

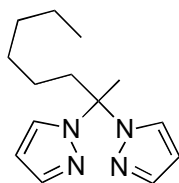
SUPPORTING INFORMATION

Title: Lewis Acid Catalyzed Addition of Pyrazoles to Alkynes: Selective Synthesis of Double and Single Addition Products

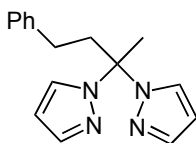
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Ref. No.: O200800353

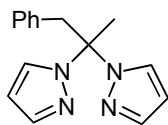
Lewis Acid-Catalyzed Double Addition of Pyrazoles to Alkynes. All *gem*-dipyrazolylalkanes in addition to pyrazolylalkenes **4ha** and **4ia** synthesized in Table 2 were fully characterized by ^1H NMR, ^{13}C NMR and HRMS spectroscopy as the following.



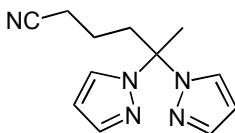
2,2-Bis(pyrazol-1-yl)octane (3aa). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 0.86 (t, $J = 6.9$ Hz, 3H), 1.19–1.41 (m, 8H), 2.24 (s, 3H), 2.64–2.70 (m, 2H), 6.26 (t, $J = 2.3$ Hz, 2H), 7.40 (d, $J = 2.8$ Hz, 2H), 7.55 (d, $J = 1.8$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 13.9, 22.5, 23.6, 24.6, 29.1, 31.5, 40.2, 79.5, 106.0, 127.2, 139.4. HRMS (ESI) Calcd for $\text{C}_{14}\text{H}_{23}\text{N}_4$: $\text{M}^+ + \text{H}$, 247.1917. Found: m/z 247.1923.



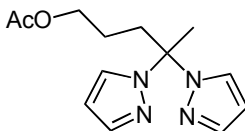
2,2-Bis(pyrazol-1-yl)-4-phenylbutane (3ba). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 2.34 (s, 3H), 2.50–2.56 (m, 2H), 2.97–3.03 (m, 2H), 6.28 (dd, $J = 2.7$, 1.8 Hz, 2H), 7.16–7.22 (m, 3H), 7.24–7.31 (m, 2H), 7.44 (d, $J = 3.2$ Hz, 2H), 7.58 (d, $J = 1.4$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 24.7, 30.2, 42.2, 79.3, 106.2, 126.2, 127.3, 128.4, 128.5, 139.7, 140.7. HRMS (ESI) Calcd for $\text{C}_{16}\text{H}_{19}\text{N}_4$: $\text{M}^+ + \text{H}$, 267.1604. Found: m/z 267.1619.



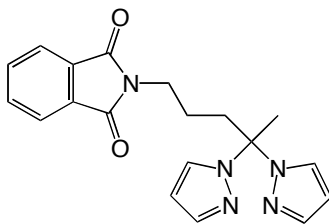
2,2-Bis(pyrazol-1-yl)-1-phenylpropane (3ca). A pale yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 2.06 (s, 3H), 4.06 (s, 2H), 6.28 (t, $J = 2.3$ Hz, 2H), 6.81 (dd, $J = 7.6, 1.4$ Hz, 2H), 7.14–7.21 (m, 3H), 7.42 (d, $J = 2.7$ Hz, 2H), 7.63 (d, $J = 1.8$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 24.7, 45.7, 79.6, 106.1, 127.2, 127.9, 128.2, 130.3, 135.0, 139.7. HRMS (ESI) Calcd for $\text{C}_{15}\text{H}_{17}\text{N}_4$: $\text{M}^+\text{+H}$, 253.1448. Found: m/z 253.1447.



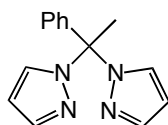
5,5-Bis(pyrazol-1-yl)hexanenitrile (3da). A white solid, mp 84–85 °C. ^1H NMR (400 MHz, CDCl_3) δ 1.58–1.70 (m, 2H), 2.26 (s, 3H), 2.36 (t, $J = 7.1$ Hz, 2H), 2.79–2.87 (m, 2H), 6.29 (dd, $J = 2.3, 1.8$ Hz, 2H), 7.35 (d, $J = 1.8$ Hz, 2H), 7.57 (d, $J = 1.8$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 17.0, 20.4, 24.9, 39.4, 78.9, 106.5, 119.1, 127.3, 139.8. HRMS (ESI) Calcd for $\text{C}_{12}\text{H}_{16}\text{N}_5$: $\text{M}^+\text{+H}$, 230.1400. Found: m/z 230.1391.



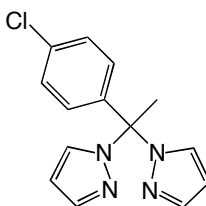
4,4-Bis(pyrazol-1-yl)pentyl acetate (3ea). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 1.53–1.63 (m, 2H), 2.05 (s, 3H), 2.25 (s 3H), 2.75–2.81 (m, 2H), 4.08 (t, $J = 6.4$ Hz, 2H), 6.27 (dd, $J = 2.7, 1.8$ Hz, 2H), 7.38 (d, $J = 3.2$ Hz, 2H), 7.56 (d, $J = 1.4$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 20.9, 23.3, 24.7, 36.9, 63.8, 79.2, 106.3, 127.3, 139.7, 171.0. HRMS (ESI) Calcd for $\text{C}_{13}\text{H}_{19}\text{N}_4\text{O}_2$: $\text{M}^+\text{+H}$, 263.1503. Found: m/z 263.1496.



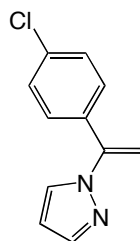
N-[4,4-Bis(pyrazol-1-yl)pent-1-yl]phthalimide (3fa). A viscous colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 1.59–1.70 (m, 2H), 2.23 (s, 3H), 2.73–2.80 (m, 2H), 3.72 (t, J = 7.1 Hz, 2H), 6.24 (t, J = 2.1 Hz, 2H), 7.37 (d, J = 2.3 Hz, 2H), 7.49 (d, J = 1.4 Hz, 2H), 7.68–7.75 (m, 2H), 7.80–7.87 (m, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 23.2, 24.6, 37.4, 37.5, 79.1, 106.2, 123.2, 127.2, 132.1, 133.9, 139.7, 168.3. HRMS (ESI) Calcd for $\text{C}_{19}\text{H}_{19}\text{N}_5\text{O}_2\text{Na}$: M^++Na , 372.1431. Found: m/z 372.1407.



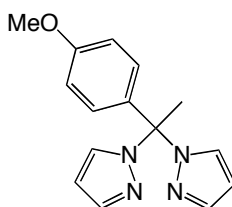
1,1-Bis(pyrazol-1-yl)-1-phenylethane (3ga). A pale yellow solid, mp 58–59 °C. ^1H NMR (400 MHz, CDCl_3) δ 2.72 (s, 3H), 6.30 (t, J = 2.3 Hz, 2H), 6.76–6.80 (m, 2H), 7.19 (d, J = 2.7 Hz, 2H), 7.32–7.37 (m, 3H), 7.65 (d, J = 1.8 Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 28.5, 82.2, 106.0, 126.3, 128.6, 128.9, 129.8, 140.3, 142.3. HRMS (ESI) Calcd for $\text{C}_{14}\text{H}_{15}\text{N}_4$: M^++H , 239.1291. Found: m/z 239.1303.



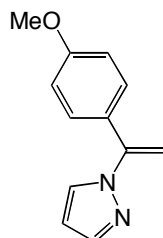
1,1-Bis(pyrazol-1-yl)-1-(4-chlorophenyl)ethane (3ha). A viscous pale yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 2.68 (s, 3H), 6.31 (t, J = 2.3 Hz, 2H), 6.71 (dt, J = 6.9, 2.1 Hz, 2H), 7.22 (d, J = 2.3 Hz, 2H), 7.31 (dt, J = 6.9, 2.1 Hz, 2H), 7.65 (d, J = 1.7 Hz, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 28.6, 81.7, 106.3, 127.8, 128.8, 129.6, 134.9, 140.4, 141.0. HRMS (ESI) Calcd for $\text{C}_{14}\text{H}_{13}\text{ClN}_4\text{Na}$: M^++Na , 295.0721. Found: m/z 295.0713.



1-(4-Chlorophenyl)-1-(pyrazol-1-yl)ethene (4ha). A pale yellow oil. ^1H NMR (500 MHz, CDCl_3) δ 5.20 (s, 1H), 5.57 (s, 1H), 6.38 (dd, $J = 2.3, 1.7$ Hz, 1H), 7.31 (dt, $J = 8.6, 2.3$ Hz, 2H), 7.37 (dt, $J = 8.6, 2.3$ Hz, 2H), 7.51 (d, $J = 2.3$ Hz, 1H), 7.68 (d, $J = 1.7$ Hz, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 105.5, 106.8, 128.8, 129.3, 129.6, 134.4, 135.3, 141.1, 144.9. HRMS (ESI) Calcd for $\text{C}_{11}\text{H}_{10}\text{ClN}_2$: $\text{M}^+\text{+H}$, 205.0527. Found: m/z 205.0527.

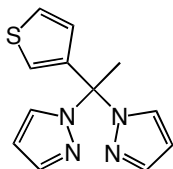


1,1-Bis(pyrazol-1-yl)-1-(4-methoxyphenyl)ethane (3ia). A pale white oil. ^1H NMR (400 MHz, CDCl_3) δ 2.69 (s, 3H), 3.80 (s, 3H), 6.28 (dd, $J = 2.7, 1.8$ Hz, 2H), 6.73 (ddd, $J = 8.7, 2.6, 2.5$ Hz, 2H), 6.86 (ddd, $J = 8.7, 2.8, 2.7$ Hz, 2H), 7.14 (d, $J = 3.2$, Hz, 2H), 7.64 (d, $J = 1.8$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 28.5, 55.3, 82.0, 105.9, 113.9, 127.6, 129.7, 134.3, 140.2, 159.8. HRMS (ESI) Calcd for $\text{C}_{15}\text{H}_{16}\text{N}_4\text{ONa}$: $\text{M}^+\text{+Na}$, 291.1216. Found: m/z 291.1196.

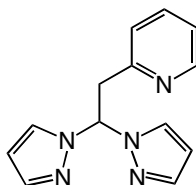


1-(4-Methoxyphenyl)-1-(pyrazol-1-yl)ethene (4ia). A colorless oil. ^1H NMR (500 MHz, CDCl_3) δ 3.84 (s, 3H), 5.12 (s, 1H), 5.49 (s, 1H), 6.35 (t, $J = 2.3$ Hz, 1H), 6.91 (dt, $J = 9.2, 2.6$ Hz, 2H), 7.31 (dt, $J = 9.2, 2.6$ Hz, 2H), 7.51 (d, $J = 1.7$ Hz, 1H), 7.68 (d, $J = 1.2$ Hz, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 55.4, 103.7, 106.4, 113.7,

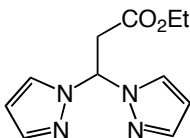
113.9, 128.4, 129.4, 129.6, 130.6, 140.8. HRMS (ESI) Calcd for $C_{12}H_{13}N_2O$: $M^+ + H$, 201.1022. Found: m/z 201.1022.



1,1-Bis(pyrazol-1-yl)-1-(thien-3-yl)ethane (3ja). A pale brown solid, mp 108–109 °C. 1H NMR (400 MHz, $CDCl_3$) δ 2.70 (s, 3H), 6.28 (dd, $J = 3.2, 1.6$ Hz, 2H), 6.75 (dd, $J = 2.7, 1.4$ Hz, 1H), 6.83 (dd, $J = 5.0, 1.4$ Hz, 1H), 7.12 (dd, $J = 2.3, 0.7$ Hz, 2H), 7.35 (dd, $J = 5.3, 3.0$ Hz, 1H), 7.64 (d, $J = 1.4$ Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 28.0, 79.8, 106.0, 124.0, 126.1, 126.8, 129.2, 140.3, 143.1. HRMS (ESI) Calcd for $C_{12}H_{12}N_4SNa$: $M^+ + Na$, 267.0675. Found: m/z 267.0649.

