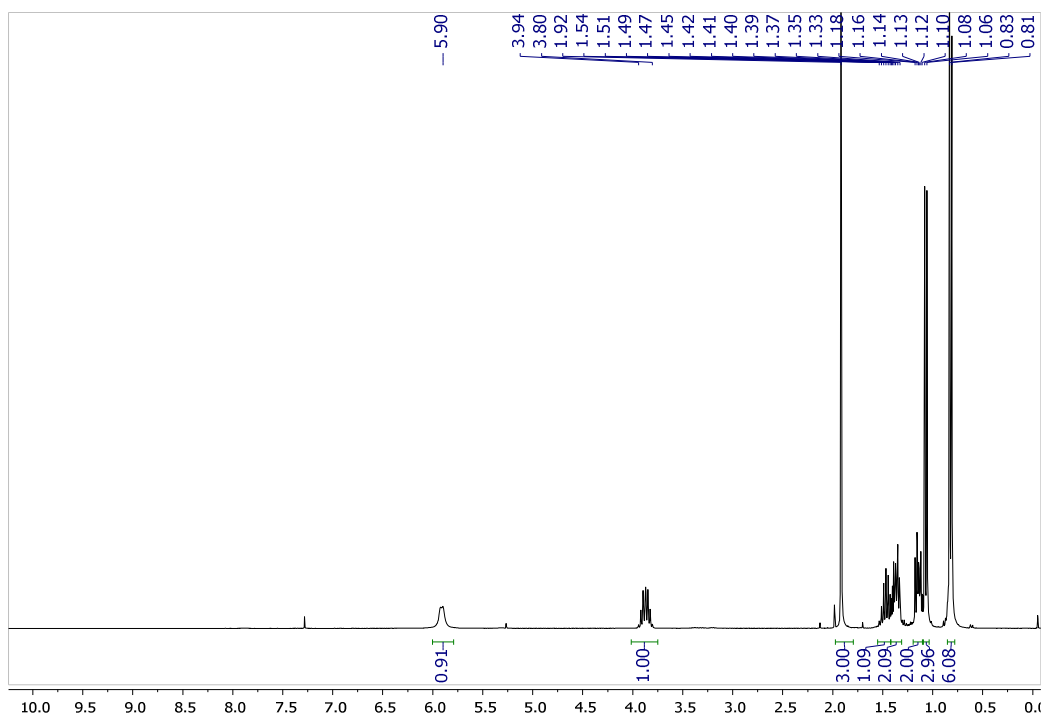


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S5** in CDCl_3

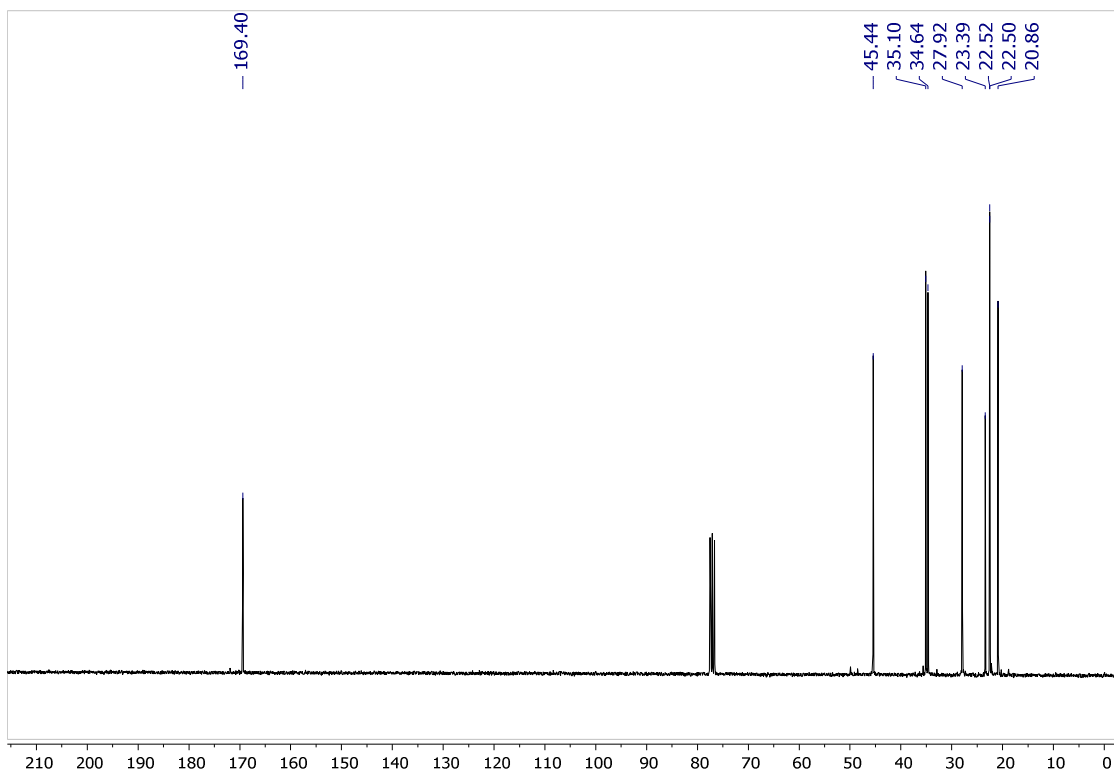


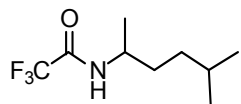


$^1\text{H-NMR}$ of **S6** in CDCl_3

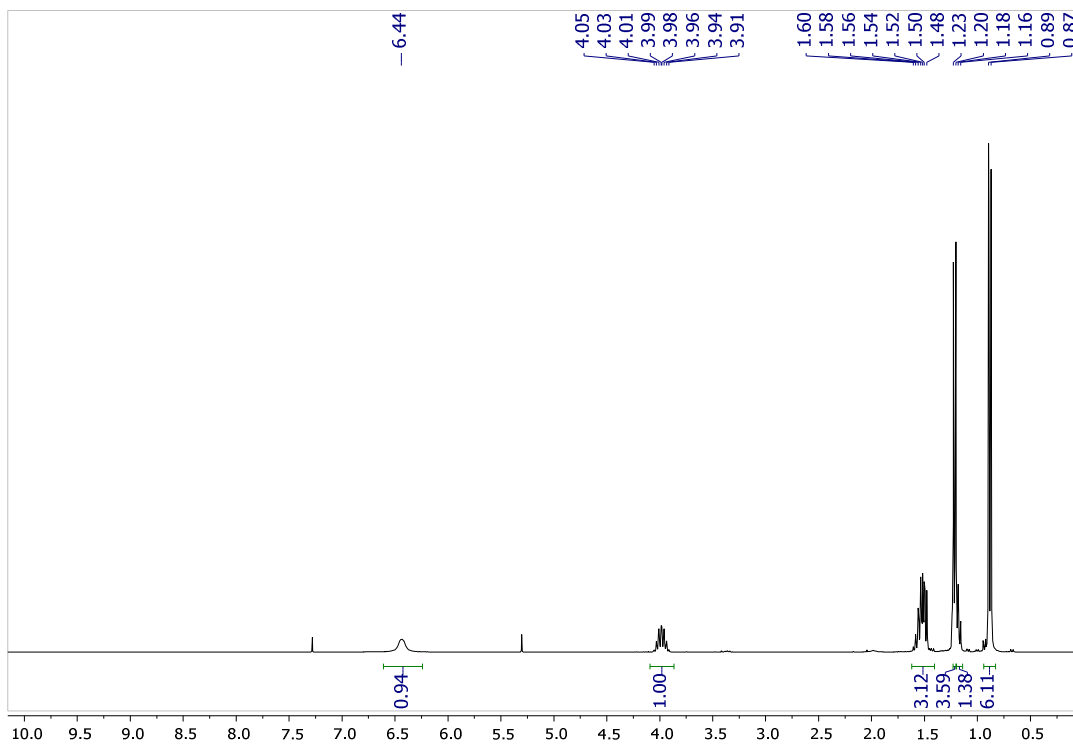


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S6** in CDCl_3

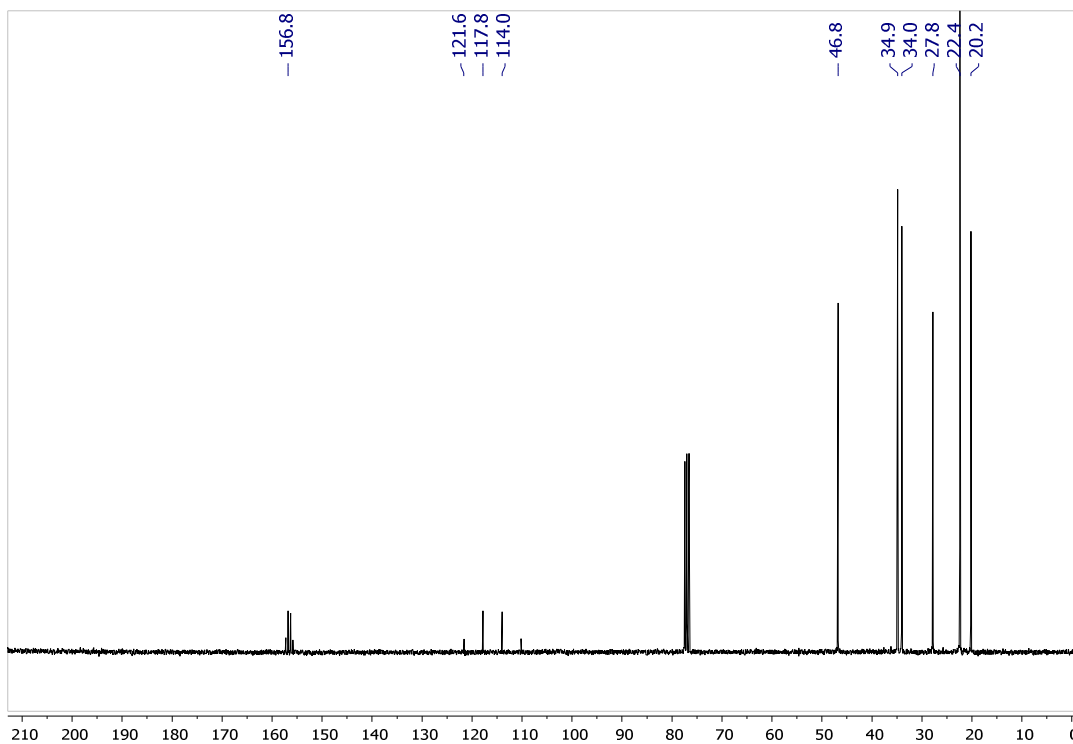


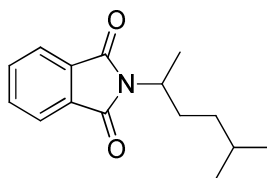


$^1\text{H-NMR}$ of **S7** in CDCl_3

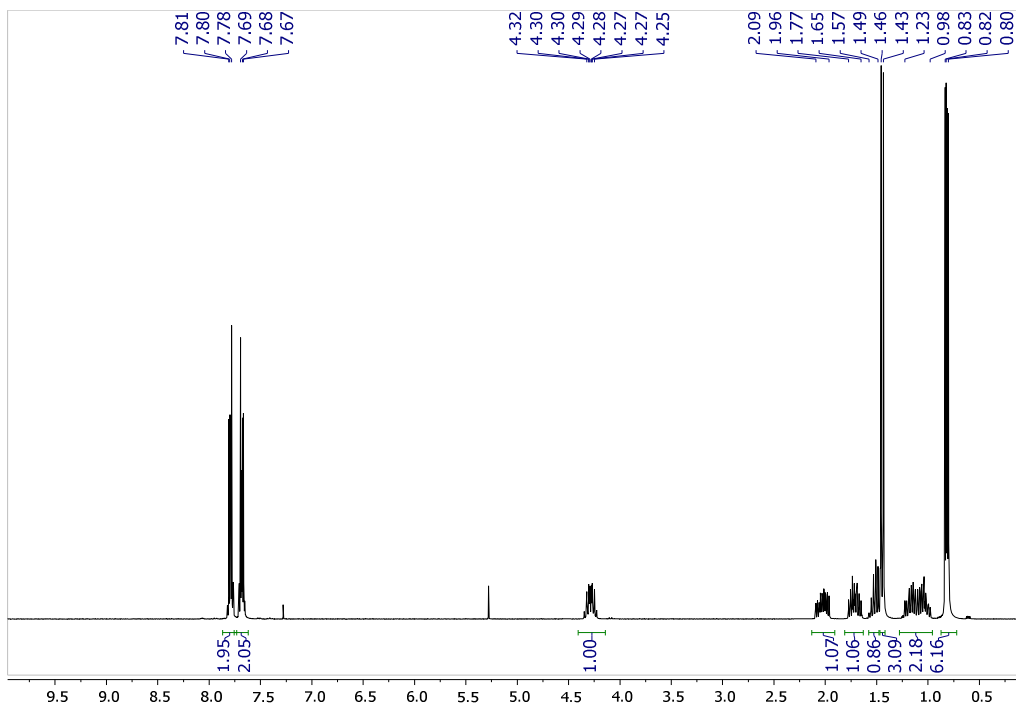


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S7** in CDCl_3

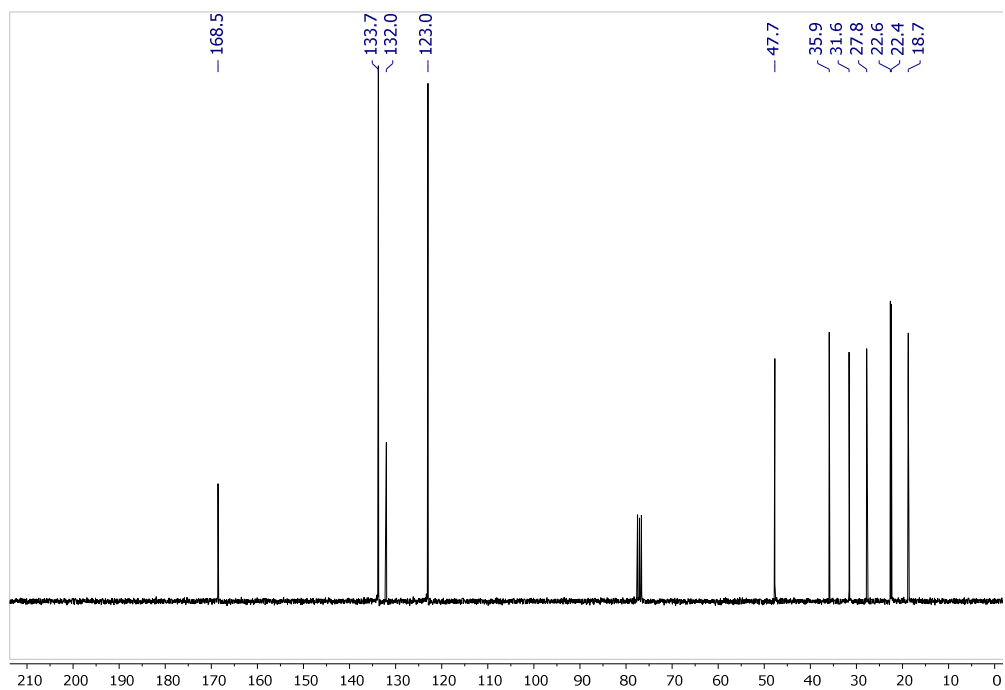


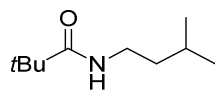


$^1\text{H-NMR}$ of **S8** in CDCl_3

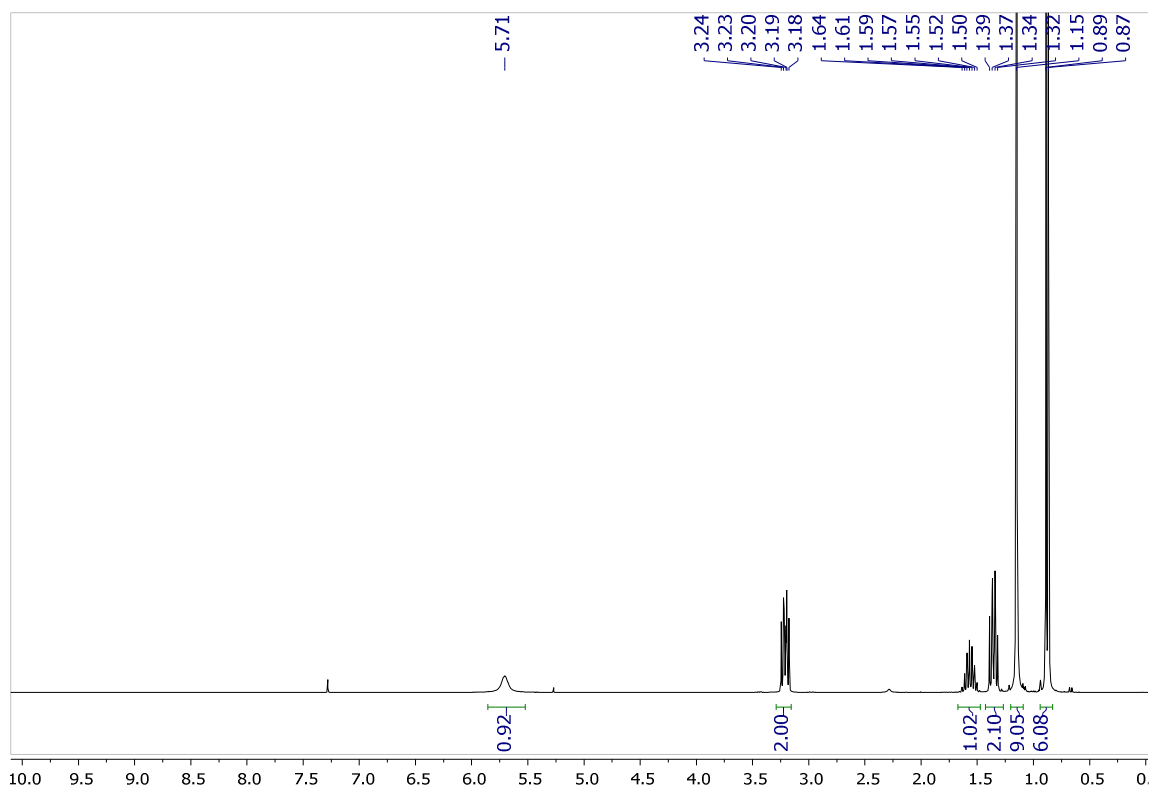


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S8** in CDCl_3

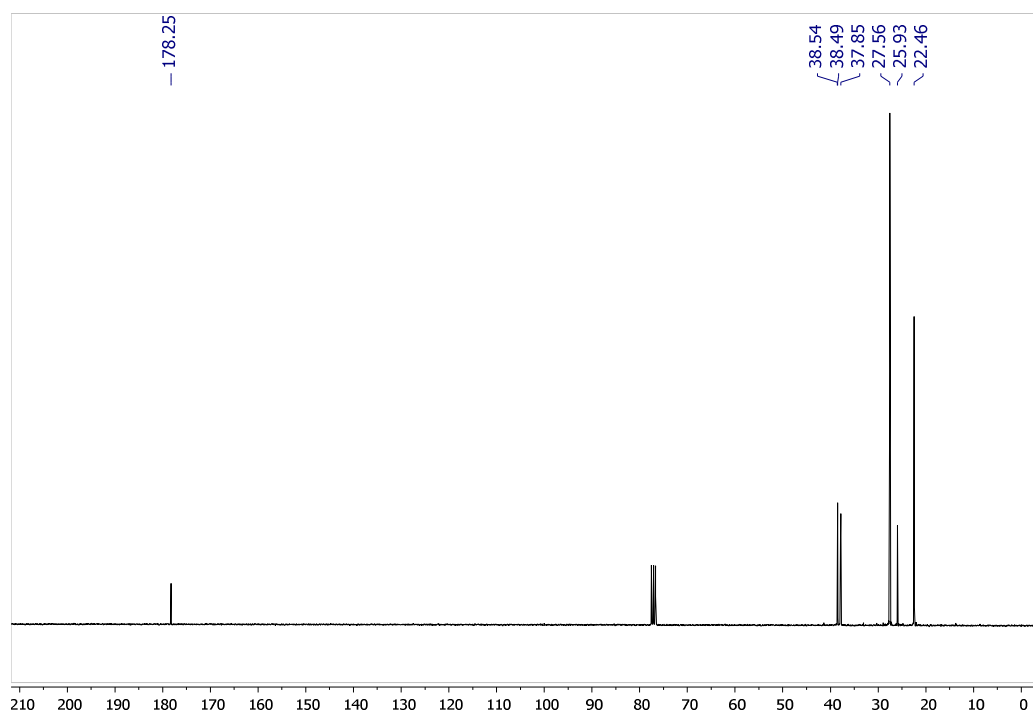


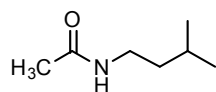


$^1\text{H-NMR}$ of **S9** in CDCl_3