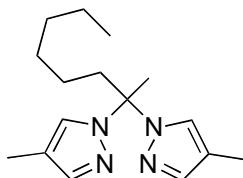


1,1-Bis(pyrazol-1-yl)-2-(pyrid-2-yl)ethane (3ka). A pale orange solid, mp 88–89 °C. 1H NMR (400 MHz, $CDCl_3$) δ 4.08 (d, $J = 7.8$ Hz, 2H), 6.20 (t, $J = 2.3$ Hz, 2H), 7.03 (d, $J = 7.8$ Hz, 1H), 7.06 (t, $J = 7.6$ Hz, 1H), 7.10 (ddd, $J = 6.4, 5.0, 1.2$ Hz, 1H), 7.47–7.75 (m, 3H), 7.64 (d, $J = 1.8$ Hz, 2H), 8.50–8.54 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 42.1, 74.8, 106.2, 122.0, 123.9, 128.8, 136.5, 140.2, 149.5, 155.3. HRMS (ESI) Calcd for $C_{13}H_{14}N_5$: $M^+ + H$, 240.1244. Found: m/z 240.1232.



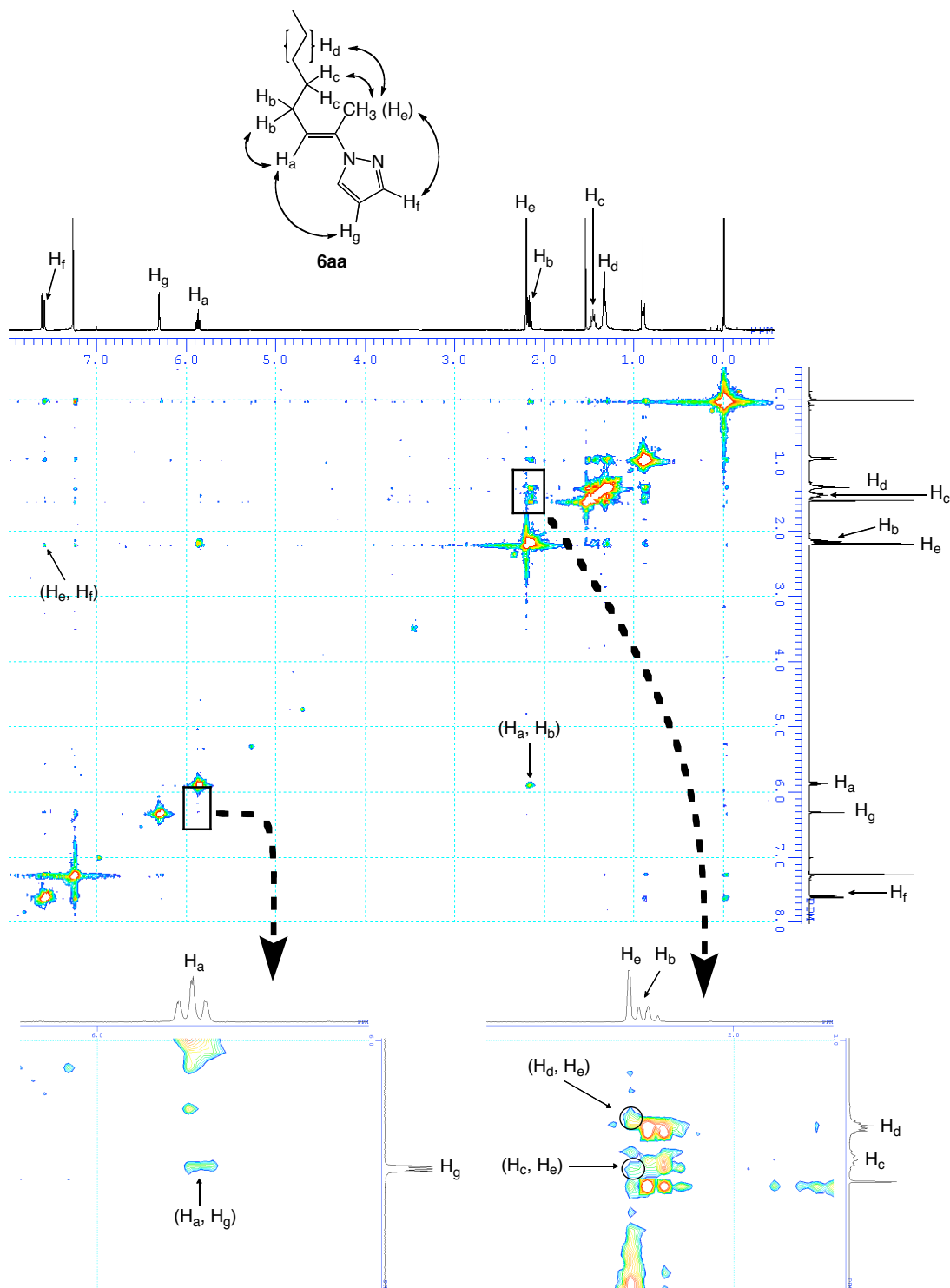
Ethyl 3,3-bis(pyrazol-1-yl)propanoate (3la). A white solid, mp 70–71 °C. 1H NMR (400 MHz, $CDCl_3$) δ 1.18 (t, $J = 7.1$ Hz, 3H), 3.68 (d, $J = 7.3$ Hz, 2H), 4.11 (q, $J = 7.1$ Hz, 2H), 6.27 (dd, $J = 2.3, 1.8$ Hz, 2H), 6.91 (t, $J = 7.3$ Hz, 1H), 7.54 (d, $J = 1.4$ Hz, 2H), 7.59 (d, $J = 2.8$ Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.0, 38.8, 61.2, 71.8,

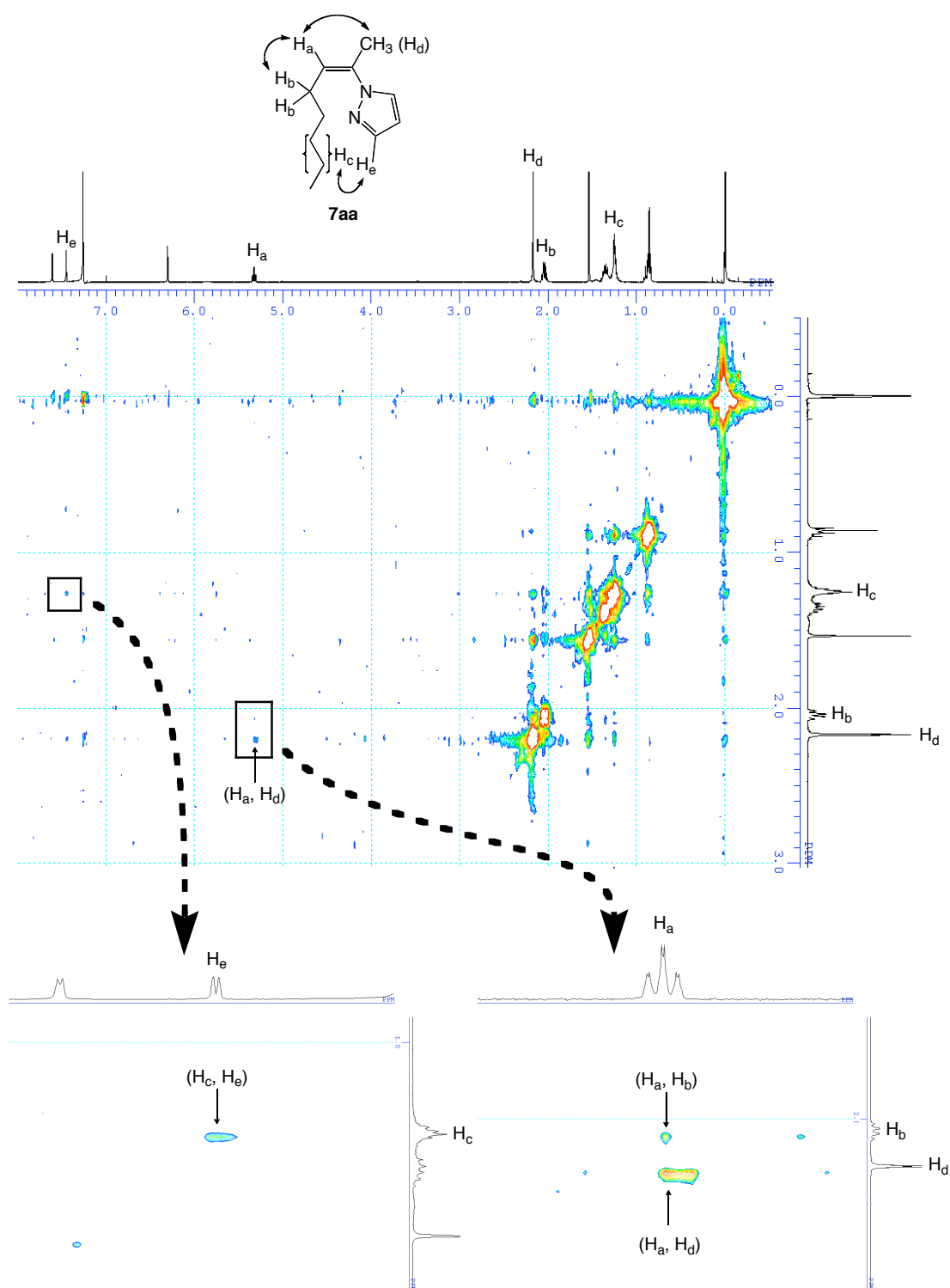
106.8, 128.8, 140.3, 168.5. HRMS (ESI) Calcd for $C_{11}H_{14}N_4O_2Na$: M^++Na , 257.1009. Found: m/z 257.1002.



2,2-Bis(4-methylpyrazol-1-yl)octane (3ab). A white solid, mp 30–31 °C. 1H NMR (400 MHz, $CDCl_3$) δ 0.86 (t, J = 6.9 Hz, 3H), 1.14–1.40 (m, 8H), 2.03 (s, 6H), 2.16 (s, 3H), 2.56–2.62 (m, 2H), 7.16 (s, 2H), 7.34 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 8.9, 14.0, 22.5, 23.7, 24.5, 29.2, 31.5, 40.0, 79.1, 116.4, 125.8, 140.0. HRMS (ESI) Calcd for $C_{16}H_{27}N_4$: M^++H , 275.2230. Found: m/z 275.2243.

Determination of Configuration of 6aa and 7aa. According to the NMR studies shown below utilizing 2D-NOESY technique, configuration of **6aa** or **7aa** was determined to be *E* or *Z*, respectively.

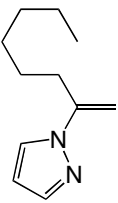
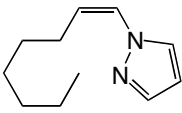
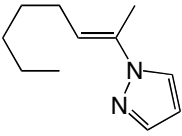
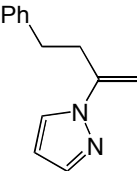
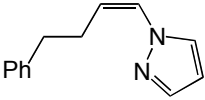
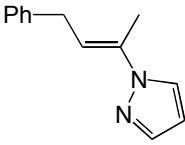
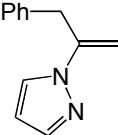
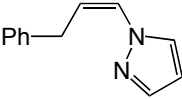
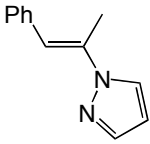




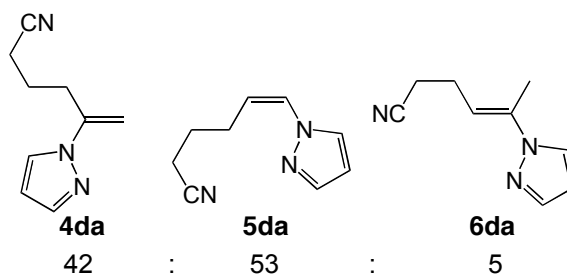
Structures and Isomer Distributions, and Spectral and Analytical Data of the 1 : 1 Adducts Generated in the Reactions of Entries 1–6 and 12–14 of Table 2.

Structures and isomer distributions of all single addition products produced in the reactions of entries 1–6 and 12–14 of Table 2 are summarized in Table S1. The pyrazolylalkenes that are not appeared in Table 1 and Table 3 were fully characterized by ^1H NMR, ^{13}C NMR and HRMS spectroscopy in this section. Their spectral and analytical data are provided after Table S1.

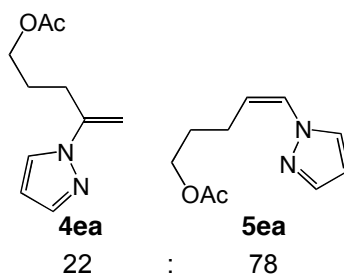
Table S1.

$\text{R}^1\text{C}\equiv\text{CR}^2$	Structure and ratio of 1 : 1 adducts		
HexC $\equiv$ CH (1a) (entry 1 of Table 2)	 4aa 34	 5aa 54	 6aa 12
Ph(CH $_2$) $_2$ C $\equiv$ CH (1b) (entry 2 of Table 2)	 4ba 11	 5ba 79	 6ba 10
BnC $\equiv$ CH (1c) (entry 3 of Table 2)	 4ca 17	 5ca 59	 6ca 24

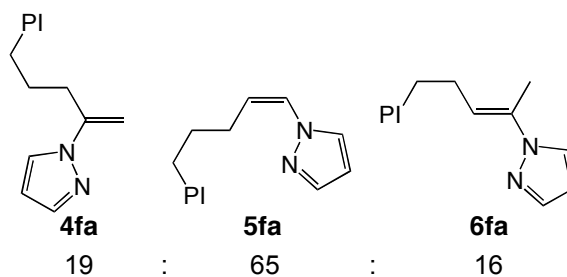
NC(CH₂)₃C≡CH (**1d**)
(entry 4 of Table 2)



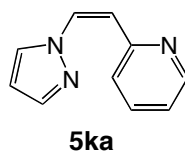
AcO(CH₂)₃C≡CH (**1e**)
(entry 5 of Table 2)



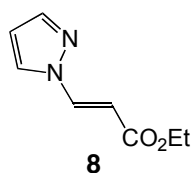
PI(CH₂)₃C≡CH (**1f**)
(PI = phthalimidoyl)
(entry 6 of Table 2)



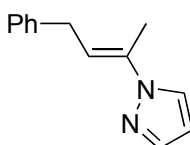
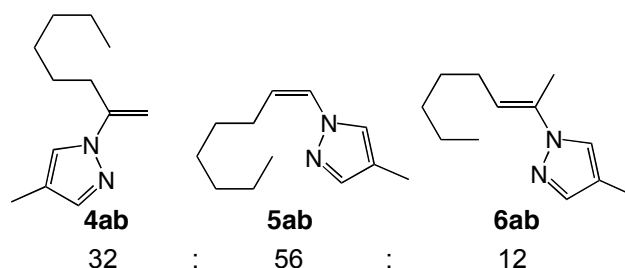
HC≡C-2-pyridyl (**1k**)
(entry 12 of Table 2)



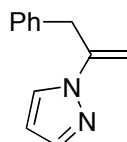
HC≡CCO₂Et (**1l**)
(entry 13 of Table 2)



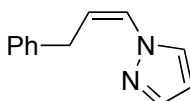
HexC≡CH (**1a**)
(entry 14 of Table 2)



(E)-4-Phenyl-2-(pyrazol-1-yl)but-2-ene (6ba). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 2.33 (d, $J = 0.9$ Hz, 3H), 3.56 (d, $J = 7.8$ Hz, 2H), 6.07 (tq, $J = 7.8$, 0.9 Hz, 1H), 6.31 (t, $J = 1.8$ Hz, 1H), 7.18–7.33 (m, 5H), 7.59 (d, $J = 1.8$ Hz, 1H), 7.65 (d, $J = 1.8$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 14.7, 33.4, 106.1, 115.8, 126.2, 126.6, 128.3, 128.6, 135.1, 139.8, 140.1. HRMS (ESI) Calcd for $\text{C}_{13}\text{H}_{15}\text{N}_2$: $\text{M}^+\text{+H}$, 199.1230. Found: m/z 199.1224.

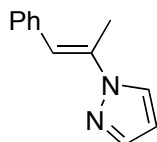


3-Phenyl-2-(pyrazol-1-yl)prop-1-ene (4ca). A pale yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 4.00 (s, 2H), 4.67 (s, 1H), 5.46 (s, 1H), 6.29 (dd, $J = 2.3$, 1.8 Hz, 1H), 7.20–7.32 (m, 5H), 7.60 (d, $J = 1.8$ Hz, 1H), 7.62 (d, $J = 3.2$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 39.0, 102.1, 106.7, 126.7, 127.2, 128.5, 128.8, 137.3, 140.3, 144.5. HRMS (ESI) Calcd for $\text{C}_{12}\text{H}_{13}\text{N}_2$: $\text{M}^+\text{+H}$, 185.1073. Found: m/z 185.1080.

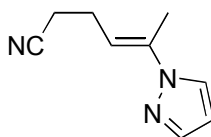


(Z)-3-Phenyl-1-(pyrazol-1-yl)prop-1-ene (5ca). A pale yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 3.90 (dd, $J = 9.6$, 1.8 Hz, 2H), 5.45 (dt, $J = 9.2$, 7.8 Hz, 1H), 6.35 (t, $J = 2.3$ Hz, 1H), 6.89 (dt, $J = 9.2$, 1.8 Hz, 1H), 7.19–7.34 (m, 5H), 7.55 (d, $J = 2.3$

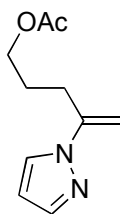
Hz, 1H), 7.65 (d, $J = 1.4$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 33.2, 106.2, 119.1, 126.2, 126.3, 128.3, 128.6, 130.0, 140.1, 140.4. HRMS (ESI) Calcd for $\text{C}_{12}\text{H}_{13}\text{N}_2$: $\text{M}^+ + \text{H}$, 185.1073. Found: m/z 185.1073.



(E)-1-Phenyl-2-(pyrazol-1-yl)prop-1-ene (6ca). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 2.45 (d, $J = 1.4$ Hz, 3H), 6.40 (t, $J = 1.8$ Hz, 1H), 7.07 (s, 1H), 7.23–7.29 (m, 1H), 7.32–7.41 (m, 4H), 7.67 (d, $J = 1.4$ Hz, 1H), 7.77 (d, $J = 1.8$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 15.8, 106.7, 117.1, 126.8, 126.9, 128.3, 129.1, 135.7, 136.0, 140.3. HRMS (ESI) Calcd for $\text{C}_{12}\text{H}_{13}\text{N}_2$: $\text{M}^+ + \text{H}$, 185.1073. Found: m/z 185.1047.

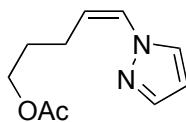


(E)-5-(Pyrazol-1-yl)hex-4-enenitrile (6da). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 2.27 (s, 3H), 2.49 (td, $J = 6.9, 1.8$ Hz, 2H), 2.58 (q, $J = 7.3$ Hz, 2H), 5.95 (td, $J = 7.8, 0.9$ Hz, 1H), 6.35 (t, $J = 1.8$ Hz, 1H), 7.60 (d, $J = 1.8$ Hz, 1H), 7.65 (d, $J = 2.3$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 14.5, 17.7, 23.6, 106.5, 112.1, 119.0, 126.6, 136.8, 140.2. HRMS (ESI) Calcd for $\text{C}_9\text{H}_{12}\text{N}_3$: $\text{M}^+ + \text{H}$, 162.1026. Found: m/z 162.1011.

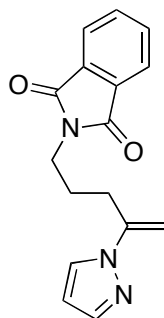


4-(Pyrazol-1-yl)pent-4-en-1-yl acetate (4ea). A pale yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 1.90 (quint, $J = 6.8$ Hz, 2H), 2.06 (s, 3H), 2.77 (t, $J = 7.8$ Hz, 2H), 4.12 (t, $J = 6.4$ Hz, 2H), 4.75 (s, 1H), 5.27 (s, 1H), 6.35 (t, $J = 1.8$ Hz, 1H), 7.61 (d, $J = 1.4$ Hz, 1H), 7.70 (d, $J = 2.3$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 20.9, 26.3, 29.3,

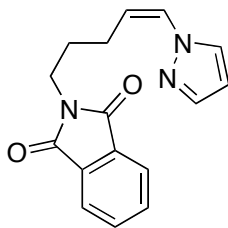
63.5, 100.2, 106.7, 126.9, 140.4, 144.7, 171.1. HRMS (ESI) Calcd for $C_{10}H_{14}N_2O_2Na$: $M^+ + Na$, 217.0948. Found: m/z 217.0926.



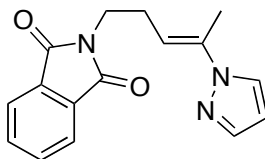
(Z)-5-(Pyrazol-1-yl)pent-4-en-1-yl acetate (5ea). A pale yellow oil. 1H NMR (400 MHz, $CDCl_3$) δ 1.82 (quint, $J = 6.8$ Hz, 2H), 2.04 (s, 3H), 2.60 (qd, $J = 7.6$, 1.8 Hz, 2H), 4.11 (t, $J = 6.9$ Hz, 2H), 5.23 (dt, $J = 9.2$, 7.2 Hz, 1H), 6.34 (t, $J = 1.8$ Hz, 1H), 6.79 (dt, $J = 9.2$, 1.8 Hz, 1H), 7.53 (d, $J = 2.3$ Hz, 1H), 7.62 (d, $J = 1.8$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 20.9, 23.6, 28.5, 63.8, 106.1, 119.3, 126.4, 129.9, 140.2, 171.1. HRMS (ESI) Calcd for $C_{10}H_{14}N_2O_2Na$: $M^+ + Na$, 217.0948. Found: m/z 217.0948.



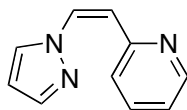
N-[4-(Pyrazol-1-yl)pent-4-en-1-yl]phthalimide (4fa). A white solid, mp 57–58 °C. 1H NMR (400 MHz, $CDCl_3$) δ 1.95 (quint, $J = 6.9$ Hz, 2H), 2.75 (t, $J = 7.8$ Hz, 2H), 3.77 (t, $J = 6.9$ Hz, 2H), 4.81 (s, 1H), 5.27 (s, 1H), 6.33 (t, $J = 2.3$ Hz, 1H), 7.57 (d, $J = 1.8$ Hz, 1H), 7.67 (d, $J = 2.8$ Hz, 1H), 7.69–7.75 (m, 2H), 7.81–7.88 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 26.2, 30.1, 37.3, 100.4, 106.7, 123.2, 126.9, 132.1, 133.9, 140.3, 144.6, 168.3. HRMS (ESI) Calcd for $C_{16}H_{16}N_3O_2$: $M^+ + H$, 282.1237. Found: m/z 282.1242.