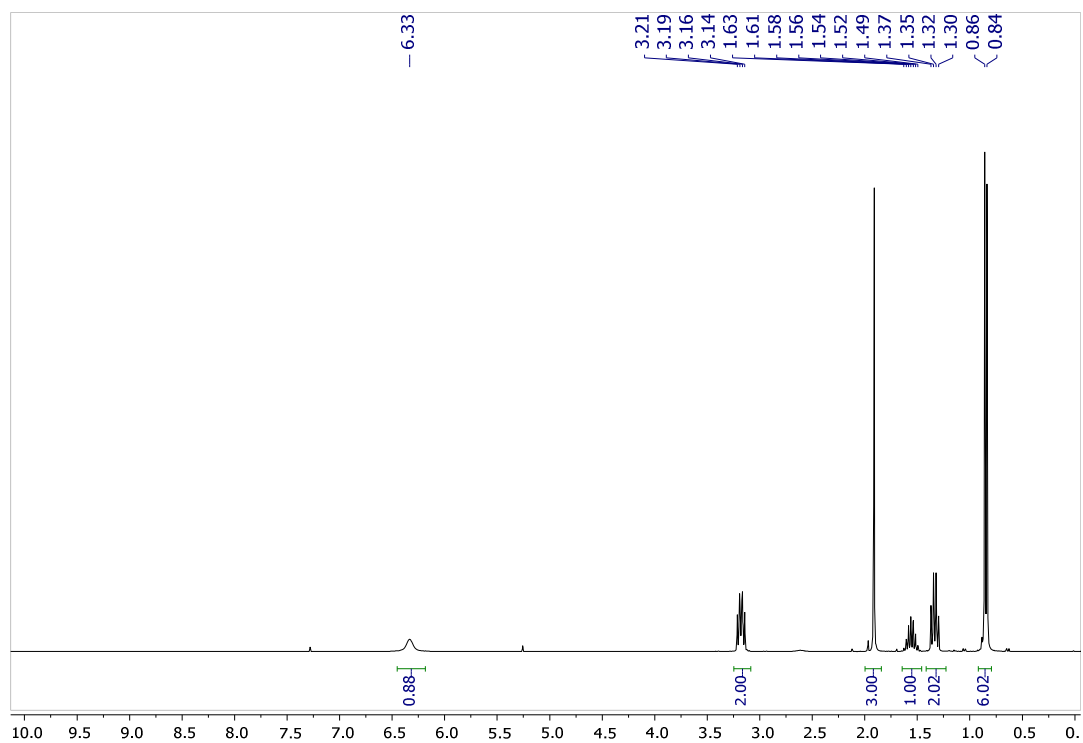


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S9** in CDCl_3

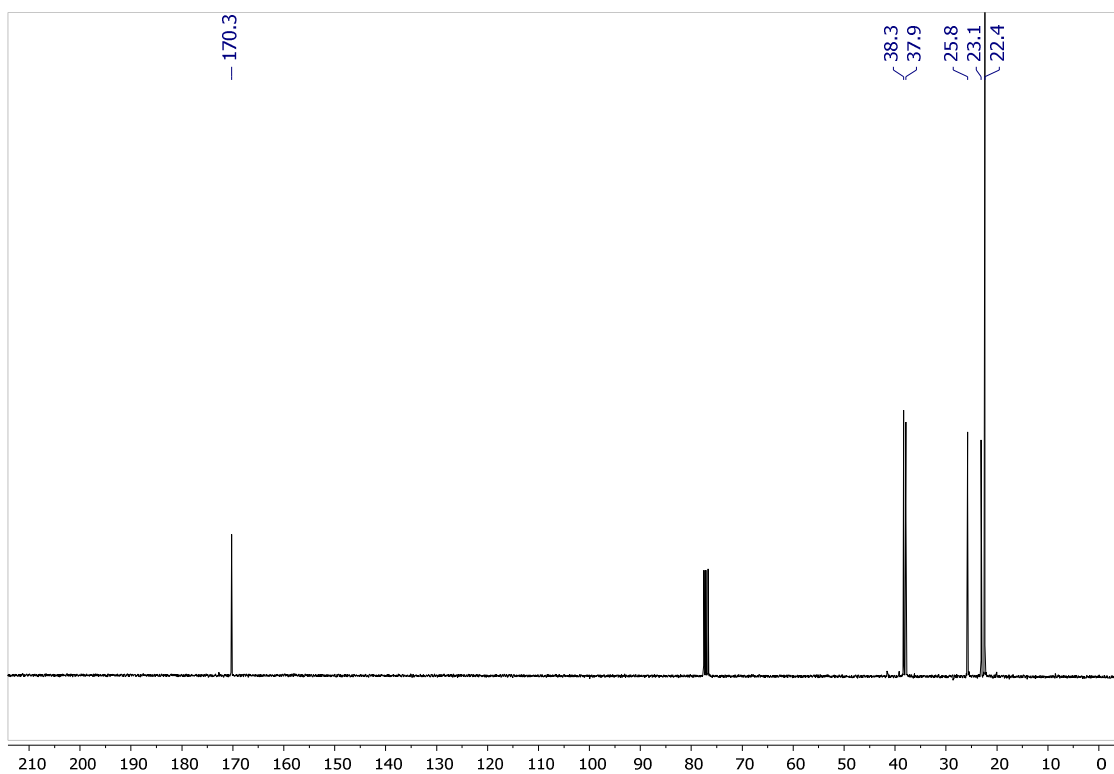


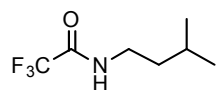


$^1\text{H-NMR}$ of **S10** in CDCl_3

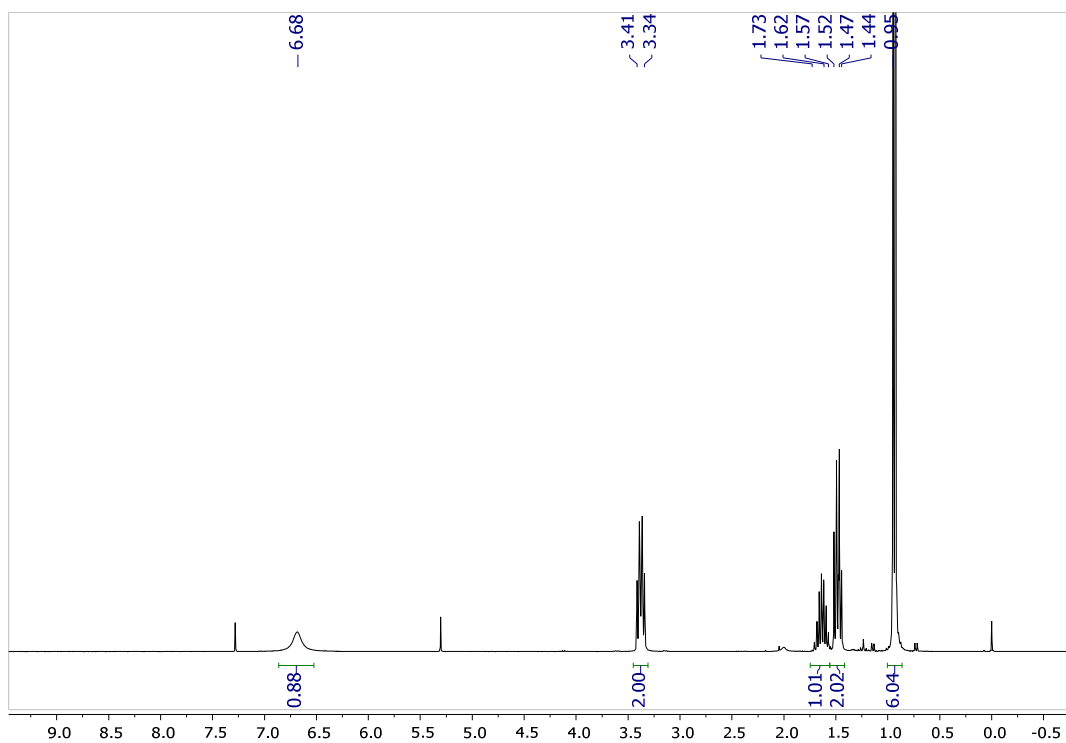


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S10** in CDCl_3

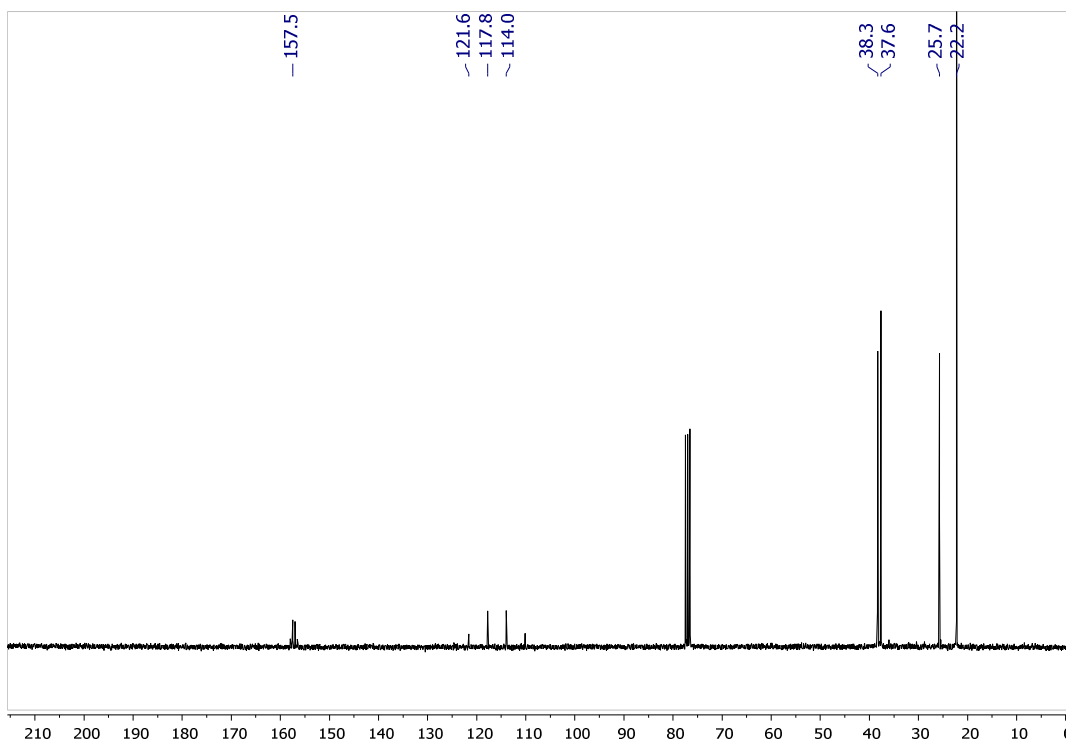


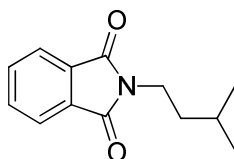


$^1\text{H-NMR}$ of **S11** in CDCl_3

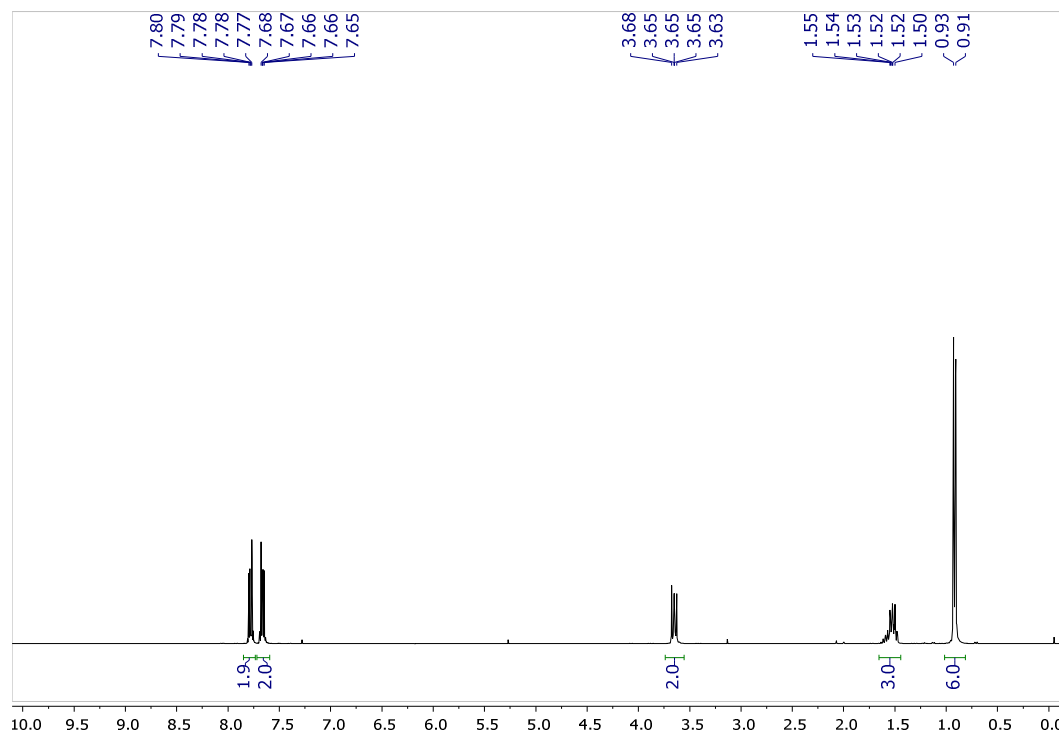


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S11** in CDCl_3

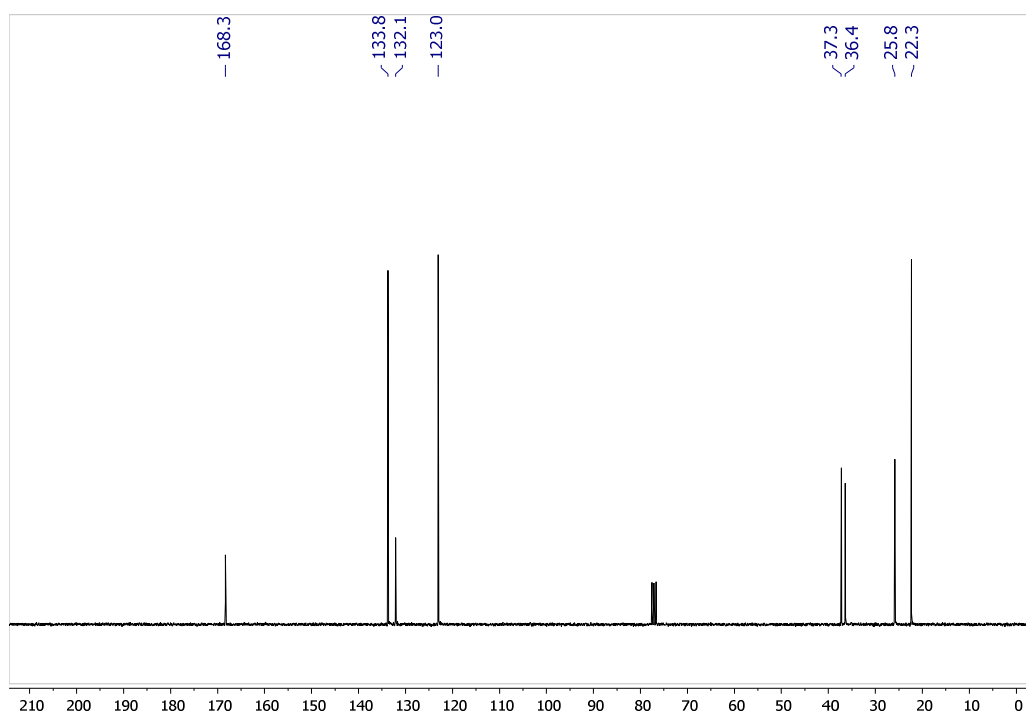


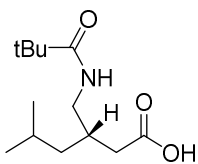


$^1\text{H-NMR}$ of **S12** in CDCl_3

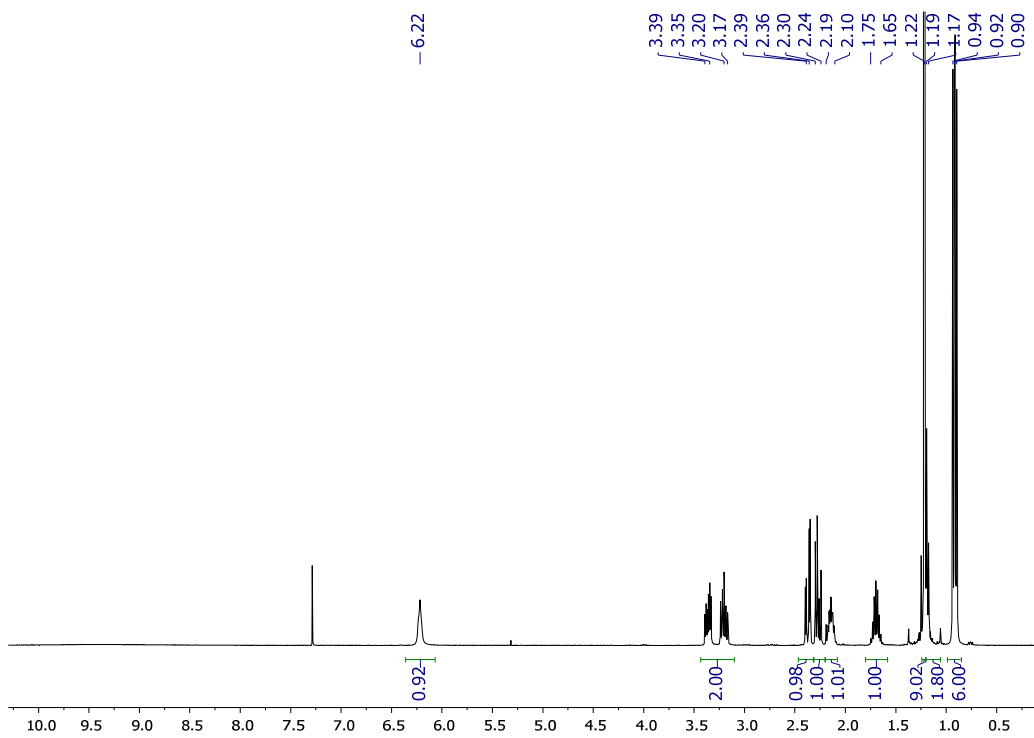


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S12** in CDCl_3

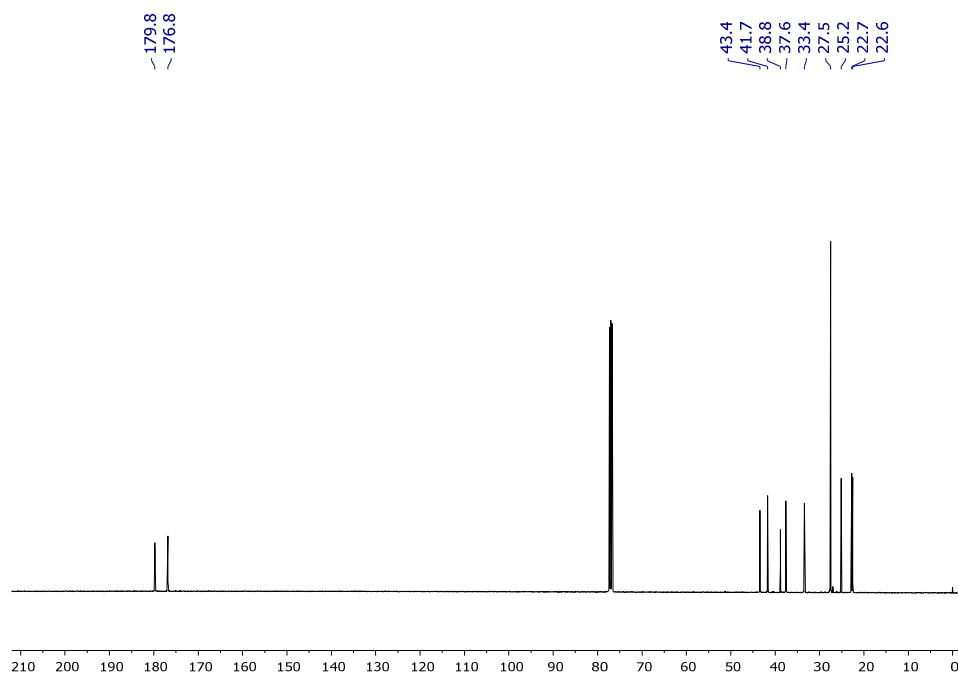


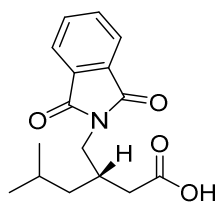


$^1\text{H-NMR}$ of **S13** in CDCl_3

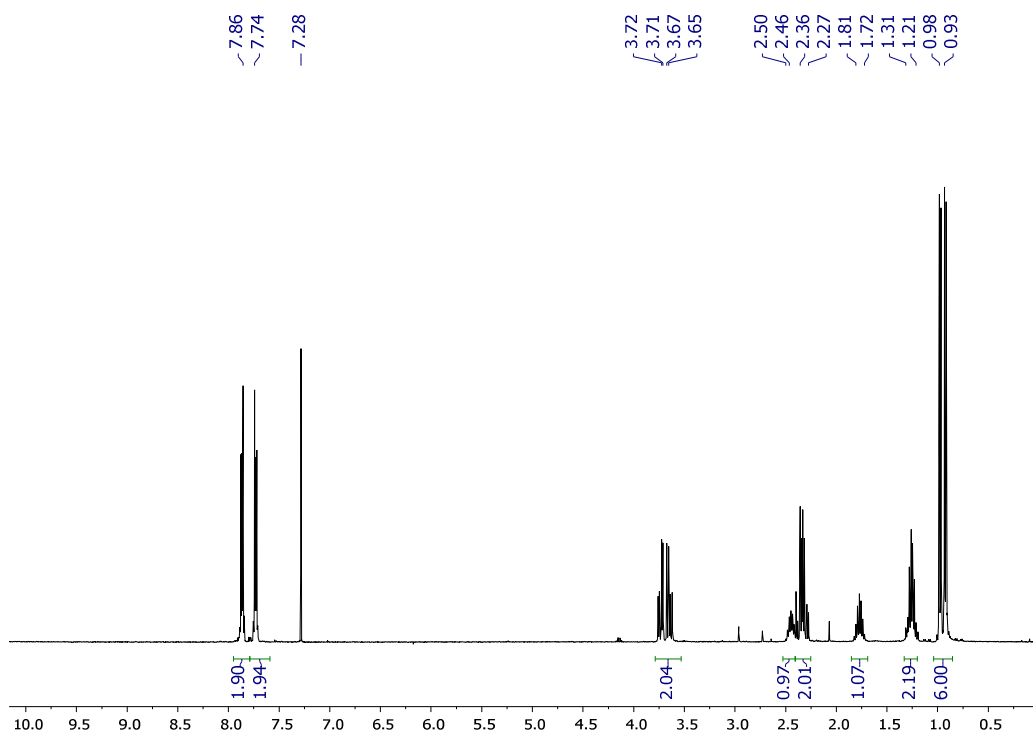


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S13** in CDCl_3

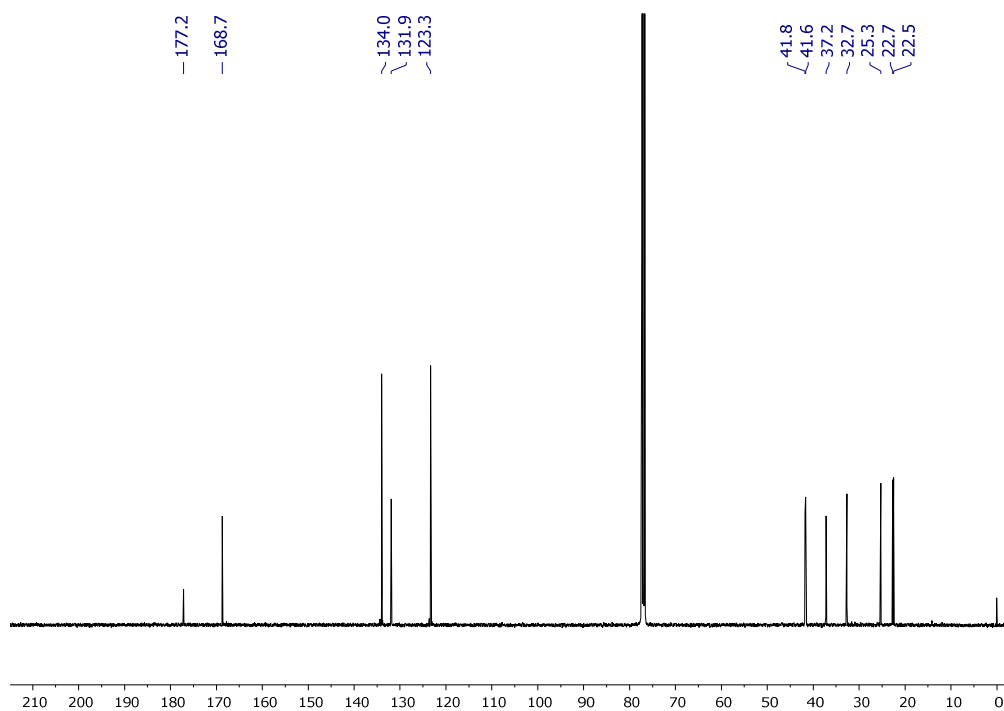


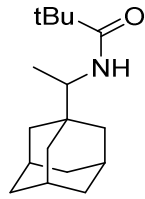


$^1\text{H-NMR}$ of **S14** in CDCl_3

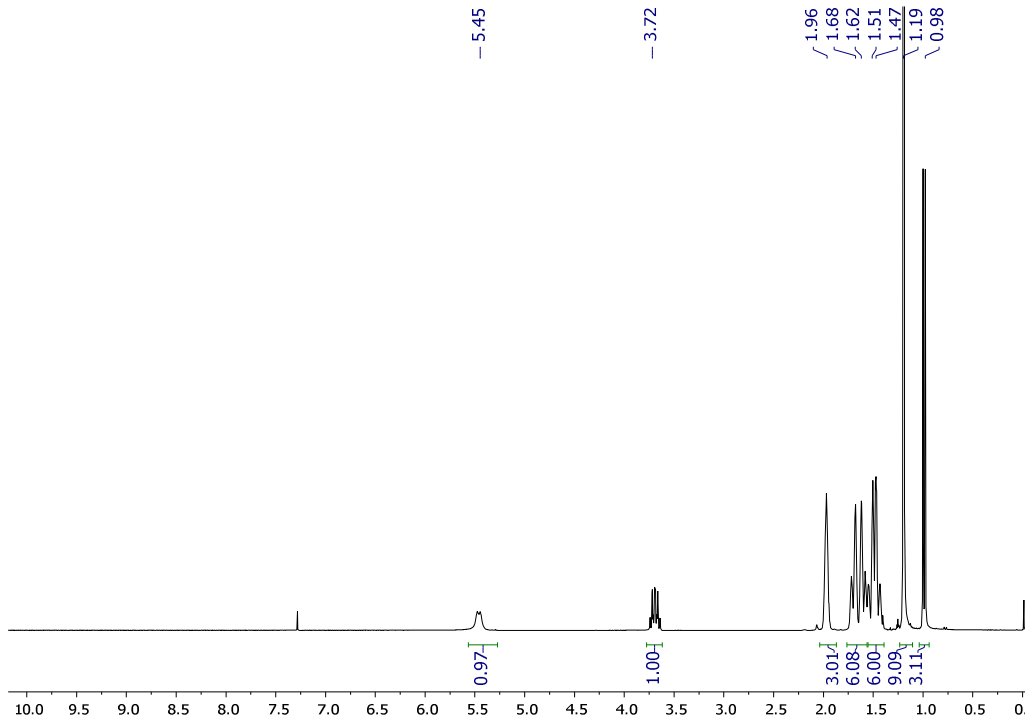


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S14** in CDCl_3

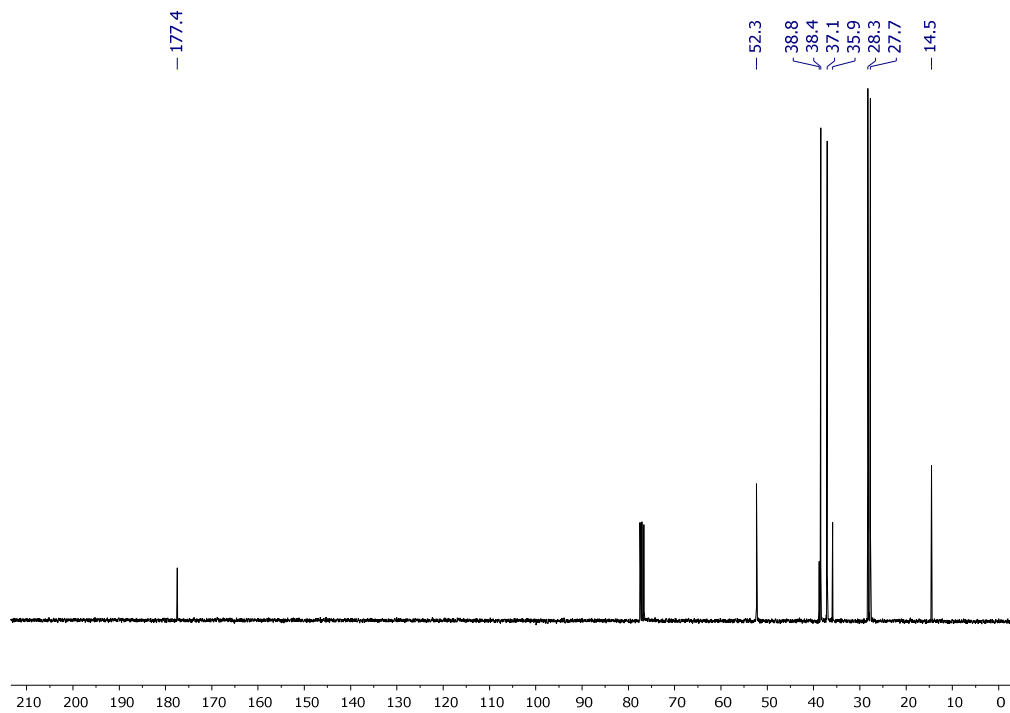


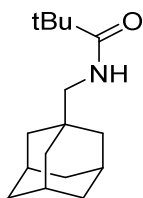


$^1\text{H-NMR}$ of **S15** in CDCl_3

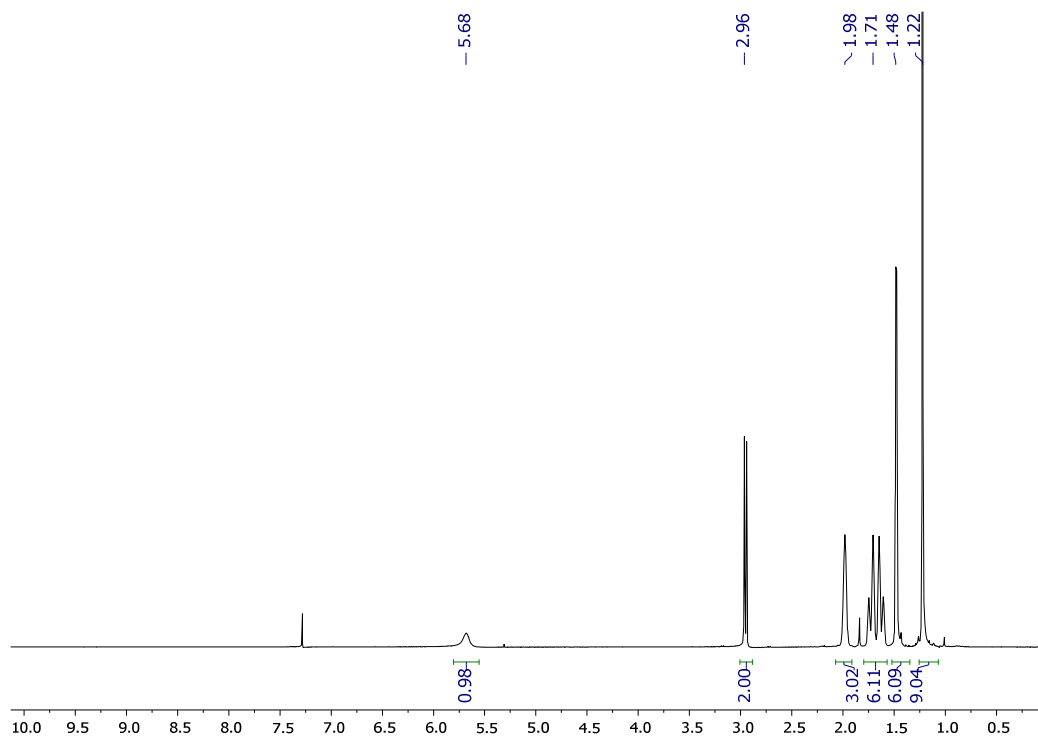


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S15** in CDCl_3

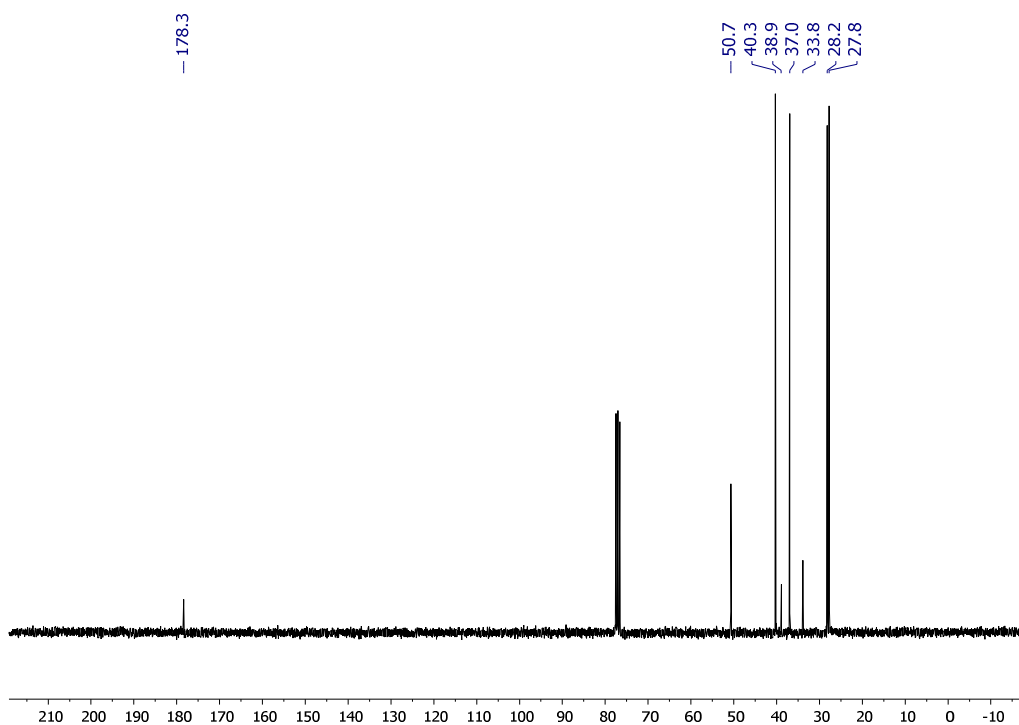




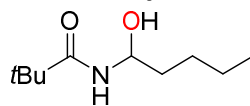
$^1\text{H-NMR}$ of **S17** in CDCl_3



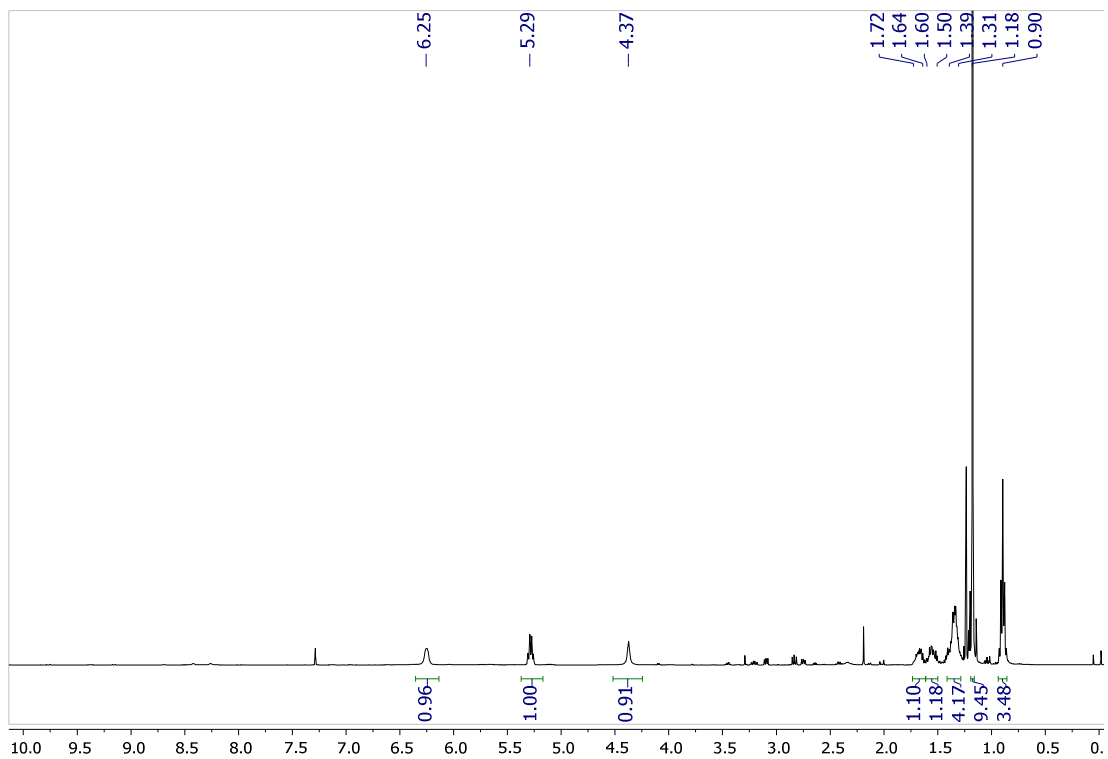
$^{13}\text{C}\{^1\text{H}\}$ -NMR of **S17** in CDCl_3



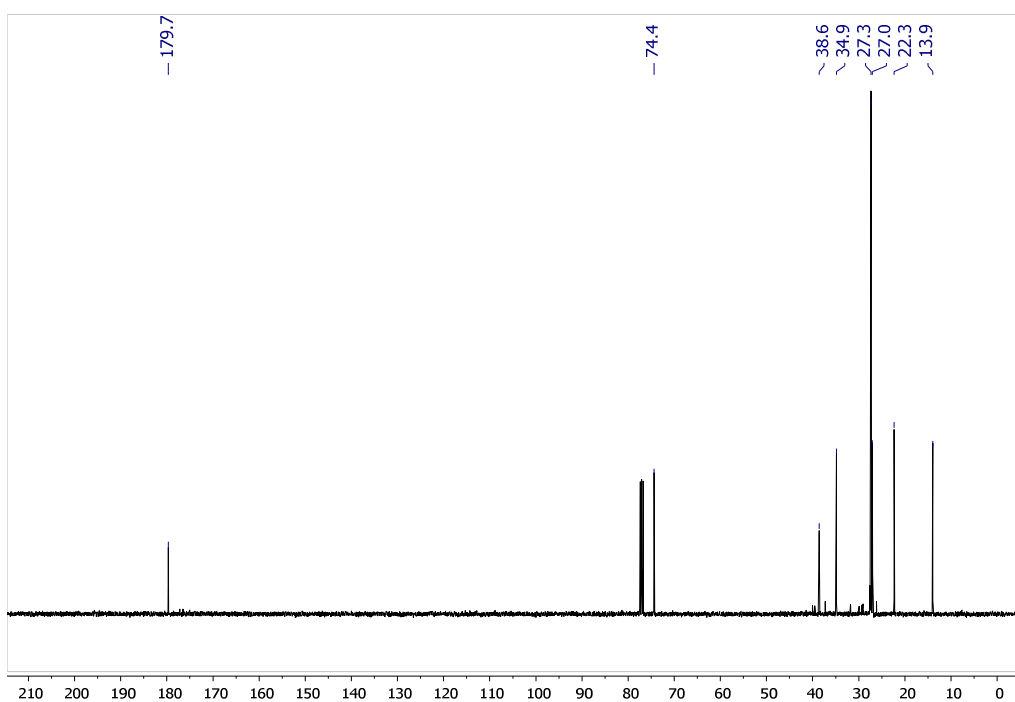
A2 ^1H and $^{13}\text{C}\{^1\text{H}\}$ NMR spectra of isolated products