(Z)-N-[5-(Pyrazol-1-yl)pent-4-en-1-yl]phthalimide (5fa). A white solid, mp 55–56 °C. ^1H NMR (400 MHz, CDCl_3) δ 1.88 (quint, $J = 7.3$ Hz, 2H), 2.59 (qd, $J = 7.6, 1.4$ Hz, 2H), 3.74 (t, $J = 7.3$ Hz, 2H), 5.26 (dt, $J = 9.2, 7.4$ Hz, 1H), 6.30 (t, $J = 2.3$ Hz, 1H), 6.77 (dt, $J = 9.2, 1.4$ Hz, 1H), 7.49 (d, $J = 2.3$ Hz, 1H), 7.51 (d, $J = 1.4$ Hz, 1H), 7.68–7.74 (m, 2H), 7.81–7.87 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 24.5, 28.3, 37.5, 106.1, 119.0, 123.2, 126.4, 129.9, 132.1, 133.9, 140.2, 168.4. HRMS (ESI) Calcd for $\text{C}_{16}\text{H}_{16}\text{N}_3\text{O}_2$: $\text{M}^+ + \text{H}$, 282.1237. Found: m/z 282.1232.

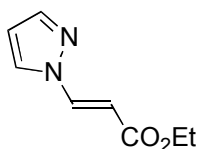


(E)-N-[4-(Pyrazol-1-yl)pent-3-en-1-yl]phthalimide (6fa). A white solid, mp 118–119 °C. ^1H NMR (400 MHz, CDCl_3) δ 2.19 (d, $J = 0.9$ Hz, 3H), 2.60 (qt, $J = 6.9, 0.9$ Hz, 2H), 3.82 (t, $J = 7.3$ Hz, 2H), 5.84 (tq, $J = 7.8, 0.9$ Hz, 1H), 6.30 (dd, $J = 2.3, 1.8$ Hz, 1H), 7.57 (dd, $J = 1.4, 0.5$ Hz, 1H), 7.62 (dd, $J = 2.3, 0.8$ Hz, 1H), 7.69–7.74 (m, 2H), 7.81–7.88 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 14.5, 26.7, 37.4, 106.2, 112.7, 123.3, 126.8, 132.0, 134.0, 136.8, 139.9, 168.3. HRMS (ESI) Calcd for $\text{C}_{16}\text{H}_{16}\text{N}_3\text{O}_2$: $\text{M}^+ + \text{H}$, 282.1237. Found: m/z 282.1236.

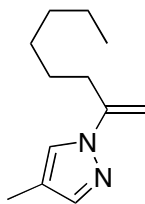


(Z)-1-(Pyrazol-1-yl)-2-(pyrid-2-yl)ethene (5ka). An orange solid, mp 68–69 °C. ^1H NMR (400 MHz, CDCl_3) δ 6.41 (dd, $J = 2.3, 1.8$ Hz, 1H), 7.13 (d, $J = 13.8$ Hz, 1H), 7.14 (ddd, $J = 7.5, 4.8, 1.2$ Hz, 1H), 7.25 (d, $J = 7.8$ Hz, 1H), 7.65 (td, $J = 7.8, 1.8$ Hz, 1H), 7.67 (d, $J = 2.3$ Hz, 1H), 7.70 (d, $J = 1.4$ Hz, 1H), 8.09 (d, $J = 14.2$ Hz, 1H), 8.55 (dd, $J = 4.6, 0.9$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 107.6, 115.7, 122.0,

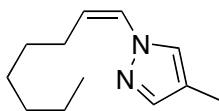
122.6, 129.5, 129.7, 136.7, 141.8, 149.6, 154.1. HRMS (ESI) Calcd for $C_{10}H_{10}N_3$: $M^+ + H$, 172.0869. Found: m/z 172.0861.



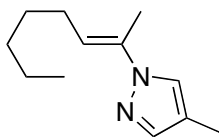
Ethyl (*E*)-3-(pyrazol-1-yl)prop-2-enoate (8). A white solid, mp 71–72 °C. 1H NMR (400 MHz, $CDCl_3$) δ 1.33 (t, $J = 7.3$ Hz, 3H), 4.26 (q, $J = 7.2$ Hz, 2H), 6.35 (d, $J = 14.2$ Hz, 1H), 6.45 (dd, $J = 2.6, 2.1$ Hz, 1H), 7.66 (d, $J = 2.3$ Hz, 1H), 7.72 (d, $J = 1.4$ Hz, 1H), 7.99 (d, $J = 14.2$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.3, 60.6, 105.9, 109.0, 130.0, 139.6, 143.4, 166.5. HRMS (ESI) Calcd for $C_8H_{11}N_2O_2$: $M^+ + H$, 167.0815. Found: m/z 167.0807.



2-(4-Methylpyrazol-1-yl)oct-1-ene (4ab). A colorless oil. 1H NMR (400 MHz, $CDCl_3$) δ 0.88 (t, $J = 7.3$ Hz, 3H), 1.23–1.42 (m, 6H), 1.53 (quint, $J = 7.6$ Hz, 2H), 2.10 (s, 3H), 2.61 (t, $J = 7.8$ Hz, 2H), 4.63 (s, 1H), 5.18 (s, 1H), 7.41 (s, 1H), 7.45 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 8.9, 14.0, 22.6, 27.4, 28.8, 31.6, 32.6, 98.5, 117.0, 125.5, 140.9, 145.8. HRMS (ESI) Calcd for $C_{12}H_{21}N_2$: $M^+ + H$, 193.1699. Found: m/z 193.1673.

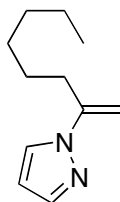


(*Z*)-1-(4-Methylpyrazol-1-yl)oct-1-ene (5ab). A colorless oil. 1H NMR (400 MHz, $CDCl_3$) δ 0.88 (t, $J = 6.9$ Hz, 3H), 1.25–1.40 (m, 6H), 1.46 (quint, $J = 7.3$ Hz, 2H), 2.10 (s, 3H), 2.42 (qd, $J = 7.6, 1.8$ Hz, 2H), 5.15 (dt, $J = 9.2, 7.3$ Hz, 1H), 6.71 (d, $J = 9.2$ Hz, 1H), 7.33 (s, 1H), 7.40 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 8.8, 14.1, 22.6, 27.2, 28.9, 29.6, 31.6, 116.6, 119.9, 126.0, 128.4, 140.6. HRMS (ESI) Calcd for $C_{12}H_{21}N_2$: $M^+ + H$, 193.1699. Found: m/z 193.1681.

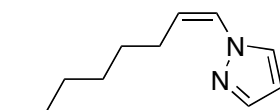


(*E*)-2-(4-Methylpyrazol-1-yl)oct-2-ene (6ab). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 0.89 (t, $J = 6.9$ Hz, 3H), 1.28–1.37 (m, 4H), 1.44 (quint, $J = 6.9$ Hz, 2H), 2.09 (s, 3H), 2.16 (q, $J = 7.3$ Hz, 2H), 2.17 (s, 3H), 5.78 (t, $J = 7.3$ Hz, 1H), 7.38 (s, 1H), 7.40 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 8.9, 14.0, 14.4, 22.5, 27.2, 29.4, 31.4, 116.4, 116.8, 125.3, 134.1, 140.1. HRMS (ESI) Calcd for $\text{C}_{12}\text{H}_{21}\text{N}_2$: M^++H , 193.1699. Found: m/z 193.1681.

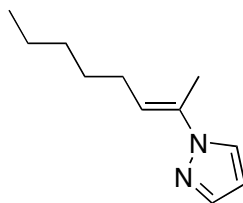
Lewis Acid-Catalyzed Single Addition of Pyrazoles to Alkynes. All pyrazolylalkenes appeared in Table 1 and Table 3 were fully characterized by ^1H NMR, ^{13}C NMR and HRMS spectroscopy as the following.



2-(Pyrazol-1-yl)oct-1-ene (4aa). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 0.88 (t, $J = 7.1$ Hz, 3H), 1.26–1.41 (m, 6H), 1.54 (quint, $J = 7.6$ Hz, 2H), 2.65 (td, $J = 7.3, 0.9$ Hz, 2H), 4.72 (s, 1H), 5.28 (s, 1H), 6.33 (dd, $J = 2.1, 1.8$ Hz, 1H), 7.61 (d, $J = 1.8$ Hz, 1H), 7.67 (d, $J = 2.8$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 14.0, 22.6, 27.3, 28.8, 31.6, 32.7, 99.8, 106.4, 126.9, 140.2, 145.9. HRMS (ESI) Calcd for $\text{C}_{11}\text{H}_{19}\text{N}_2$: $\text{M}^+ + \text{H}$, 179.1543. Found: m/z 179.1540.

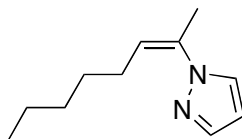


(Z)-1-(Pyrazol-1-yl)oct-1-ene (5aa). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 0.88 (t, $J = 6.9$ Hz, 3H), 1.21–1.41 (m, 6H), 1.47 (quint, $J = 7.4$ Hz, 2H), 2.43 (qd, $J = 7.3, 1.8$ Hz, 2H), 5.25 (dt, $J = 9.2, 7.2$ Hz, 1H), 6.33 (t, $J = 2.3$ Hz, 1H), 6.78 (dt, $J = 9.6, 1.7$ Hz, 1H), 7.55 (d, $J = 2.3$ Hz, 1H), 7.61 (d, $J = 1.4$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 14.0, 22.6, 27.1, 28.9, 29.5, 31.6, 106.0, 121.4, 125.9, 129.8, 140.0. HRMS (ESI) Calcd for $\text{C}_{11}\text{H}_{19}\text{N}_2$: $\text{M}^+ + \text{H}$, 179.1543. Found: m/z 179.1542.

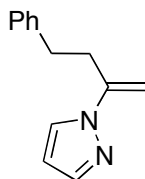


(E)-2-(Pyrazol-1-yl)oct-2-ene (6aa). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 0.90 (t, $J = 6.9$ Hz, 3H), 1.26–1.40 (m, 4H), 1.46 (quint, $J = 7.2$ Hz, 2H), 2.18 (q, $J = 7.3$ Hz, 2H), 2.20 (s, 3H), 5.87 (tq, $J = 7.6, 0.9$ Hz, 1H), 6.30 (t, $J = 2.1$ Hz, 1H), 7.58 (d, $J = 1.8$ Hz, 1H), 7.61 (d, $J = 2.3$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 14.0,

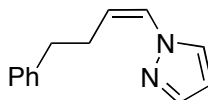
14.6, 22.5, 27.3, 29.3, 31.5, 105.8, 118.0, 126.5, 134.1, 139.6. HRMS (ESI) Calcd for $C_{11}H_{19}N_2$: $M^+ + H$, 179.1543. Found: m/z 179.1540.



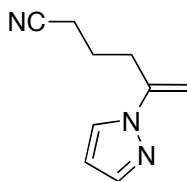
(Z)-2-(Pyrazol-1-yl)oct-2-ene (7aa). A colorless oil. 1H NMR (500 MHz, $CDCl_3$) δ 0.86 (t, J = 6.9 Hz, 3H), 1.18–1.40 (m, 6H), 2.01–2.08 (m, 2H), 2.17 (q, J = 1.4 Hz, 3H), 5.33 (tq, J = 6.0, 0.9 Hz, 1H), 6.31 (t, J = 2.1 Hz, 1H), 7.46 (d, J = 2.3 Hz, 1H), 7.61 (d, J = 1.8 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 14.0, 22.3, 22.4, 27.4, 29.3, 31.4, 105.1, 123.3, 129.5, 134.4, 139.5. HRMS (ESI) Calcd for $C_{11}H_{19}N_2$: $M^+ + H$, 179.1543. Found: m/z 179.1526.



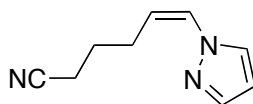
4-Phenyl-2-(pyrazol-1-yl)but-1-ene (4ba). A colorless oil. 1H NMR (500 MHz, $CDCl_3$) δ 2.86 (dd, J = 8.9, 6.6 Hz, 2H), 2.98 (dd, J = 8.9, 6.6 Hz, 2H), 4.69 (s, 1H), 5.25 (s, 1H), 6.36 (t, J = 2.0 Hz, 1H), 7.16–7.23 (m, 3H), 7.26–7.31 (m, 2H), 7.64 (d, J = 1.7 Hz, 1H), 7.69 (d, J = 2.3 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 33.7, 34.6, 100.5, 106.6, 126.1, 127.0, 128.36, 128.43, 140.4, 140.9, 145.0. HRMS (ESI) Calcd for $C_{13}H_{15}N_2$: $M^+ + H$, 199.1230. Found: m/z 199.1225.