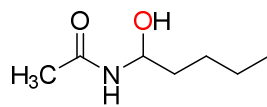


^1H -NMR of **P1** in CDCl_3

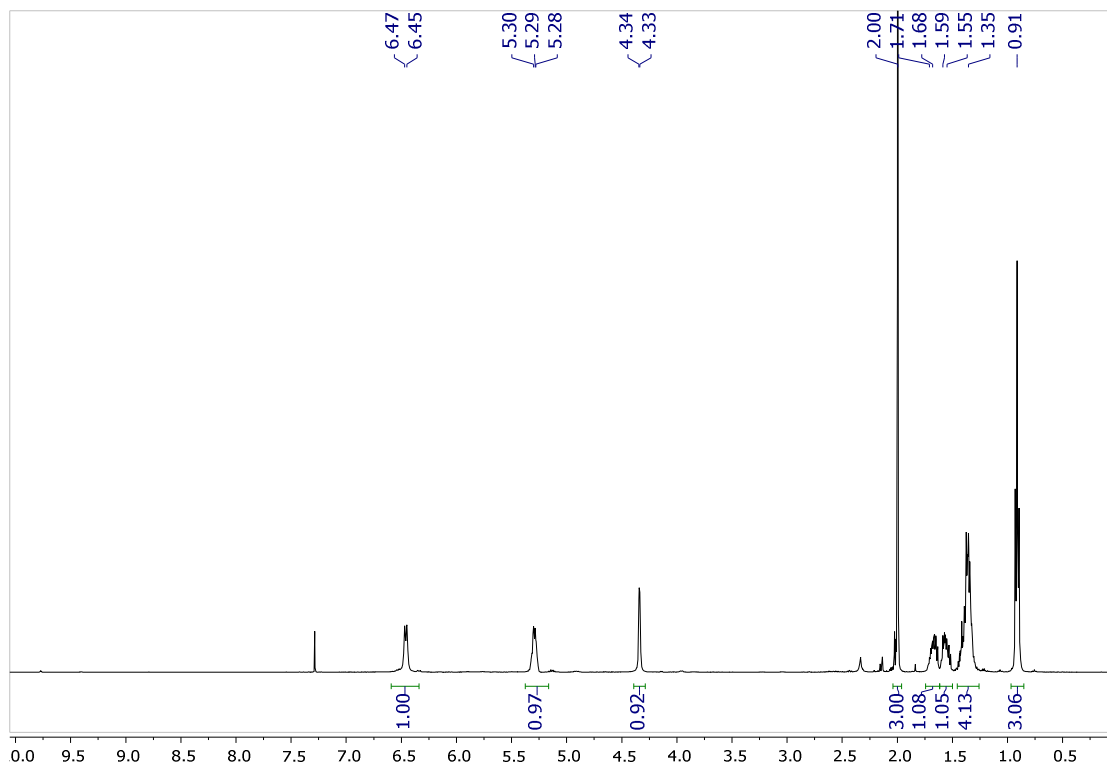


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P1** in CDCl_3

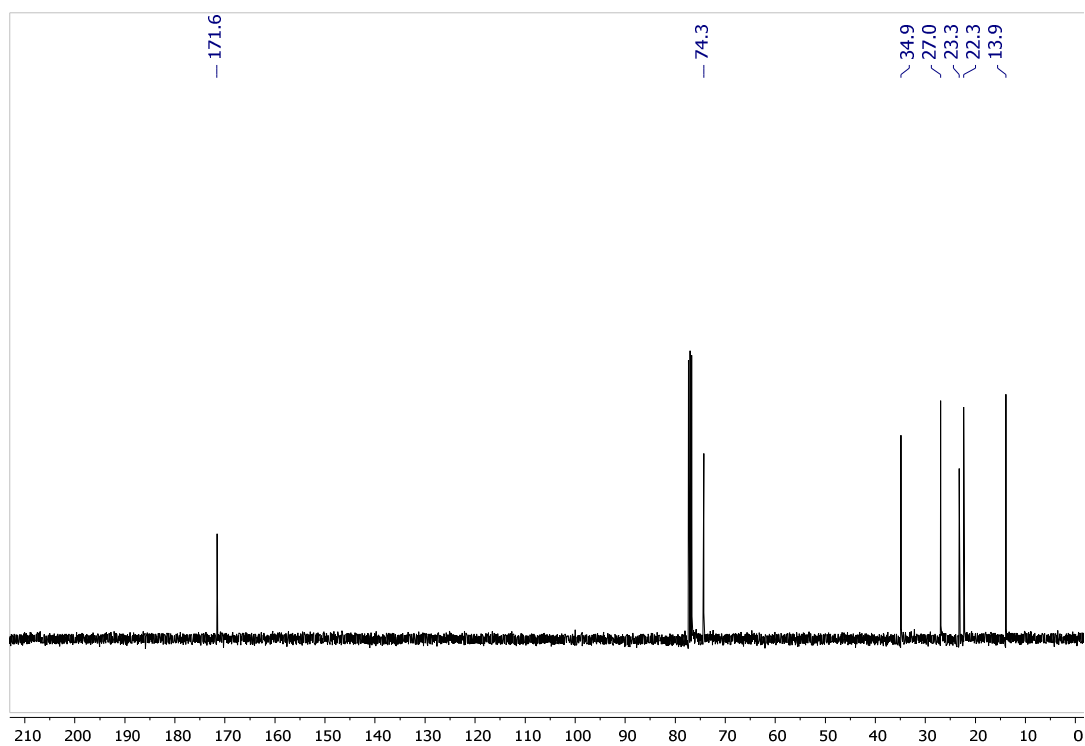


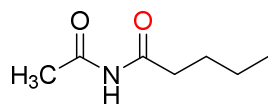


$^1\text{H-NMR}$ of **P2** in CDCl_3

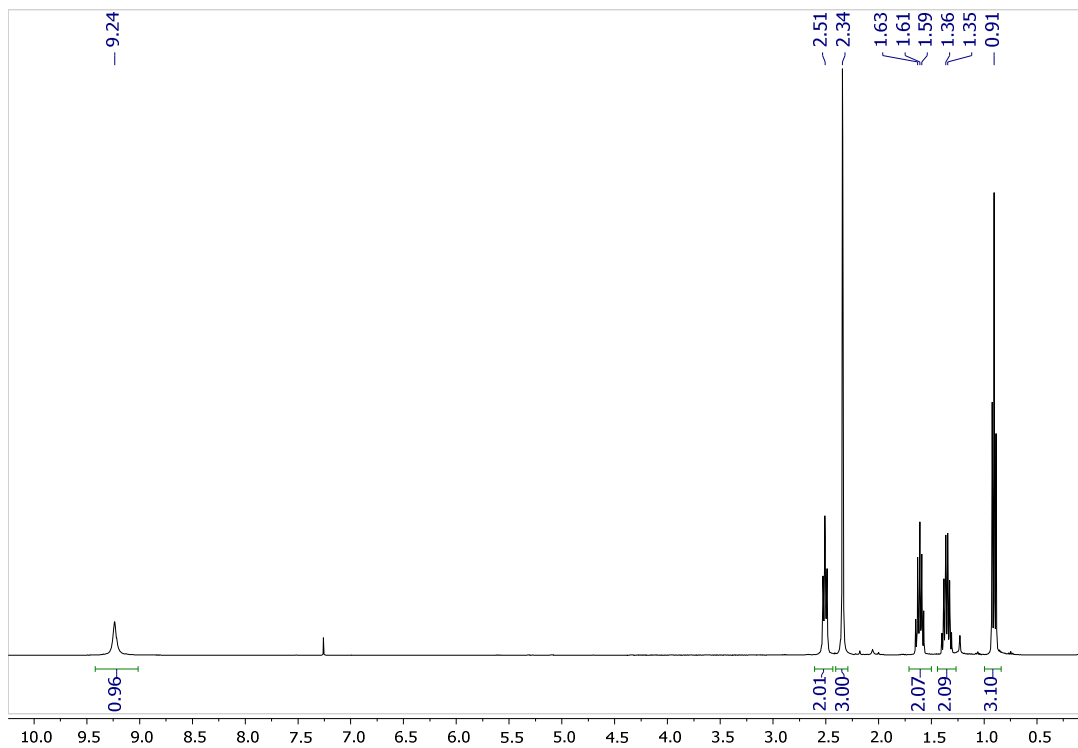


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P2** in CDCl_3

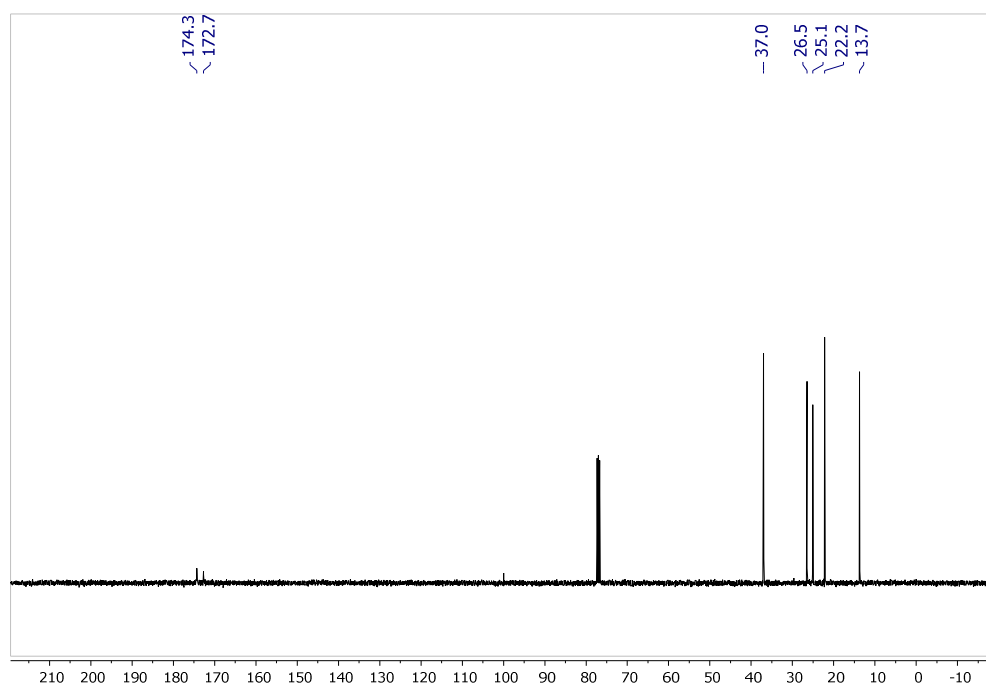


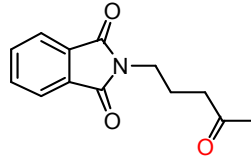


$^1\text{H-NMR}$ of **P2_i** in CDCl_3

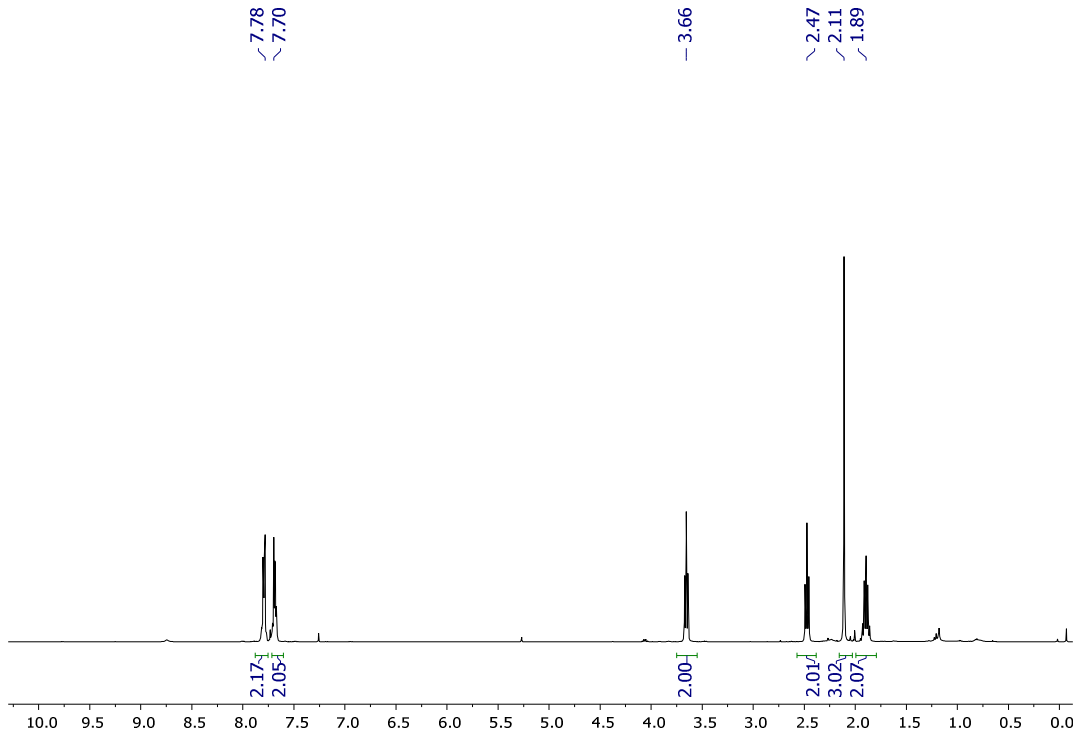


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P2_i** in CDCl_3

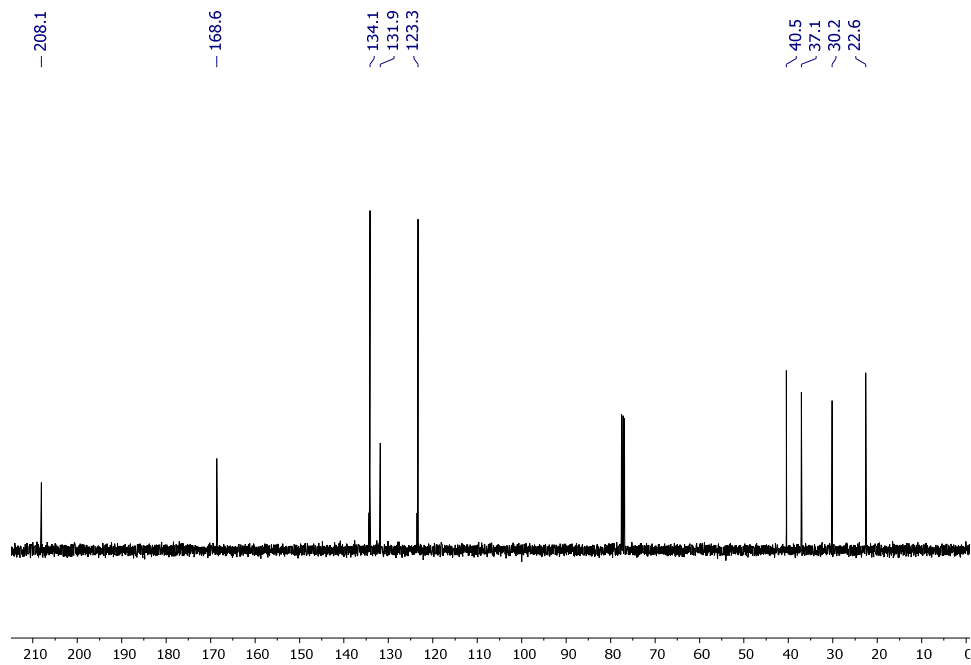


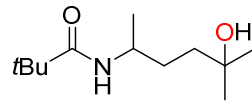


$^1\text{H-NMR}$ of **P4** in CDCl_3

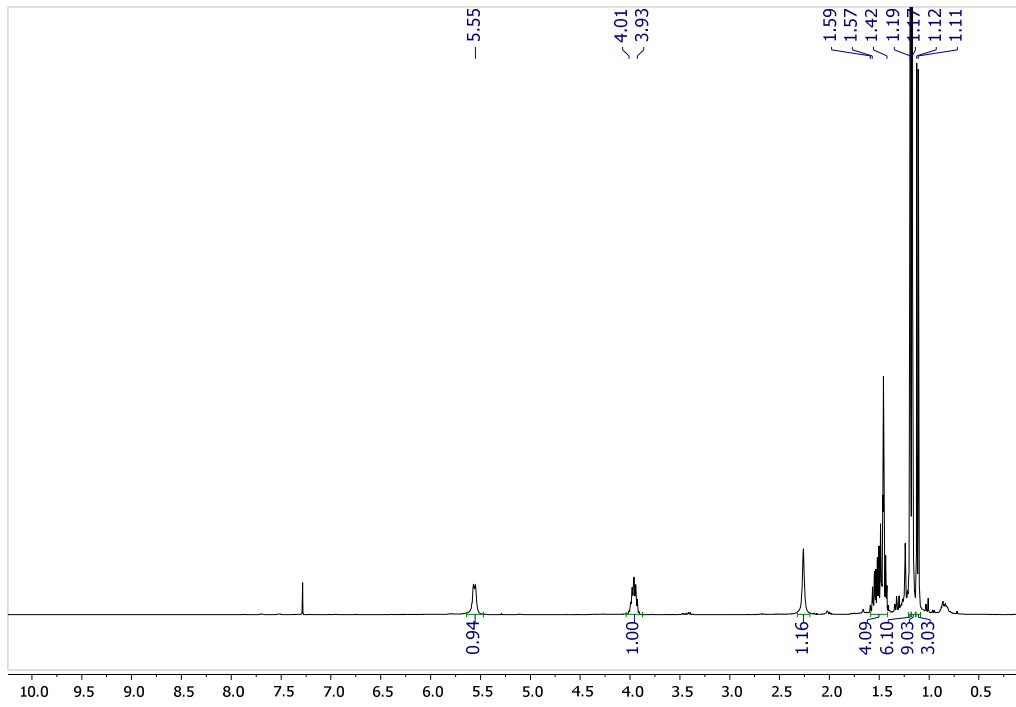


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P4** in CDCl_3

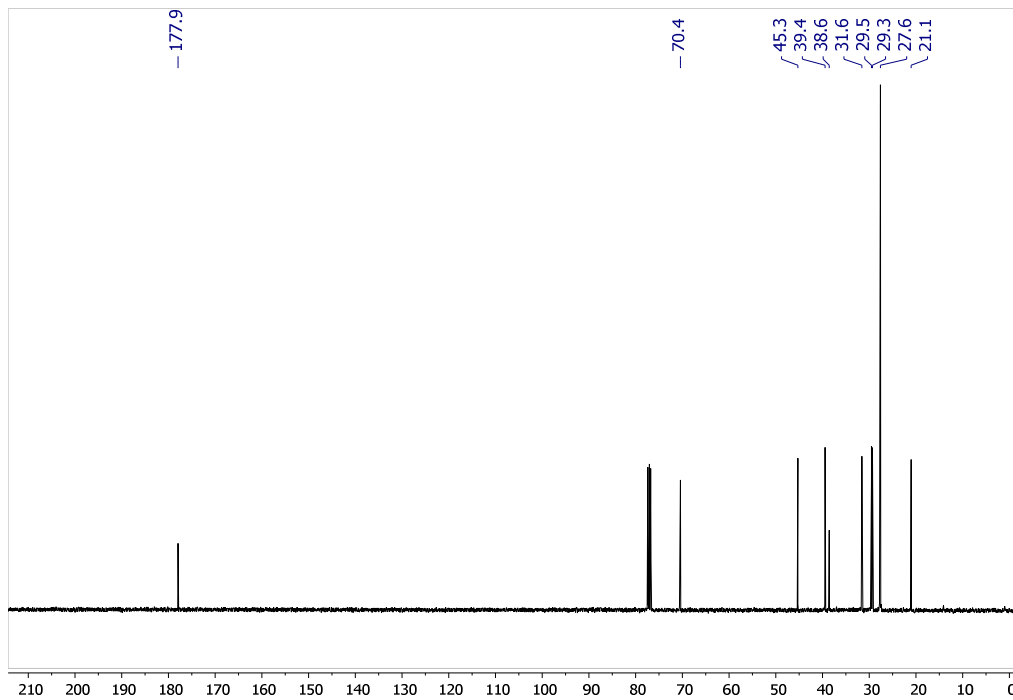


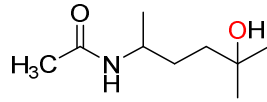


$^1\text{H-NMR}$ of **P5** in CDCl_3

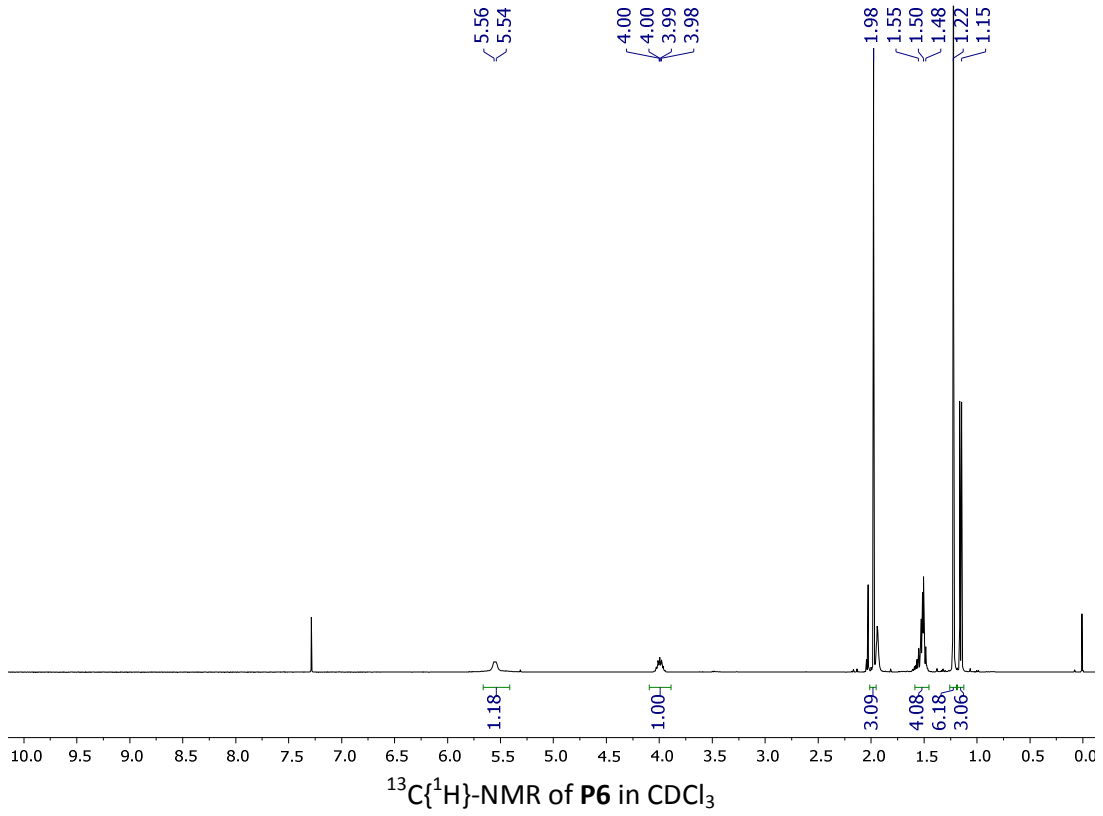


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P5** in CDCl_3

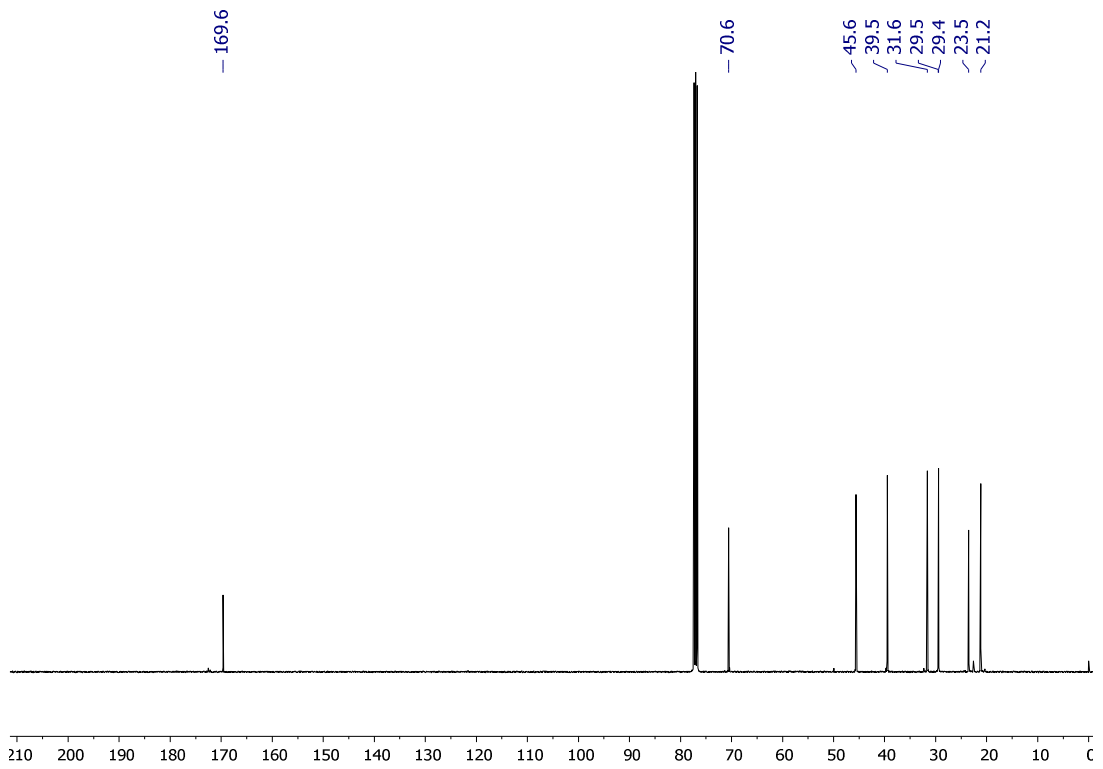


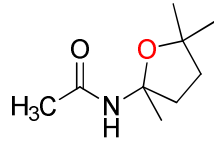


$^1\text{H-NMR}$ of **P6** in CDCl_3

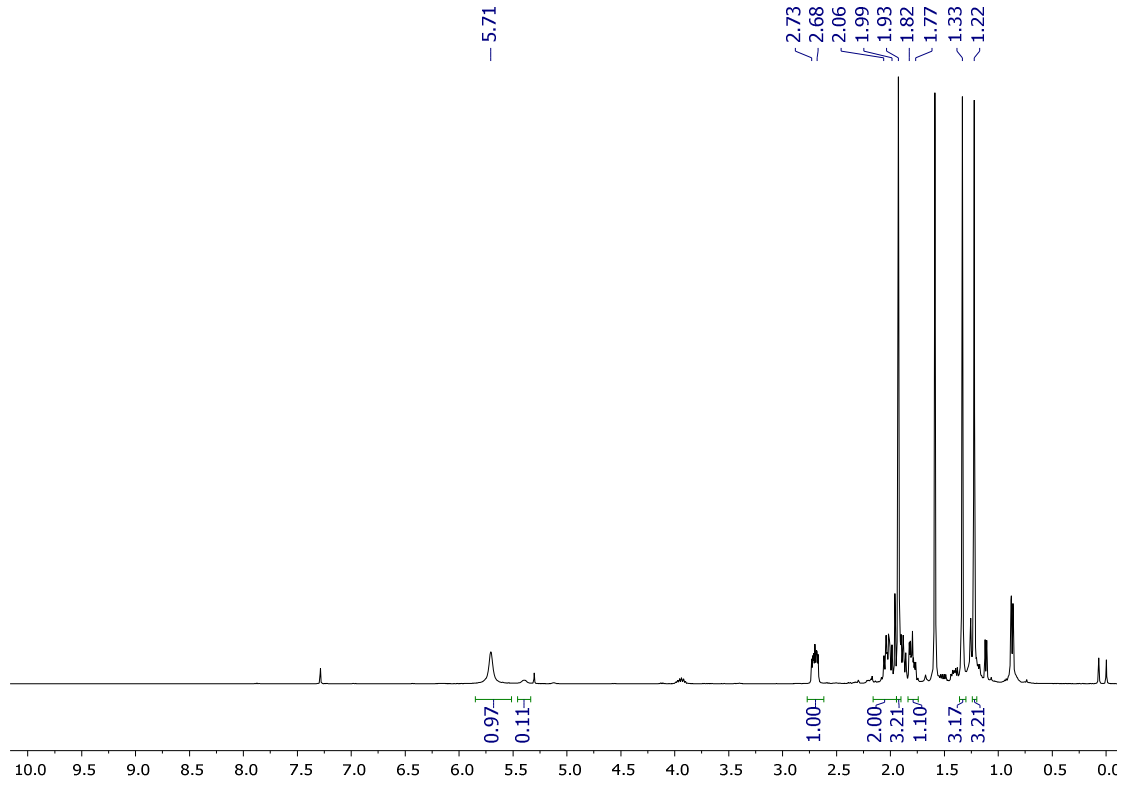


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P6** in CDCl_3

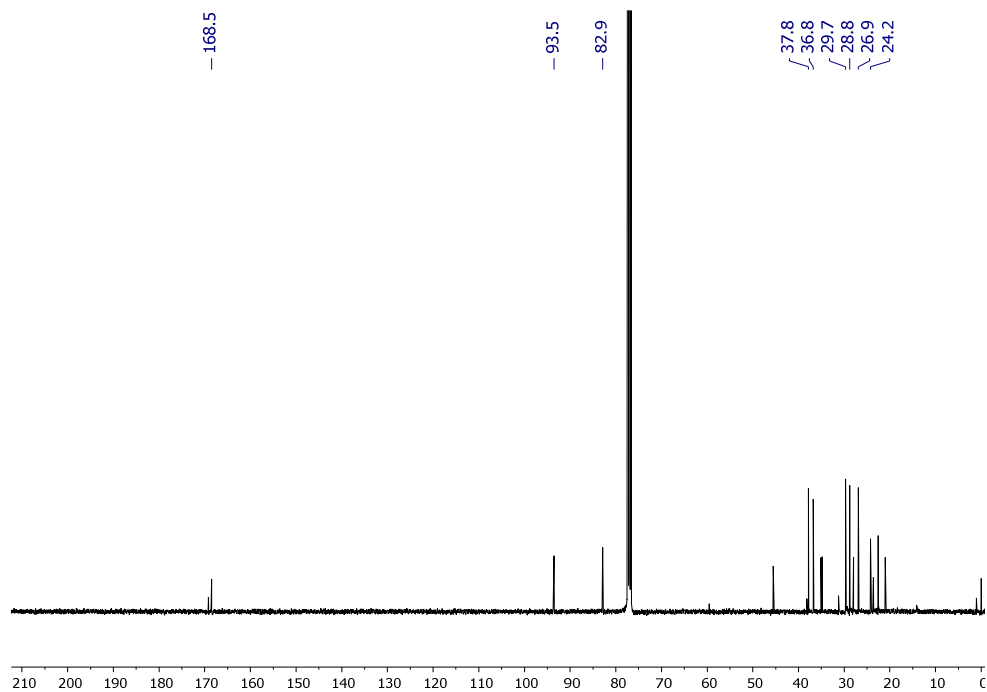


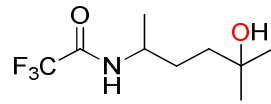


$^1\text{H-NMR}$ of **P6_a** in CDCl_3

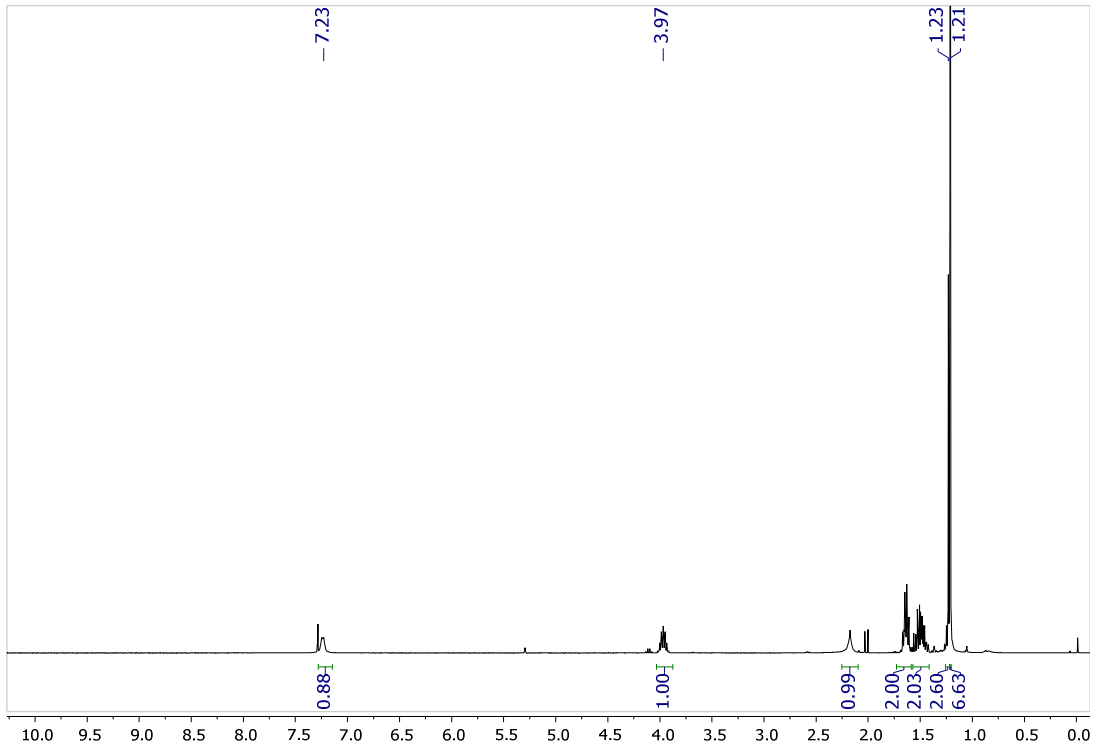


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P6_a** in CDCl_3

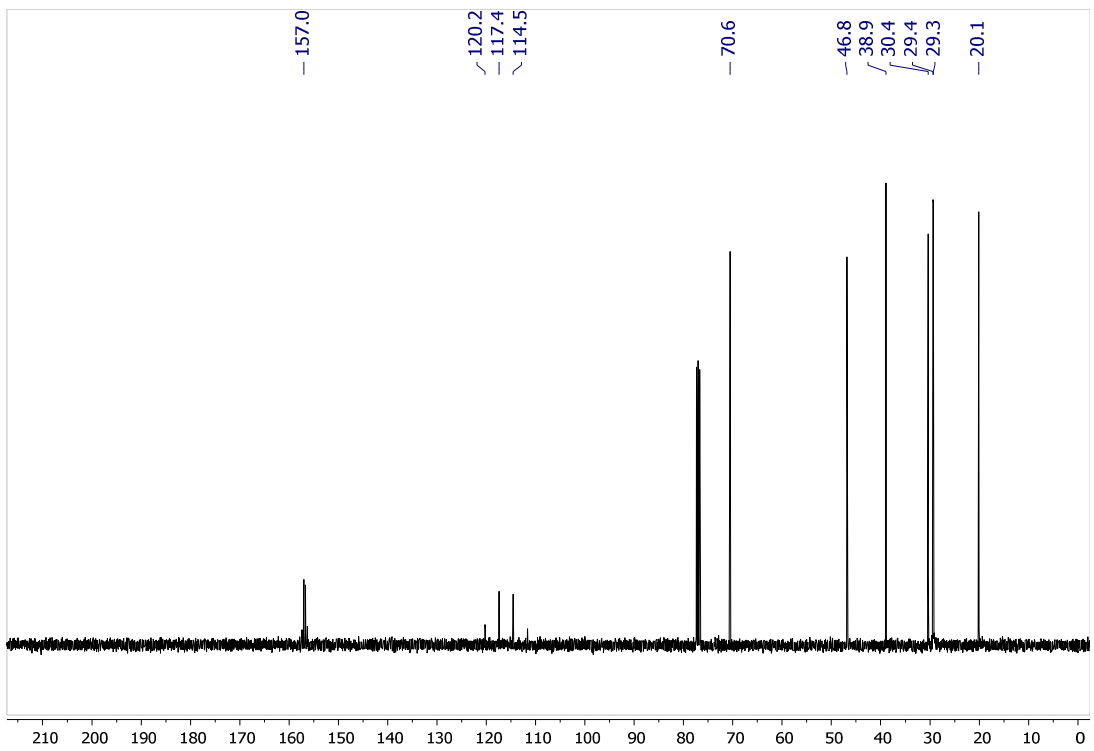


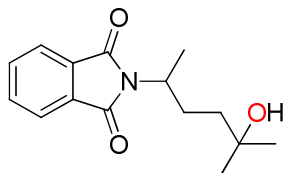


$^1\text{H-NMR}$ of **P7** in CDCl_3

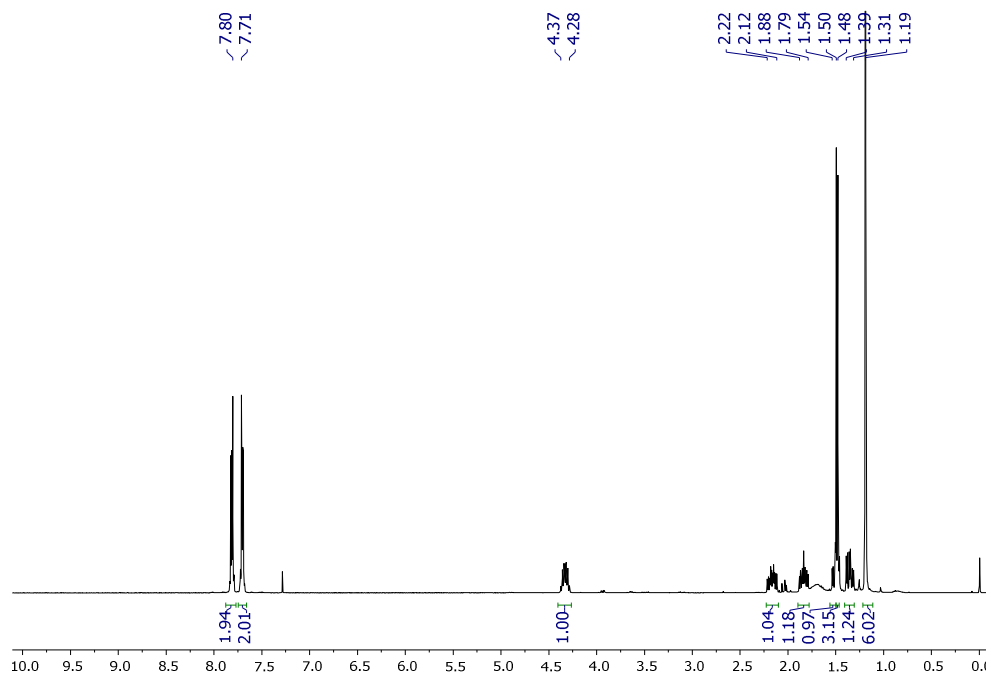


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P7** in CDCl_3

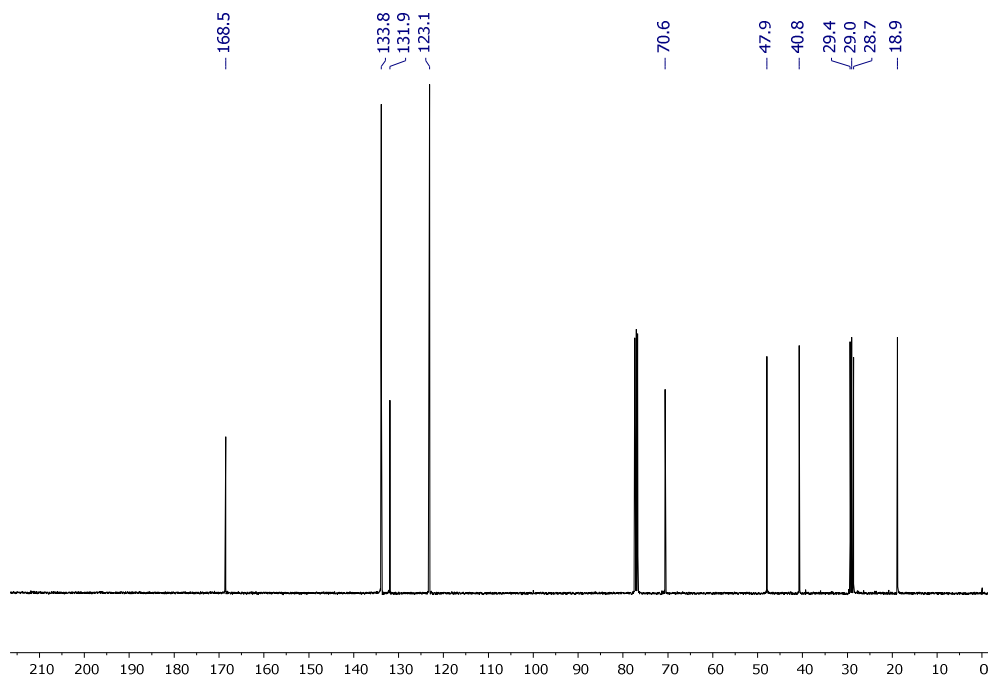


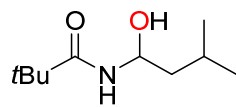