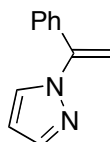
(Z)-4-Phenyl-1-(pyrazol-1-yl)but-1-ene (5ba). A colorless oil. 1H NMR (400 MHz, $CDCl_3$) δ 2.76–2.81 (m, 4H), 5.23–5.31 (m, 1H), 6.31 (t, J = 2.1 Hz, 1H), 6.75–6.80 (m, 1H), 7.18–7.23 (m, 3H), 7.25–7.32 (m, 2H), 7.45 (d, J = 2.3 Hz, 1H), 7.61 (d, J = 1.8 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 28.8, 35.5, 106.1, 119.8, 126.0, 126.2, 128.4, 128.5, 129.8, 140.2, 141.3. HRMS (ESI) Calcd for $C_{13}H_{15}N_2$: $M^+ + H$, 199.1230. Found: m/z 199.1223.



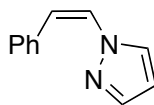
5-(Pyrazol-1-yl)hex-5-enenitrile (4da). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 1.94 (quint, $J = 7.2$ Hz, 2H), 2.40 (t, $J = 7.1$ Hz, 2H), 2.87 (t, $J = 7.4$ Hz, 2H), 4.80 (s, 1H), 5.26 (s, 1H), 6.36 (t, $J = 2.1$ Hz, 1H), 7.61 (d, $J = 1.4$ Hz, 1H), 7.72 (d, $J = 2.8$ Hz, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 16.4, 23.2, 31.7, 101.0, 107.1, 119.2, 126.9, 140.5, 143.6. HRMS (ESI) Calcd for $\text{C}_9\text{H}_{12}\text{N}_3$: $\text{M}^+ + \text{H}$, 162.1026. Found: m/z 162.1021.



(Z)-6-(Pyrazol-1-yl)hex-5-enenitrile (5da). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 1.87 (quint, $J = 7.5$ Hz, 2H), 2.41 (t, $J = 7.4$ Hz, 2H), 2.73 (qd, $J = 7.3$, 1.6 Hz, 2H), 5.17 (dt, $J = 9.2$, 7.4 Hz, 1H), 6.34 (t, $J = 2.1$ Hz, 1H), 6.79 (dt, $J = 9.2$, 1.5 Hz, 1H), 7.49 (d, $J = 2.3$ Hz, 1H), 7.62 (d, $J = 1.8$ Hz, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 16.7, 25.4, 26.1, 106.3, 117.5, 119.6, 126.8, 130.2, 140.6. HRMS (ESI) Calcd for $\text{C}_9\text{H}_{12}\text{N}_3$: $\text{M}^+ + \text{H}$, 162.1026. Found: m/z 162.1009.

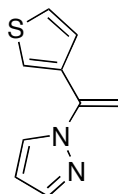


1-Phenyl-1-(pyrazol-1-yl)ethene (4ga). A pale yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 5.20 (s, 1H), 5.60 (s, 1H), 6.36 (t, $J = 2.3$ Hz, 1H), 7.36–7.42 (m, 5H), 7.49 (d, $J = 2.3$ Hz, 1H), 7.69 (d, $J = 1.4$ Hz, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 106.6, 119.0, 127.0, 127.9, 128.6, 128.7, 129.5, 134.4, 140.3. HRMS (ESI) Calcd for $\text{C}_{11}\text{H}_{11}\text{N}_2$: $\text{M}^+ + \text{H}$, 171.0917. Found: m/z 171.0922.

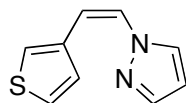


(Z)-1-Phenyl-2-(pyrazol-1-yl)ethene (5ga). A pale yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 6.20 (t, $J = 2.1$ Hz, 1H), 6.26 (d, $J = 9.6$ Hz, 1H), 7.02 (d, $J = 10.1$

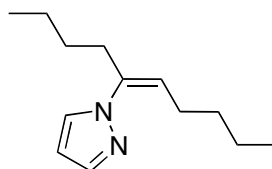
Hz, 1H), 7.21 (d, $J = 1.8$ Hz, 1H), 7.26–7.35 (m, 5H), 7.59 (d, $J = 1.4$ Hz, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 106.6, 119.0, 127.0, 127.9, 128.6, 128.7, 129.5, 134.4, 140.3. HRMS (ESI) Calcd for $\text{C}_{11}\text{H}_{11}\text{N}_2$: $\text{M}^+\text{+H}$, 171.0917. Found: m/z 171.0906.



1-(Pyrazol-1-yl)-1-(thien-3-yl)ethene (4ja). A pale yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 5.25 (s, 1H), 5.51 (s, 1H), 6.37 (dd, $J = 2.3, 1.8$ Hz, 1H), 7.16 (dd, $J = 5.0, 1.4$ Hz, 1H), 7.35 (dd, $J = 5.0, 3.2$ Hz, 1H), 7.39 (dd, $J = 3.2, 1.4$ Hz, 1H), 7.59 (d, $J = 1.8$ Hz, 1H), 7.68 (d, $J = 1.4$ Hz, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 104.5, 106.5, 124.9, 126.0, 127.0, 129.4, 137.0, 140.8, 141.0. HRMS (ESI) Calcd for $\text{C}_9\text{H}_9\text{N}_2\text{S}$: $\text{M}^+\text{+H}$, 177.0481. Found: m/z 177.0474.

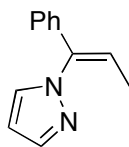


(Z)-1-(Pyrazol-1-yl)-2-(thien-3-yl)ethene (5ja). A pale yellow oil. ^1H NMR (500 MHz, CDCl_3) δ 6.20 (d, $J = 9.8$ Hz, 1H), 6.23 (dd, $J = 2.3, 1.7$ Hz, 1H), 6.74 (dd, $J = 4.9, 1.5$ Hz, 1H), 6.84 (d, $J = 9.2$ Hz, 1H), 7.15–7.19 (m, 2H), 7.38 (d, $J = 2.3$ Hz, 1H), 7.57 (d, $J = 1.7$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 106.6, 115.5, 125.1, 125.6, 125.9, 127.8, 129.8, 134.7, 140.4. HRMS (ESI) Calcd for $\text{C}_9\text{H}_9\text{N}_2\text{S}$: $\text{M}^+\text{+H}$, 177.0481. Found: m/z 177.0464.

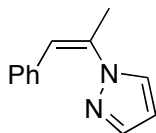


(Z)-5-(Pyrazol-1-yl)dec-5-ene (4ma). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 0.84 (t, $J = 7.1$ Hz, 3H), 0.86 (t, $J = 6.9$ Hz, 3H), 1.20–1.39 (m, 8H), 1.97 (q, $J = 7.3$ Hz, 2H), 2.49 (t, $J = 6.9$ Hz, 2H), 5.37 (t, $J = 7.3$ Hz, 1H), 6.30 (t, $J = 2.1$ Hz, 1H), 7.39 (d, $J = 2.3$ Hz, 1H), 7.61 (d, $J = 1.4$ Hz, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 13.8, 22.0, 22.3, 26.8, 29.2, 31.8, 35.7, 104.9, 123.9, 130.2, 139.2, 139.6 (One carbon signal

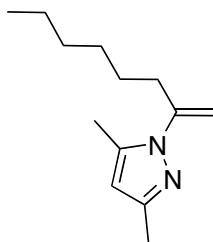
is missing due to overlapping.). HRMS (ESI) Calcd for $C_{13}H_{23}N_2$: $M^+ + H$, 207.1856. Found: m/z 207.1858.



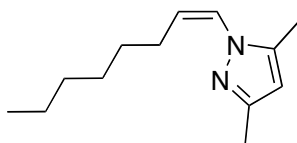
(Z)-1-Phenyl-1-(pyrazol-1-yl)prop-1-ene (4na). A white solid, mp 51–52 °C. 1H NMR (400 MHz, $CDCl_3$) δ 1.76 (d, $J = 7.3$ Hz, 3H), 6.23 (q, $J = 7.2$ Hz, 1H), 6.42 (t, $J = 2.1$ Hz, 1H), 7.10 (dd, $J = 7.5, 2.1$ Hz, 2H), 7.25–7.32 (m, 3H), 7.48 (d, $J = 2.3$ Hz, 1H), 7.71 (d, $J = 1.8$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 13.6, 105.8, 122.2, 125.7, 128.2, 128.4, 131.2, 137.6, 140.0, 140.2. HRMS (ESI) Calcd for $C_{12}H_{13}N_2$: $M^+ + H$, 185.1073. Found: m/z 185.1061.



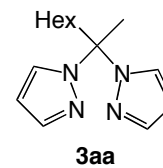
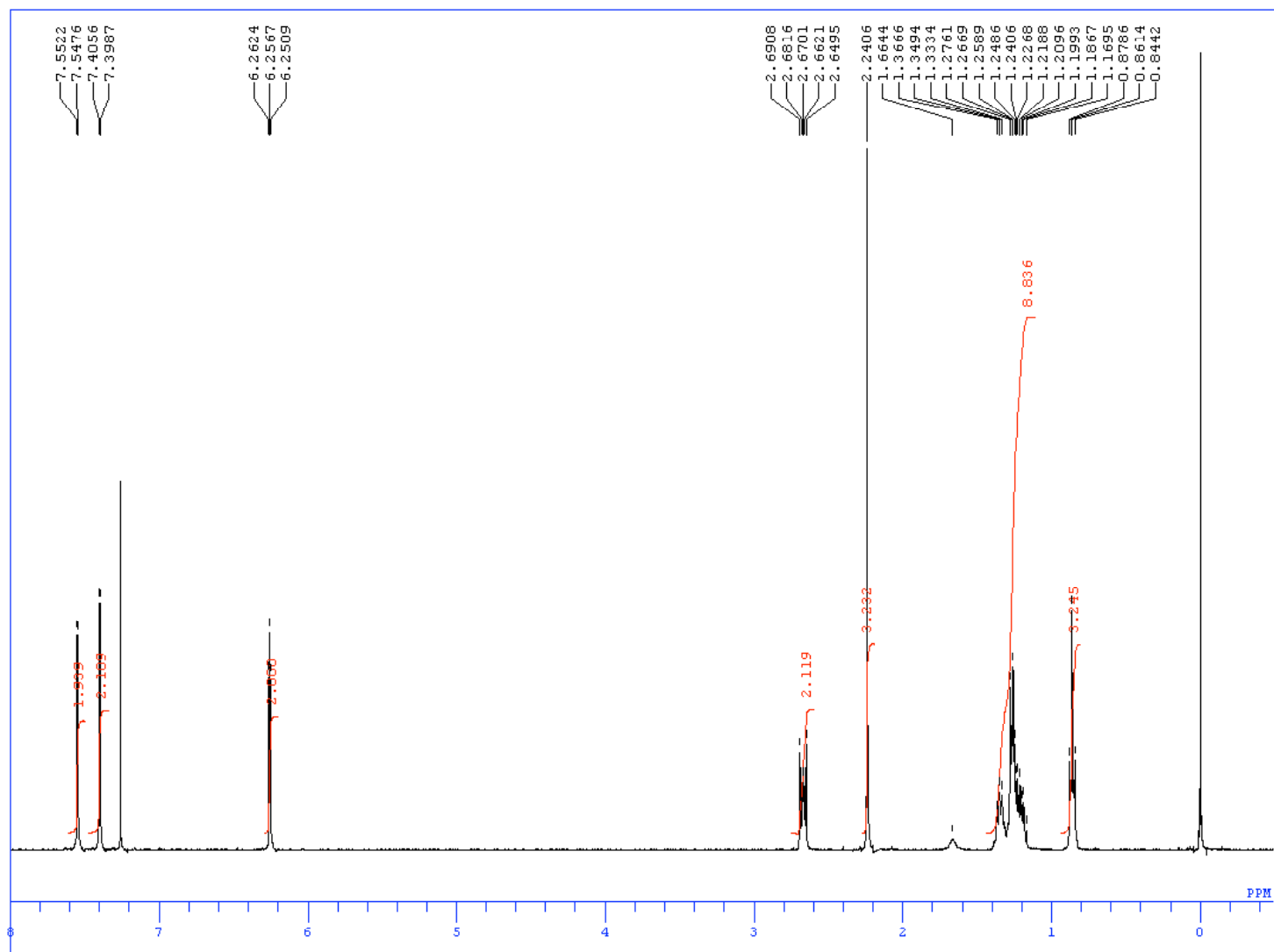
(Z)-1-Phenyl-2-(pyrazol-1-yl)prop-1-ene (5na). A colorless oil. 1H NMR (400 MHz, $CDCl_3$) δ 2.36 (d, $J = 1.4$ Hz, 3H), 6.19 (t, $J = 2.3$ Hz, 1H), 6.34 (s, 1H), 6.82 (dd, $J = 7.6, 1.6$ Hz, 2H), 7.12–7.22 (m, 4H), 7.65 (d, $J = 1.8$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 22.9, 106.0, 121.5, 127.2, 128.3, 128.4, 130.3, 134.8, 135.7, 140.2. HRMS (ESI) Calcd for $C_{12}H_{13}N_2$: $M^+ + H$, 185.1073. Found: m/z 185.1036.