$^1\text{H-NMR}$ of **P8** in CDCl_3

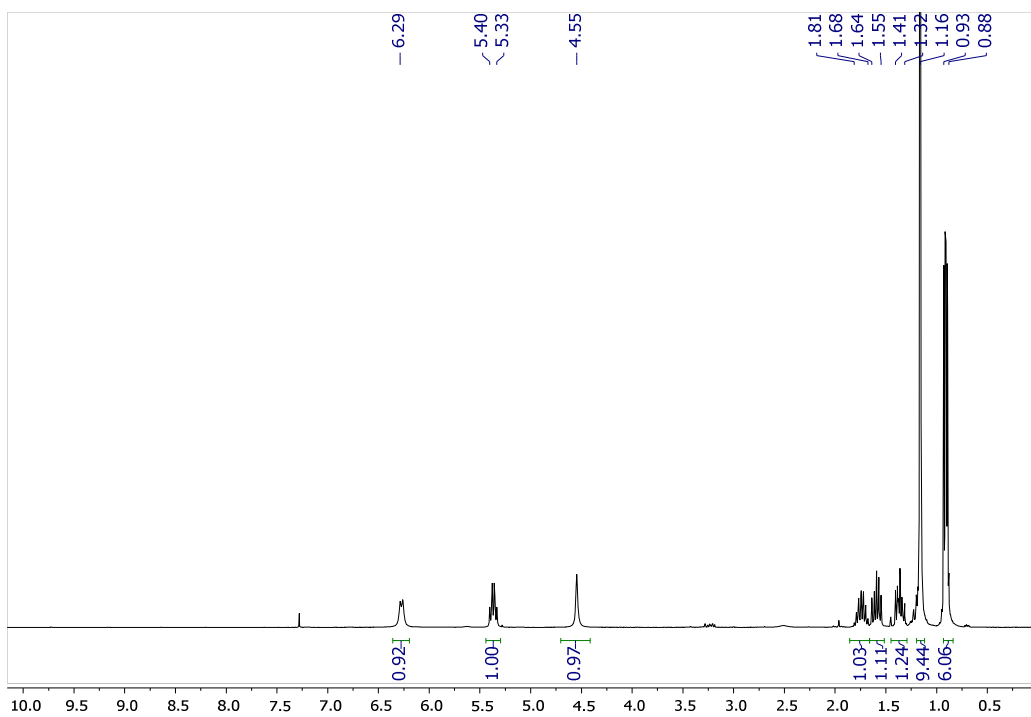


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P8** in CDCl_3

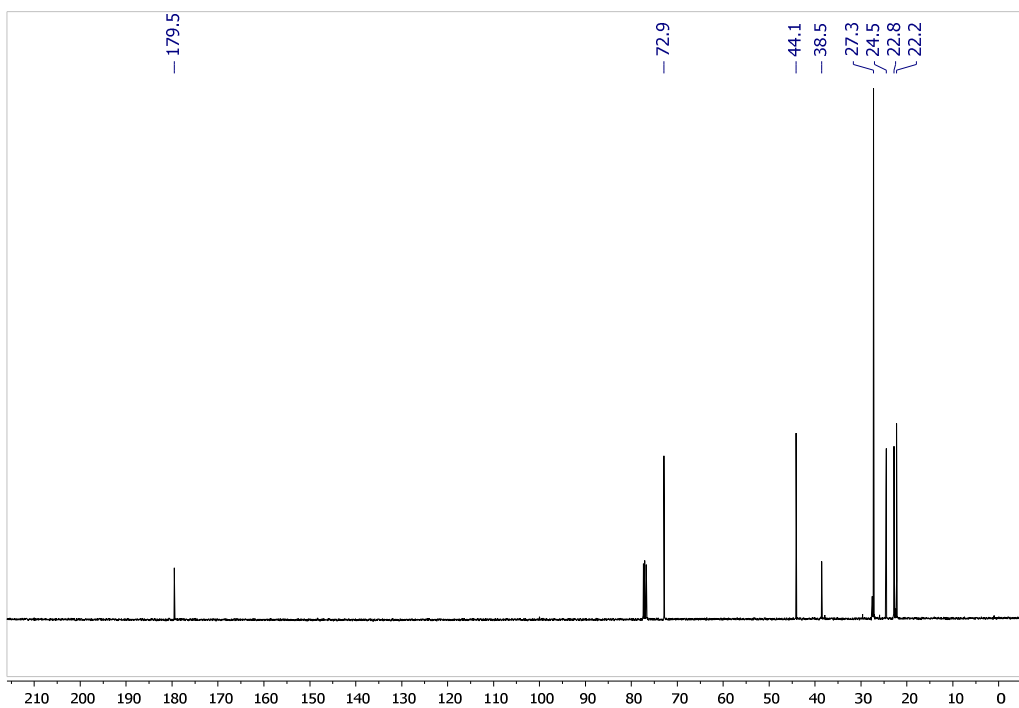


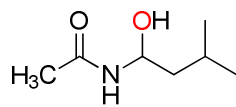


$^1\text{H-NMR}$ of **P9** in CDCl_3

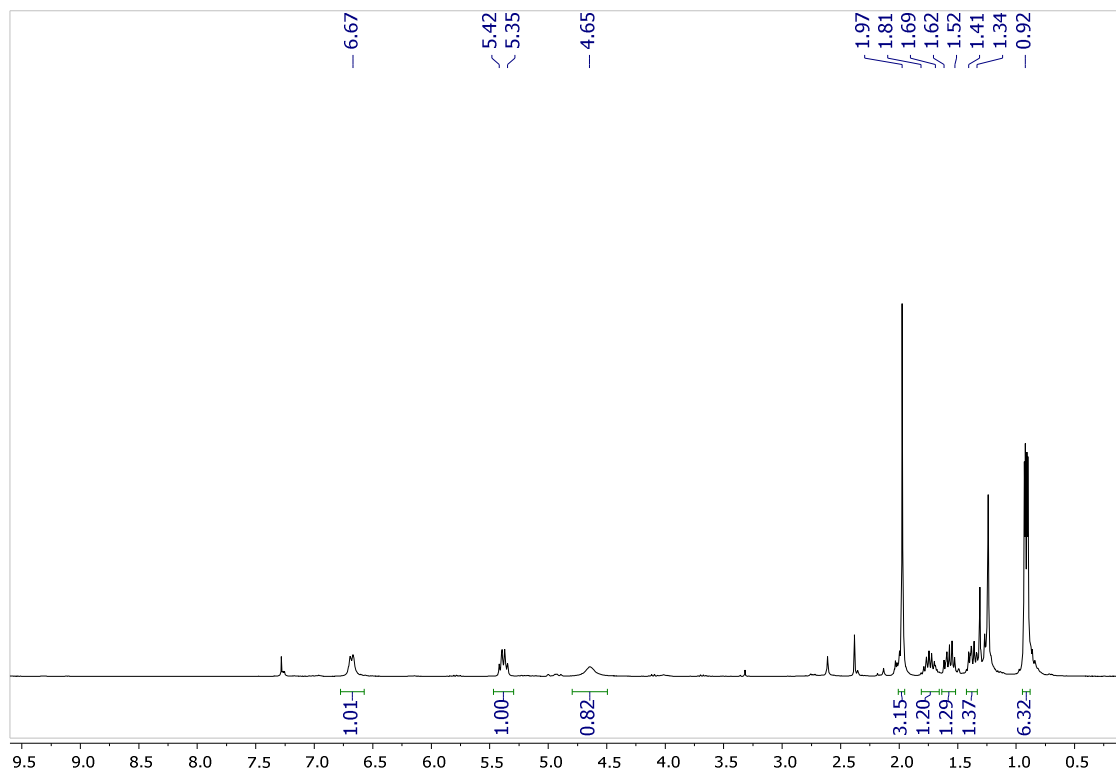


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P9** in CDCl_3

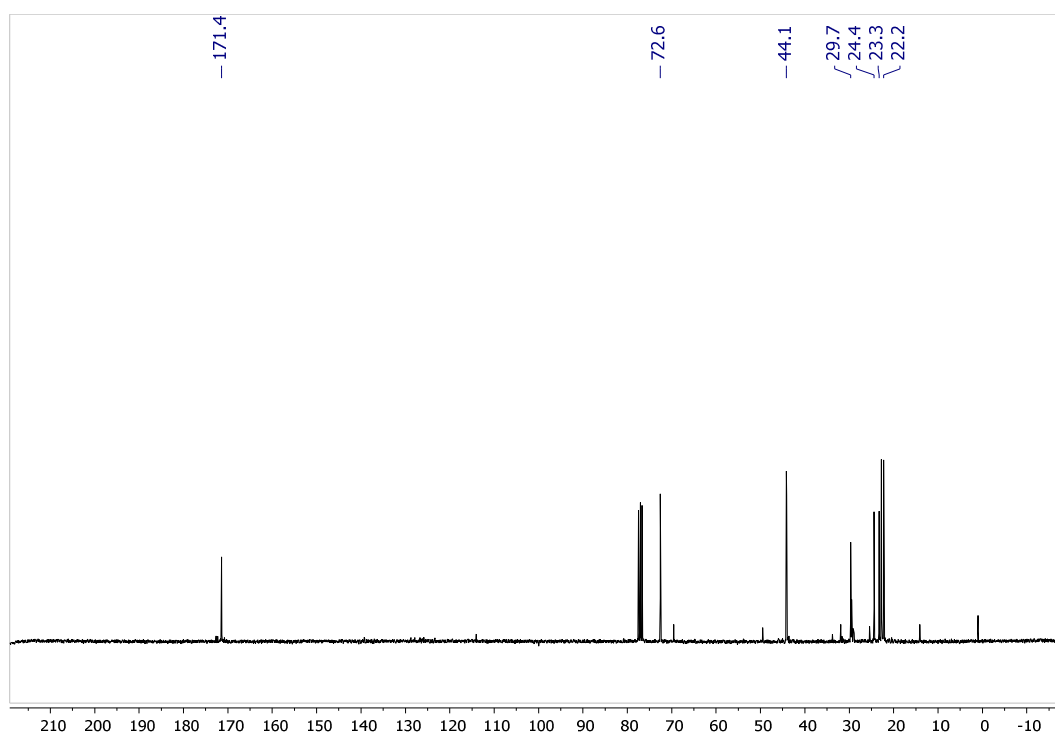


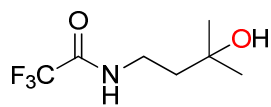


$^1\text{H-NMR}$ of **P10** in CDCl_3

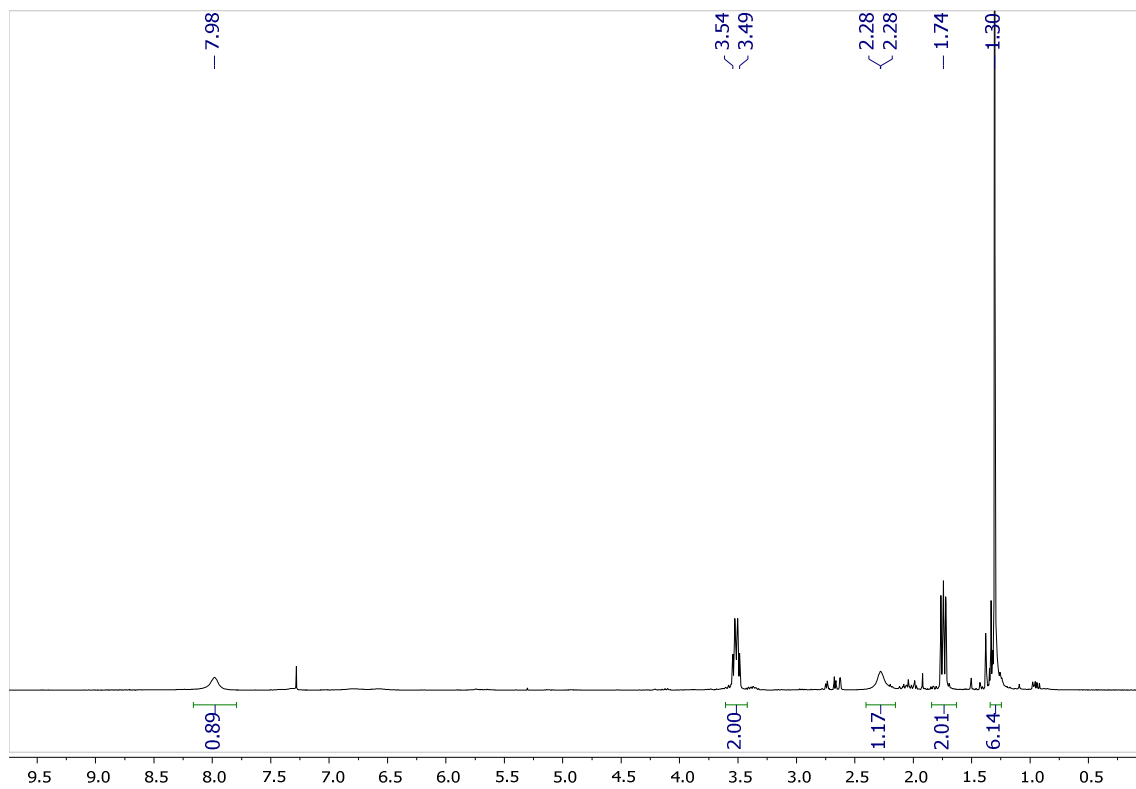


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P10** in CDCl_3

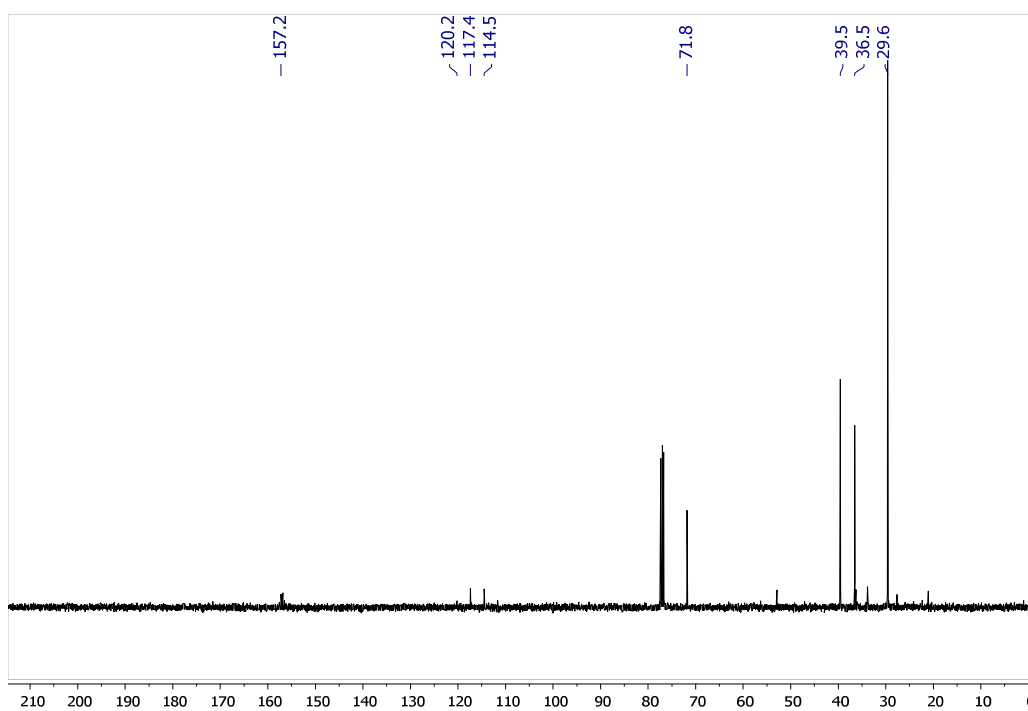


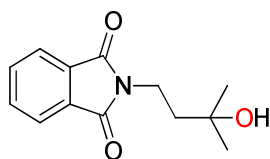


$^1\text{H-NMR}$ of **P11** in CDCl_3

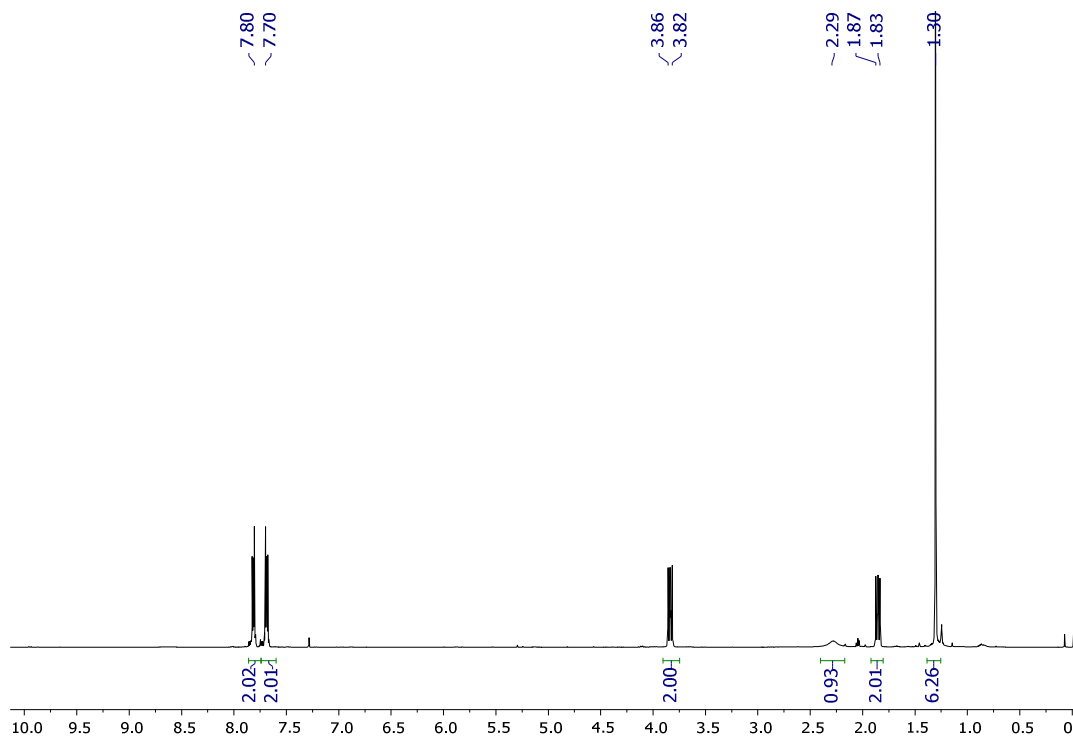


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P11** in CDCl_3

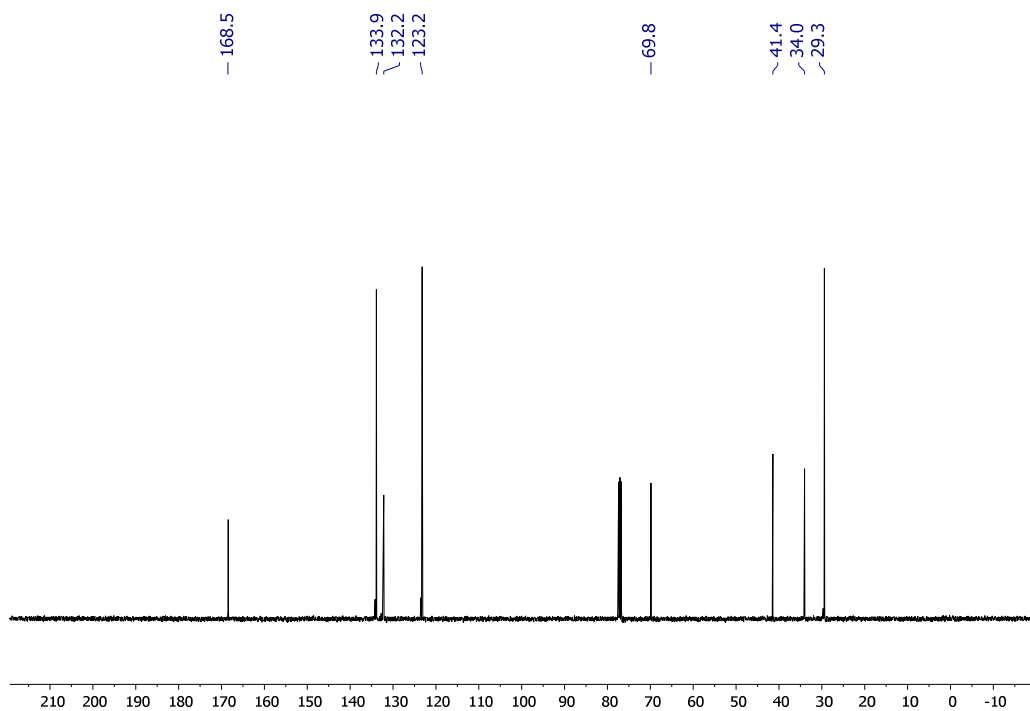


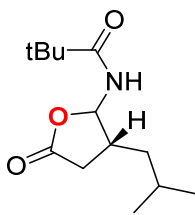


$^1\text{H-NMR}$ of **P12** in CDCl_3