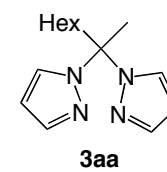
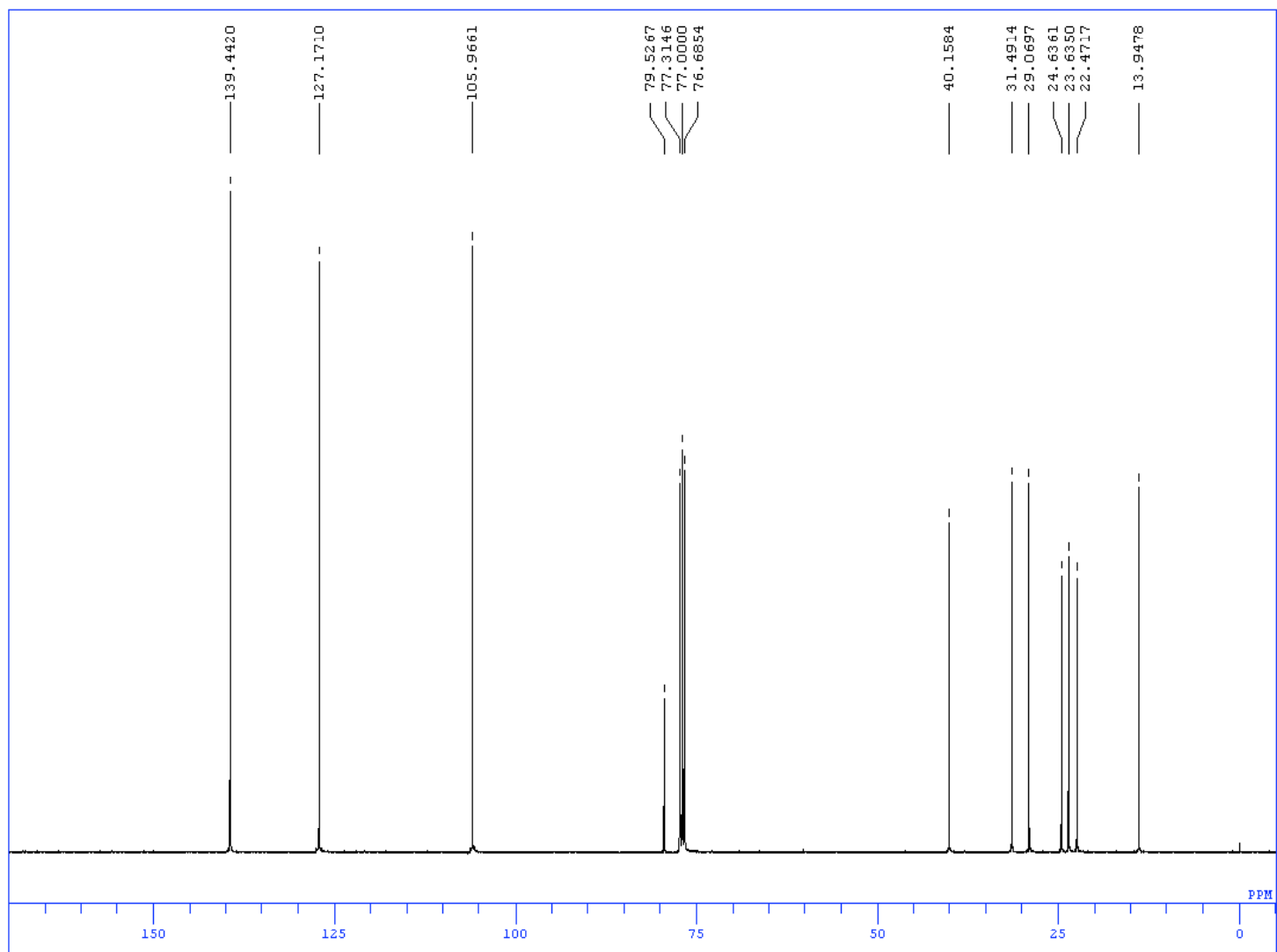


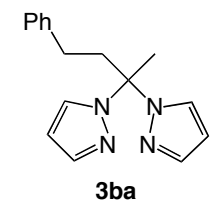
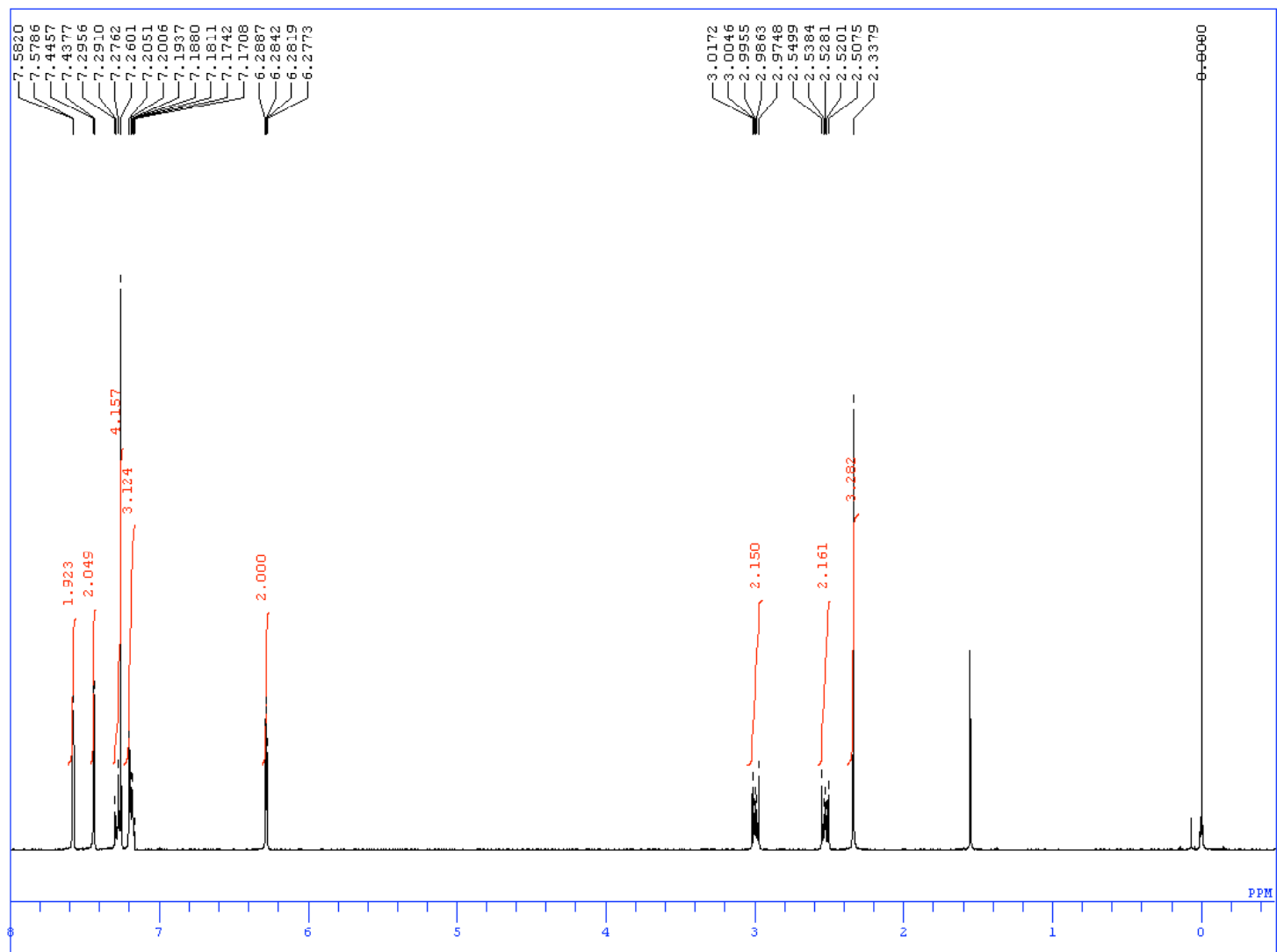
2-(3,5-Dimethylpyrazol-1-yl)oct-1-ene (4ac). A colorless oil. 1H NMR (400 MHz, $CDCl_3$) δ 0.86 (t, $J = 6.9$ Hz, 3H), 1.20–1.40 (m, 8H), 2.24 (s, 3H), 2.25 (s, 3H), 2.55 (t, $J = 7.2$ Hz, 2H), 4.87 (s, 1H), 5.06 (s, 1H), 5.85 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 12.3, 13.6, 14.0, 22.5, 26.7, 28.6, 31.6, 35.0, 106.0, 107.8, 139.3, 146.3, 148.0. HRMS (ESI) Calcd for $C_{13}H_{23}N_2$: $M^+ + H$, 207.1856. Found: m/z 207.1843.