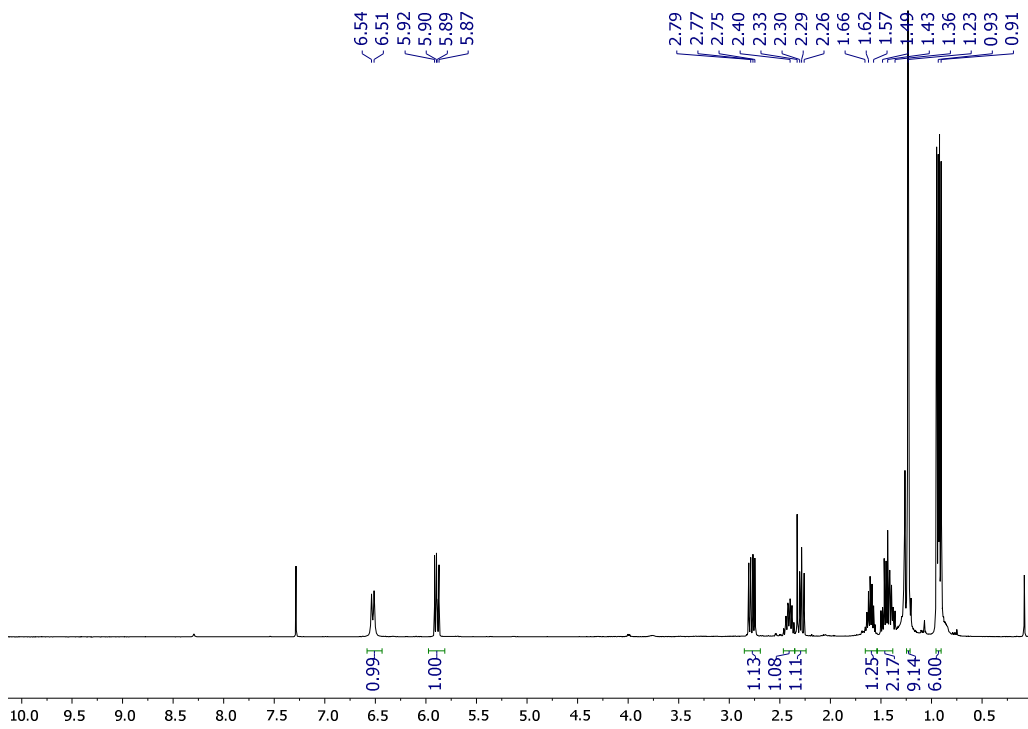


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P12** in CDCl_3

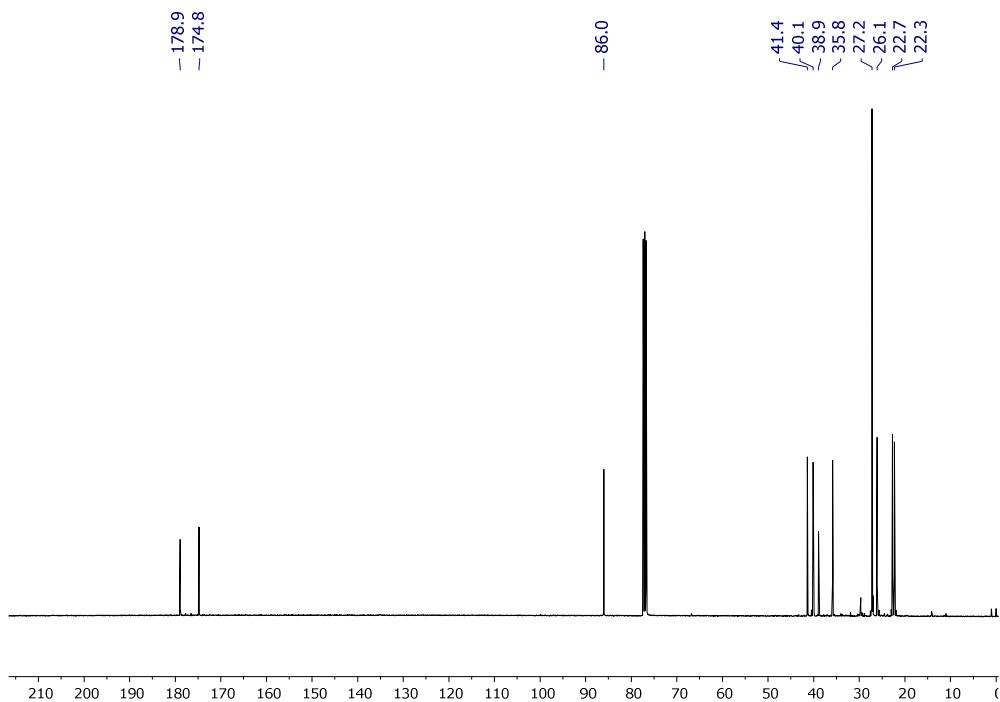


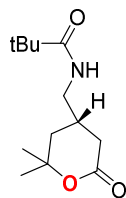


$^1\text{H-NMR}$ of P13_a in CDCl_3

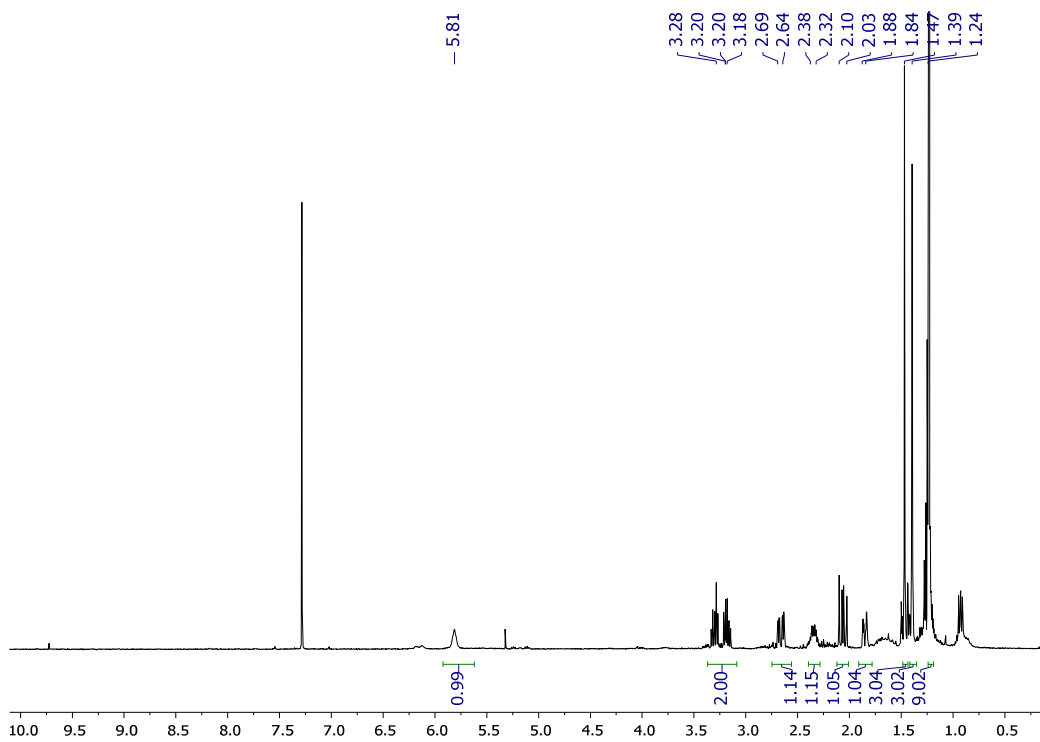


$^{13}\text{C}\{^1\text{H}\}$ -NMR of P13_a in CDCl_3

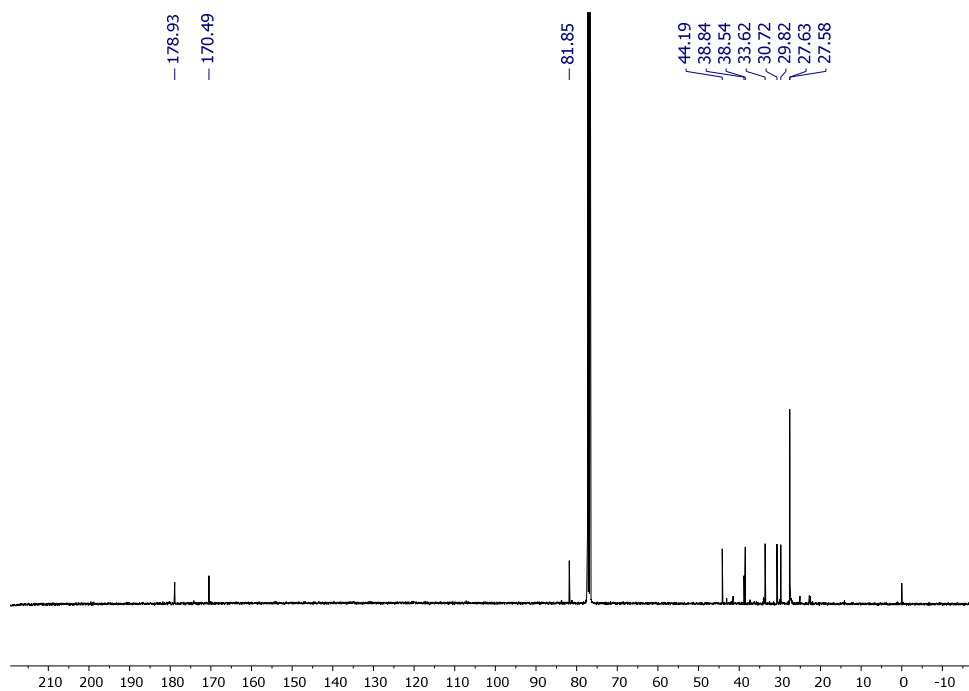


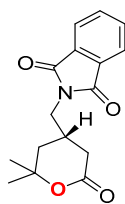


$^1\text{H-NMR}$ of P13_b in CDCl_3

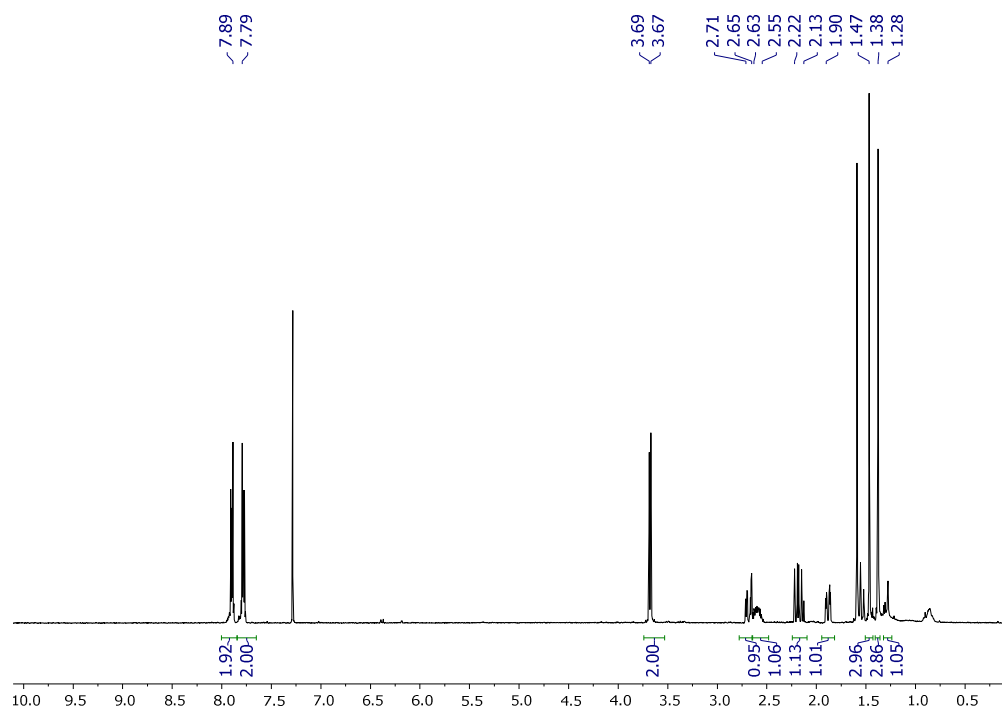


$^{13}\text{C}\{^1\text{H}\}$ -NMR of P13_b in CDCl_3

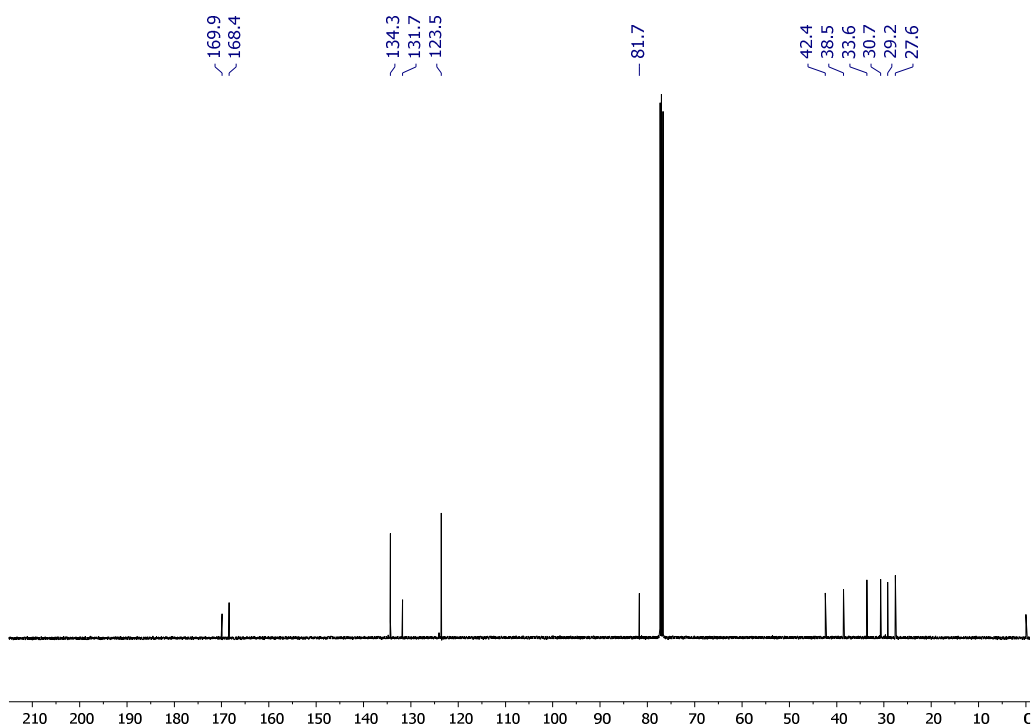


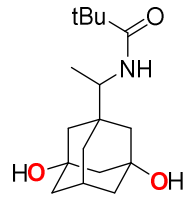


$^1\text{H-NMR}$ of **P14** in CDCl_3

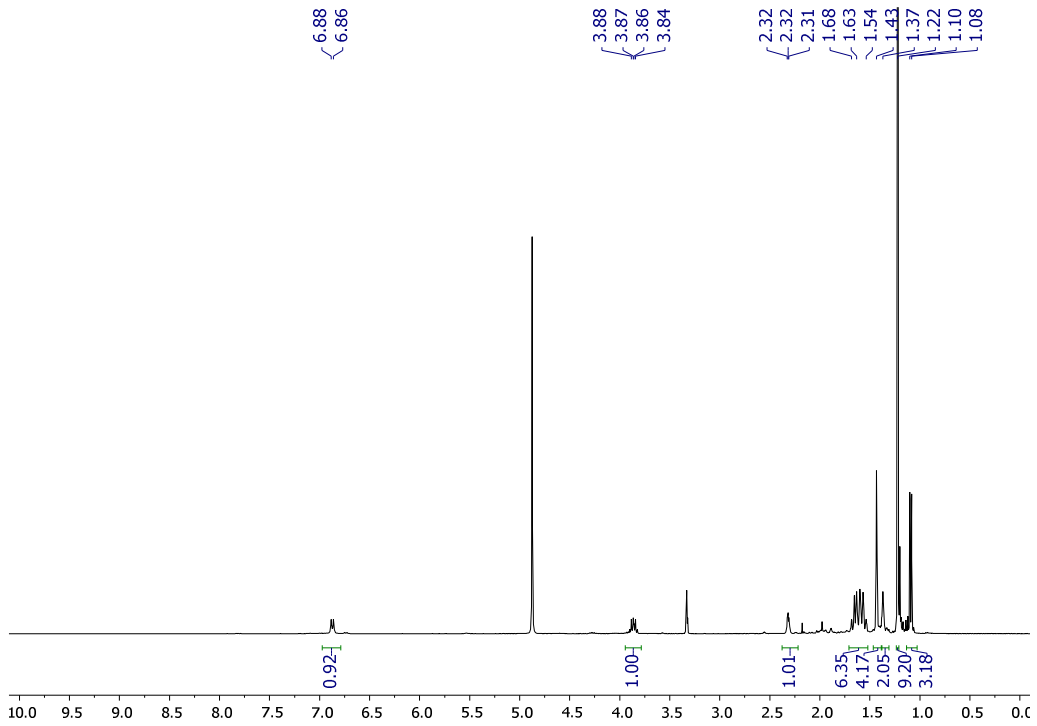


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P14** in CDCl_3

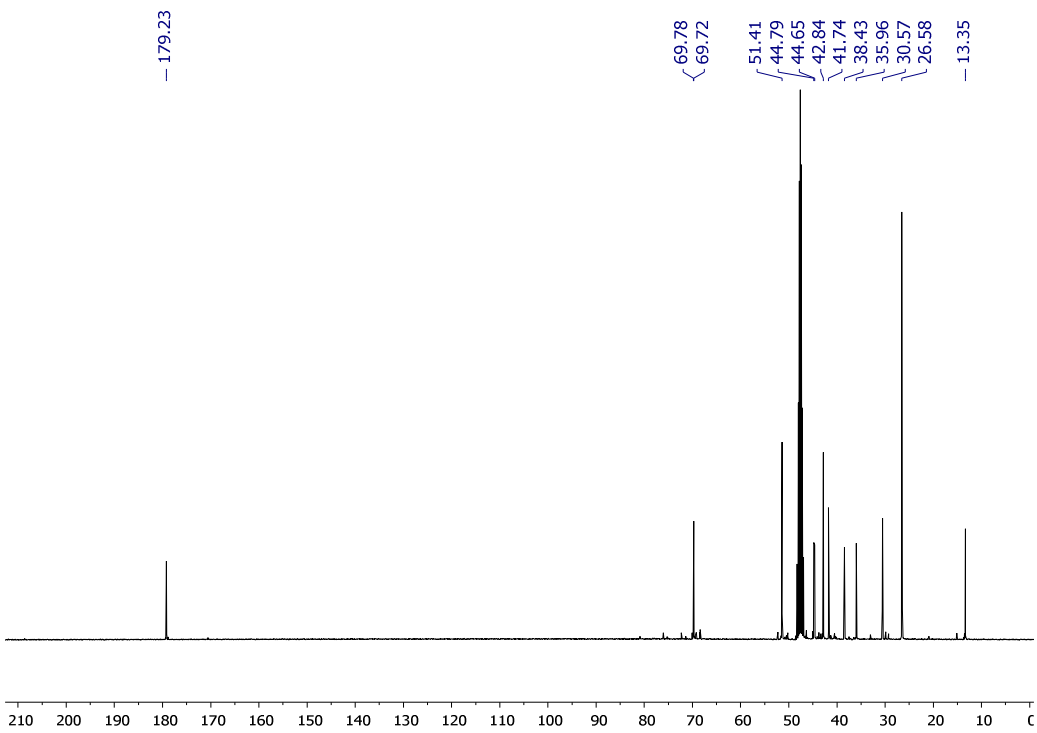


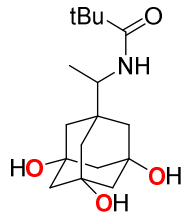


$^1\text{H-NMR}$ of **P15_a** in CH_3OD

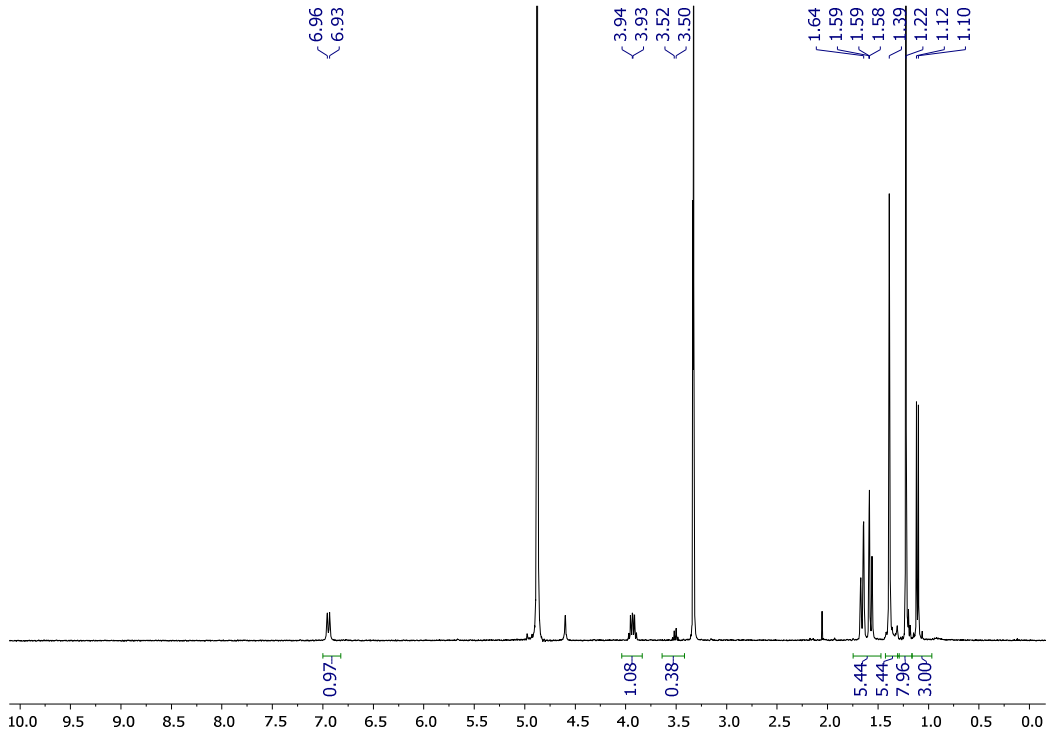