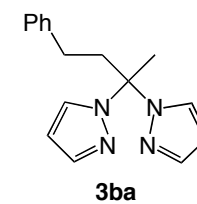
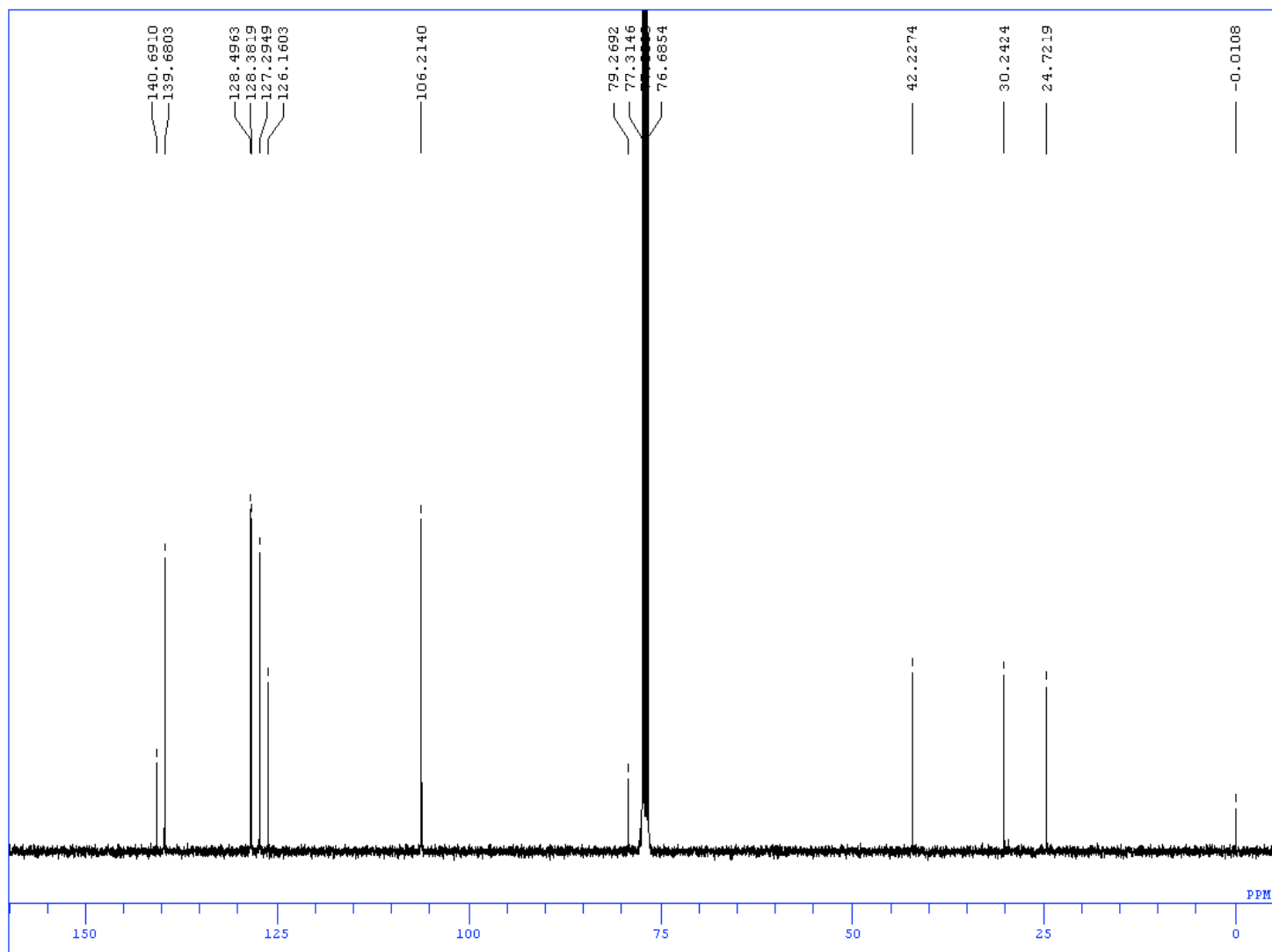


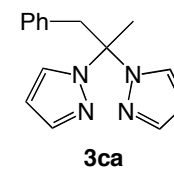
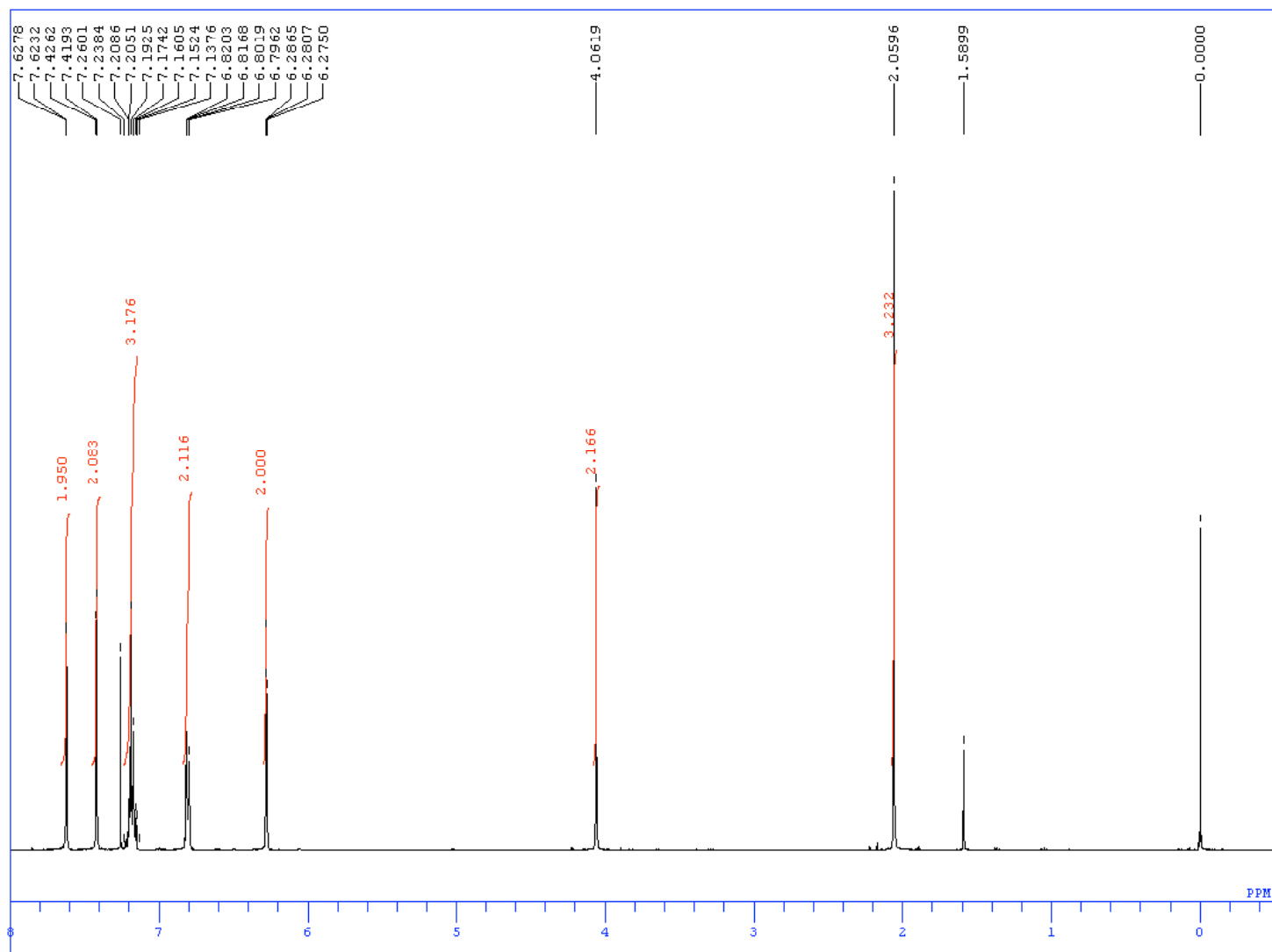
(Z)-1-(3,5-Dimethylpyrazol-1-yl)oct-1-ene (5ac). A colorless oil. ^1H NMR (400 MHz, CDCl_3) δ 0.87 (t, $J = 6.9$ Hz, 3H), 1.22–1.39 (m, 6H), 1.40 (quint, $J = 7.4$ Hz, 2H), 2.20 (s, 3H), 2.24 (s, 3H), 2.39 (qd, $J = 7.3, 1.4$ Hz, 2H), 5.36 (dt, $J = 8.7, 8.0$ Hz, 1H), 5.83 (s, 1H), 6.48 (dt, $J = 9.2, 1.7$ Hz, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 11.3, 13.7, 14.1, 22.6, 27.0, 28.9, 29.3, 31.6, 105.0, 123.0, 125.7, 139.6, 148.5. HRMS (ESI) Calcd for $\text{C}_{13}\text{H}_{23}\text{N}_2$: $\text{M}^+ + \text{H}$, 207.1856. Found: m/z 207.1835.

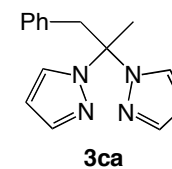
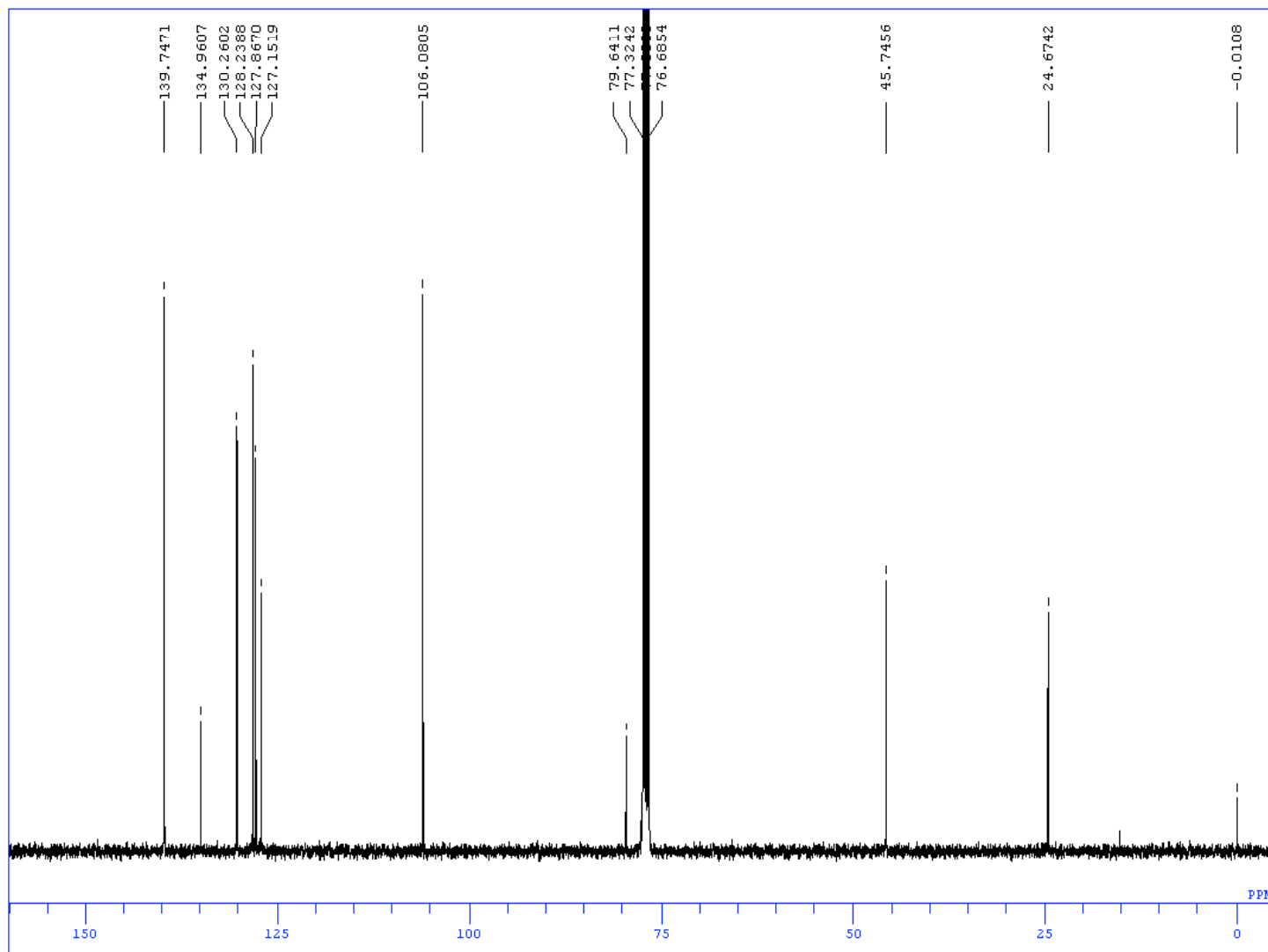