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P15_a** in CH_3OD

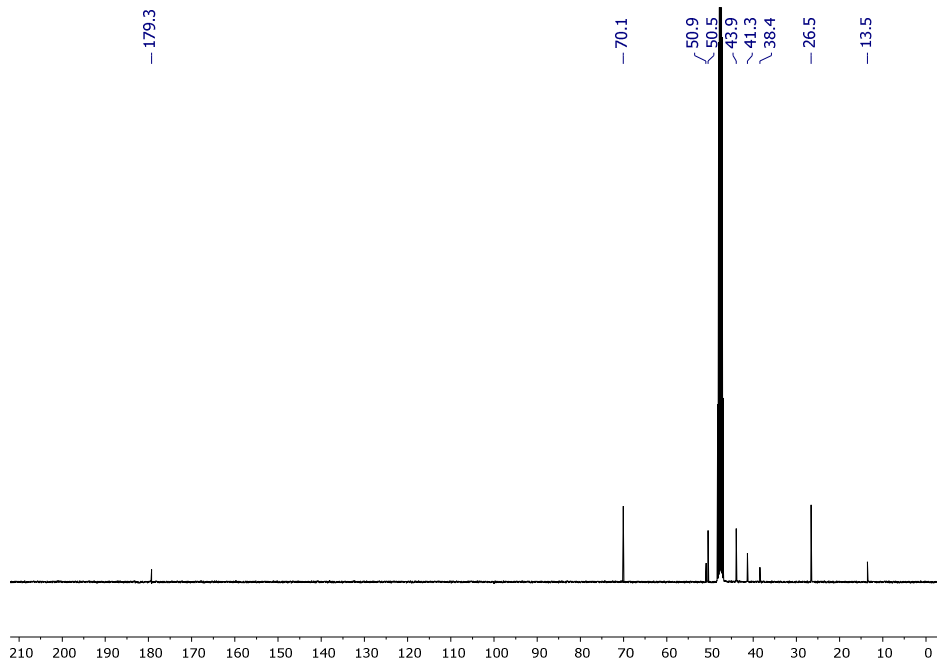


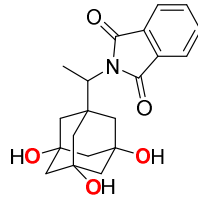


$^1\text{H-NMR}$ of P15_b in CH_3OD

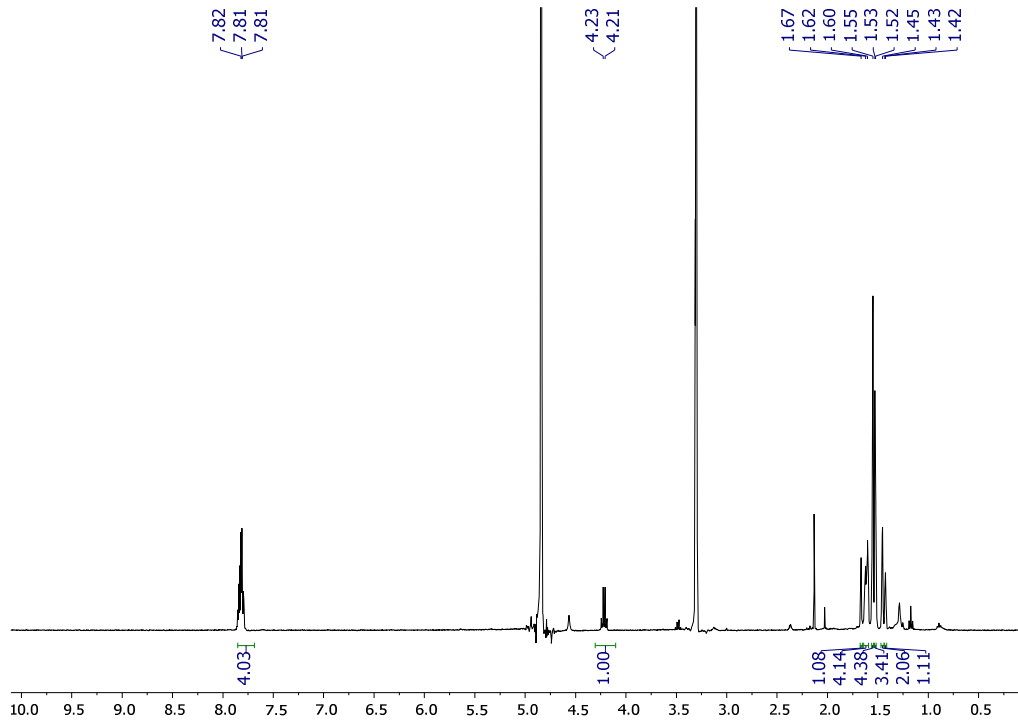


$^{13}\text{C}\{^1\text{H}\}$ -NMR of P15_b in CH_3OD

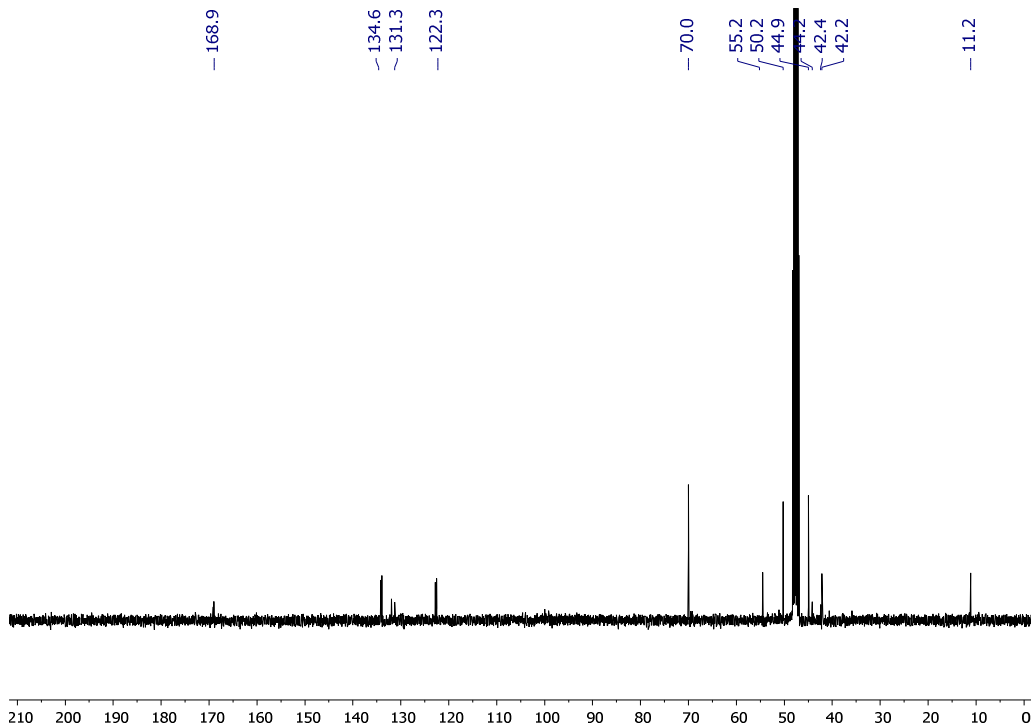


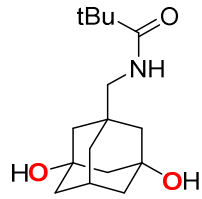


$^1\text{H-NMR}$ of **P16** in CH_3OD

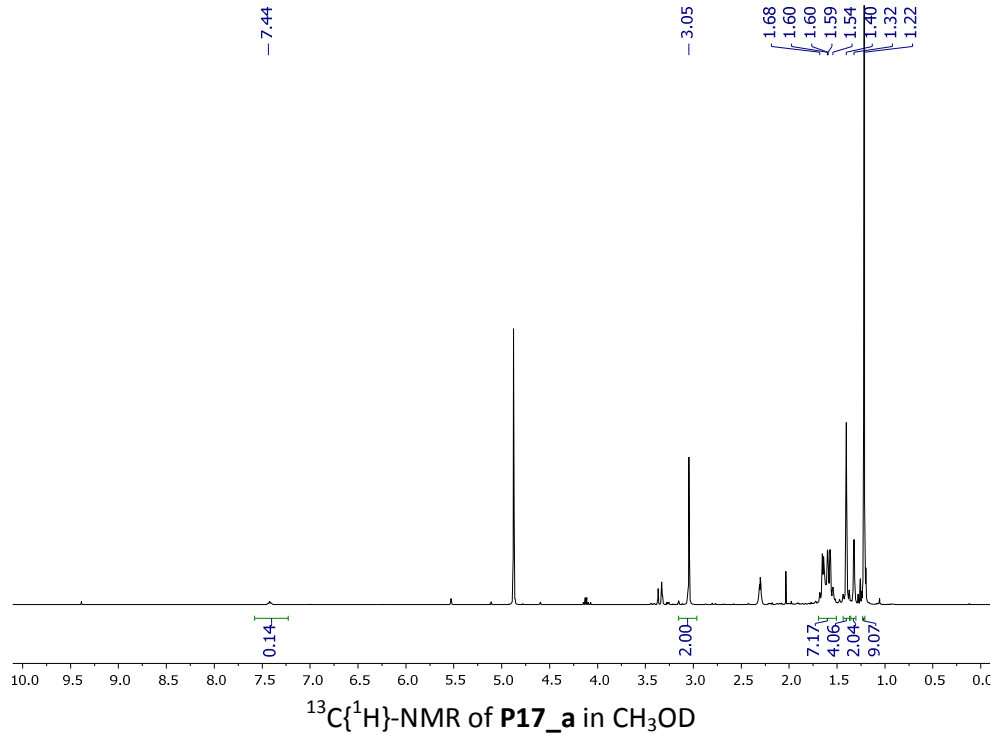


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P16** in CH_3OD

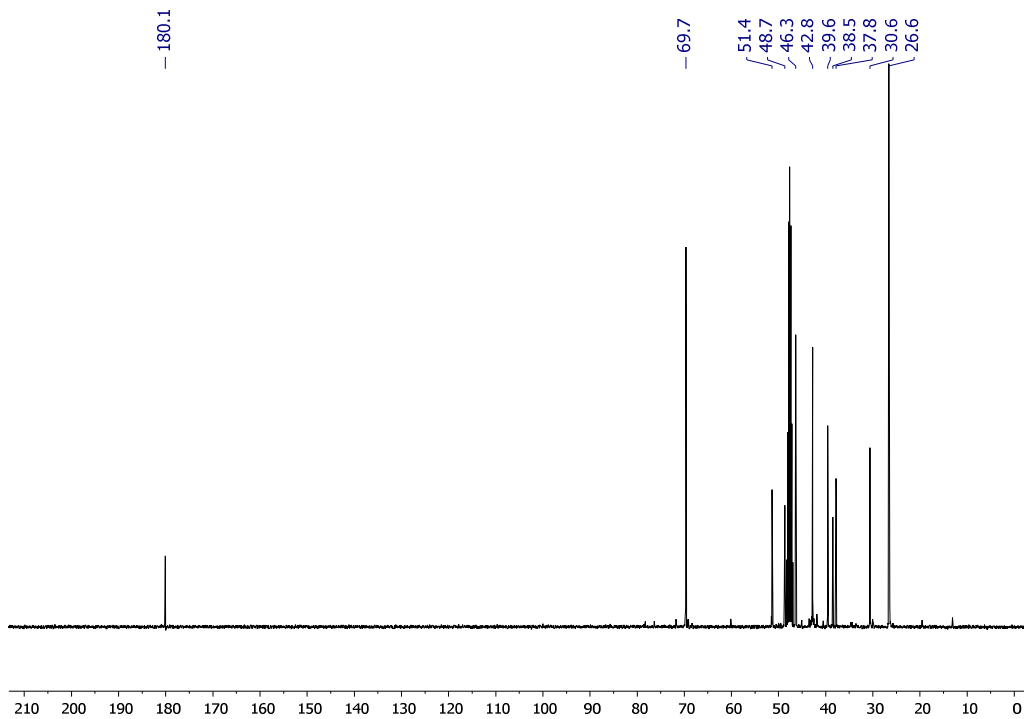


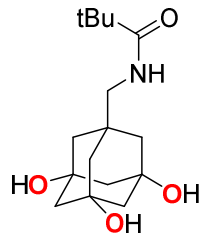


$^1\text{H-NMR}$ of **P17_a** in CH_3OD

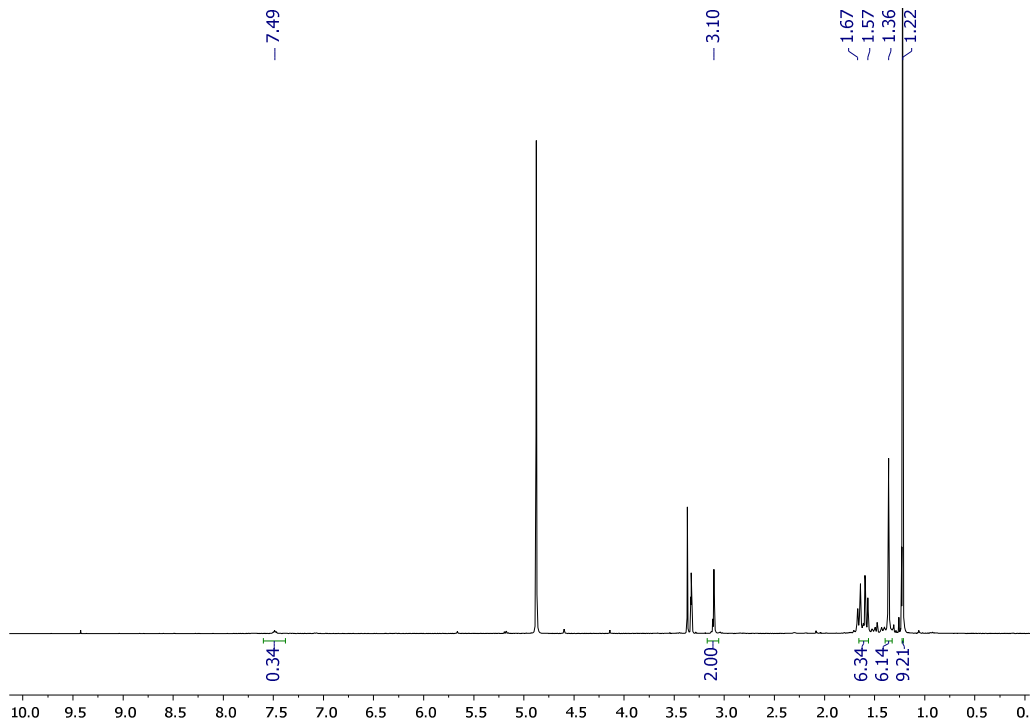


$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P17_a** in CH_3OD

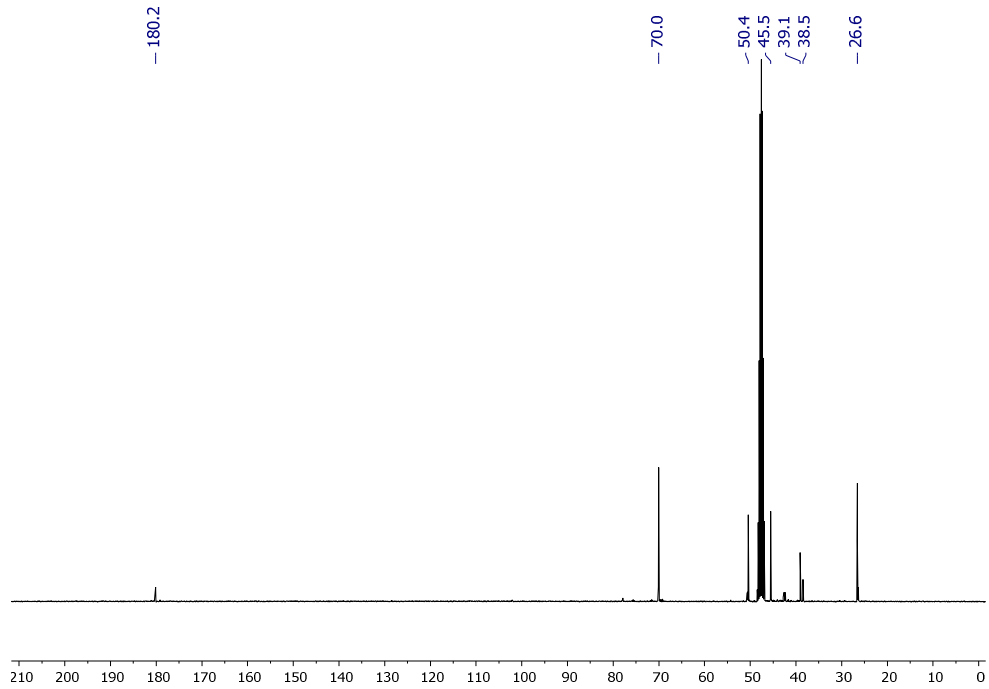




$^1\text{H-NMR}$ of **P17_b** in CH_3OD



$^{13}\text{C}\{^1\text{H}\}$ -NMR of **P17_b** in CH_3OD



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