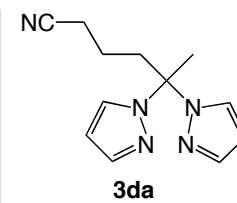
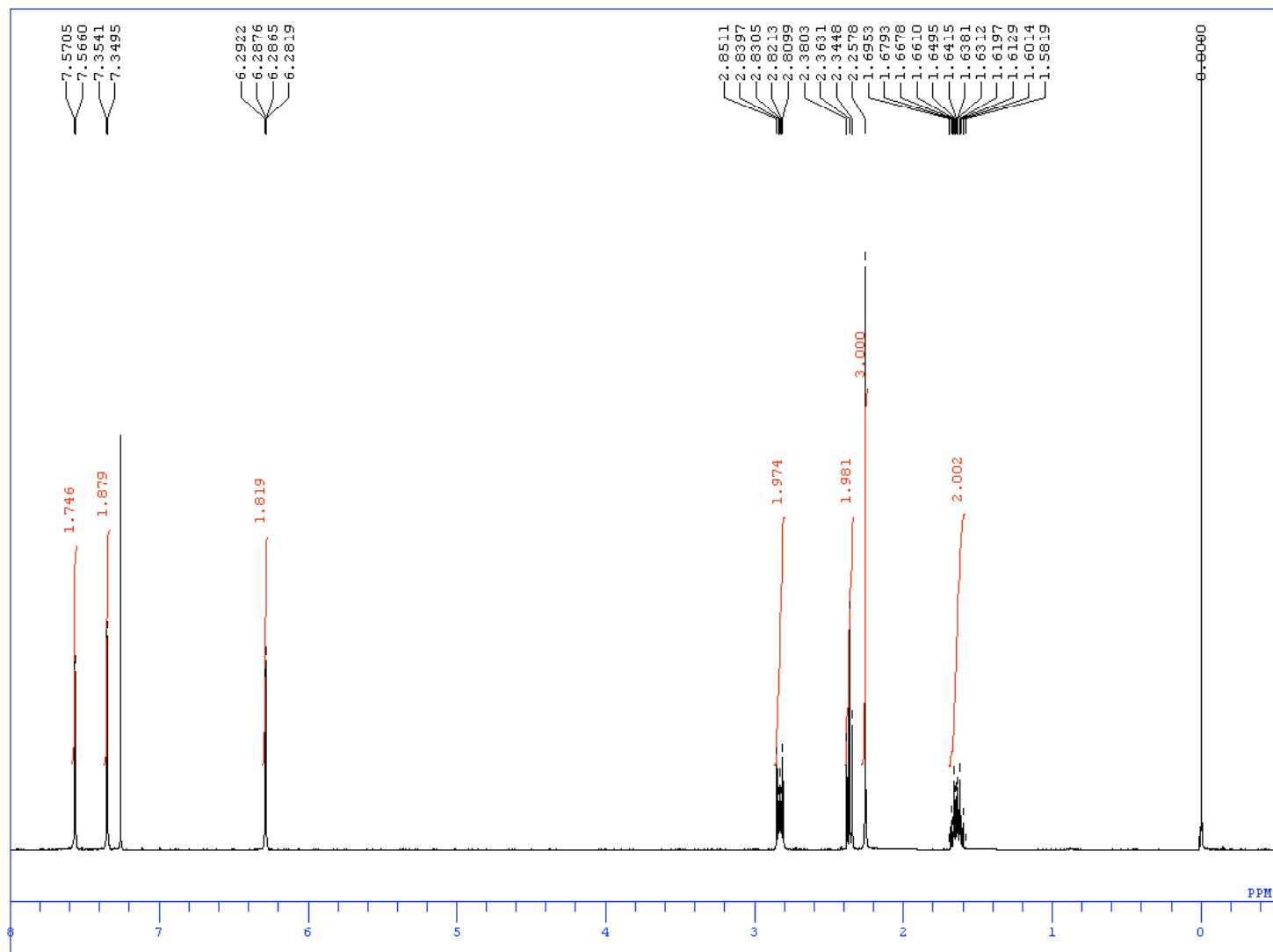


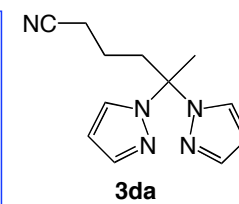
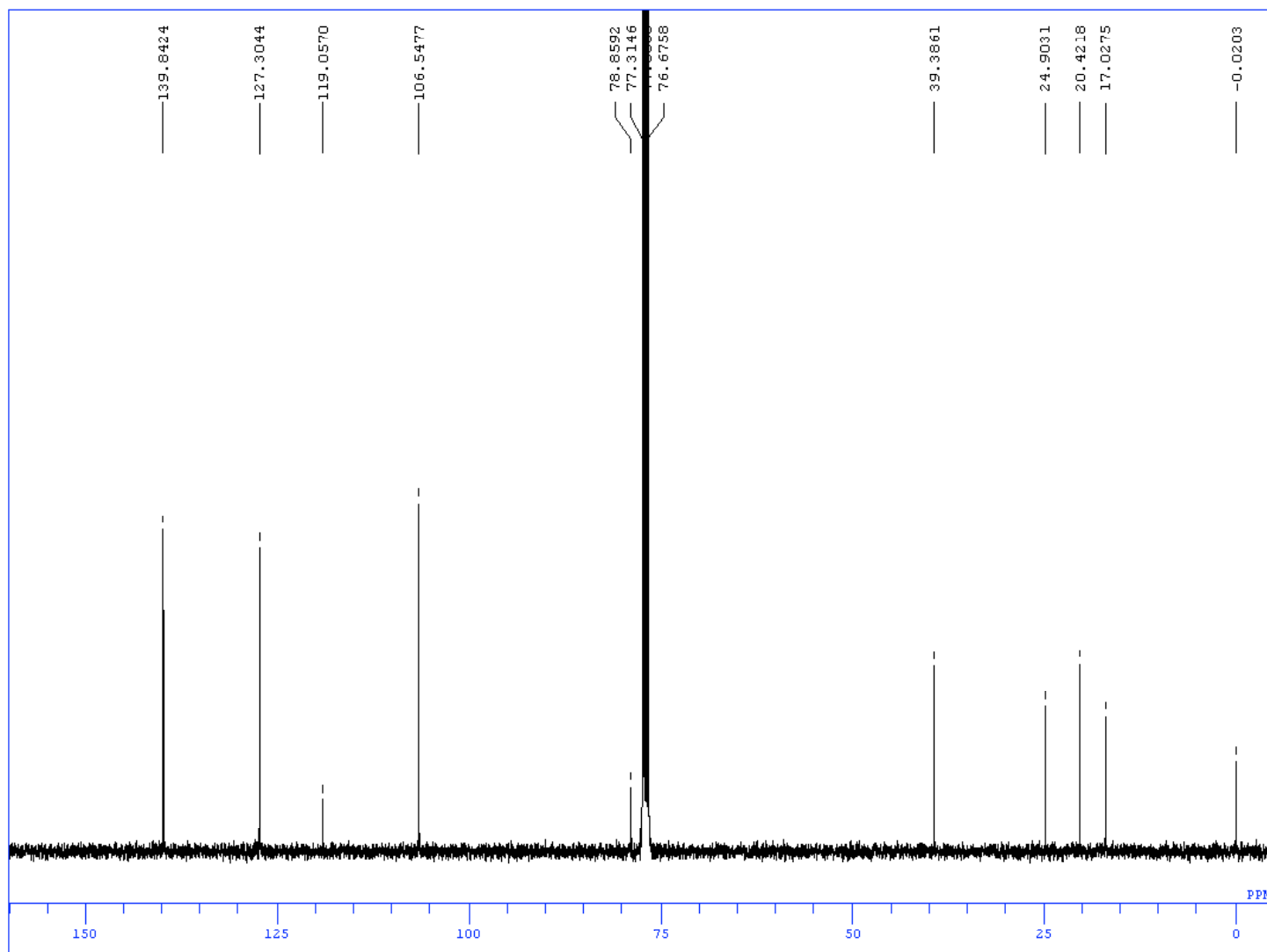


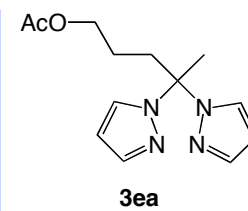
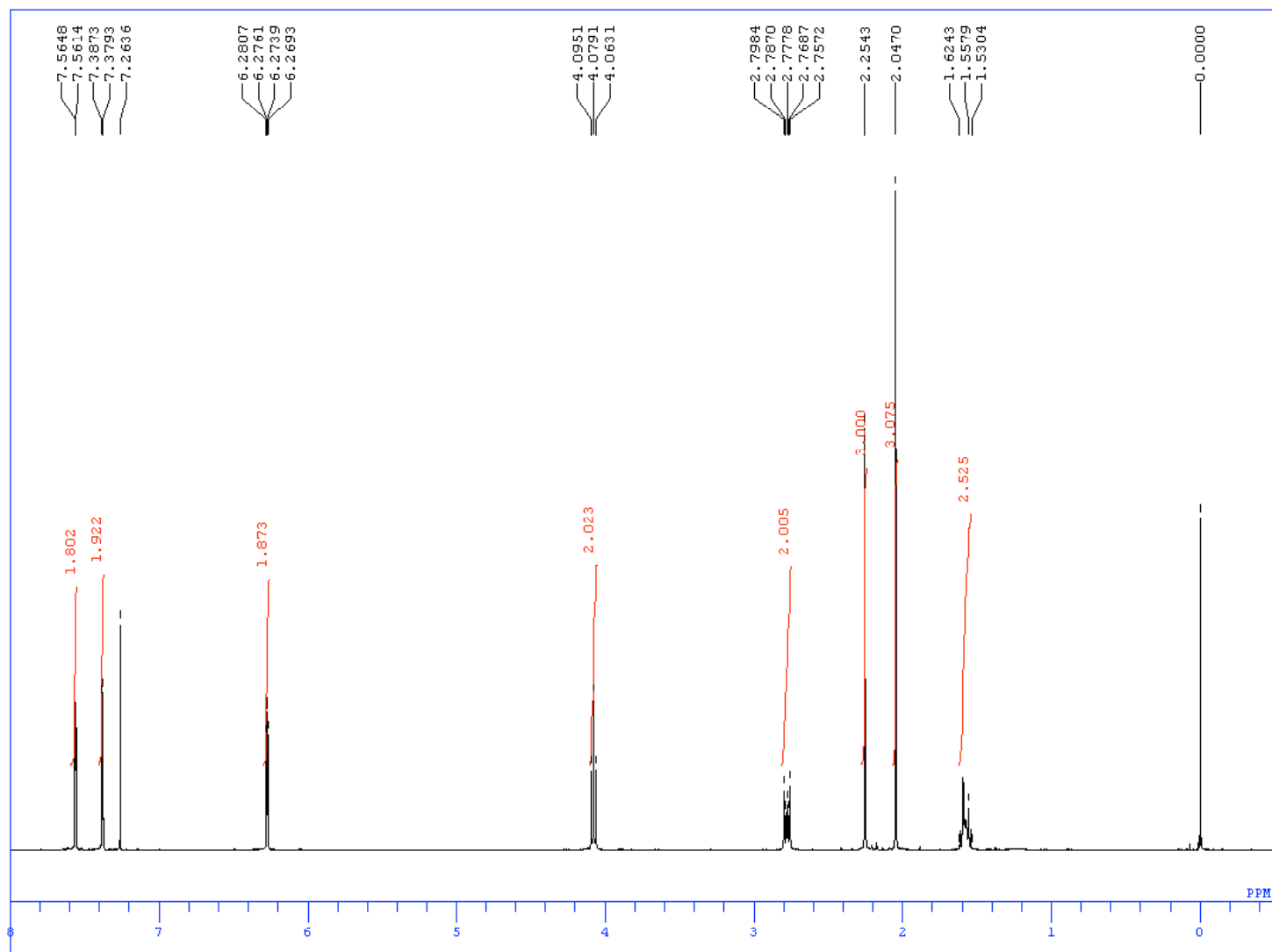


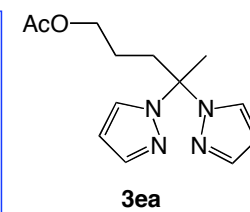
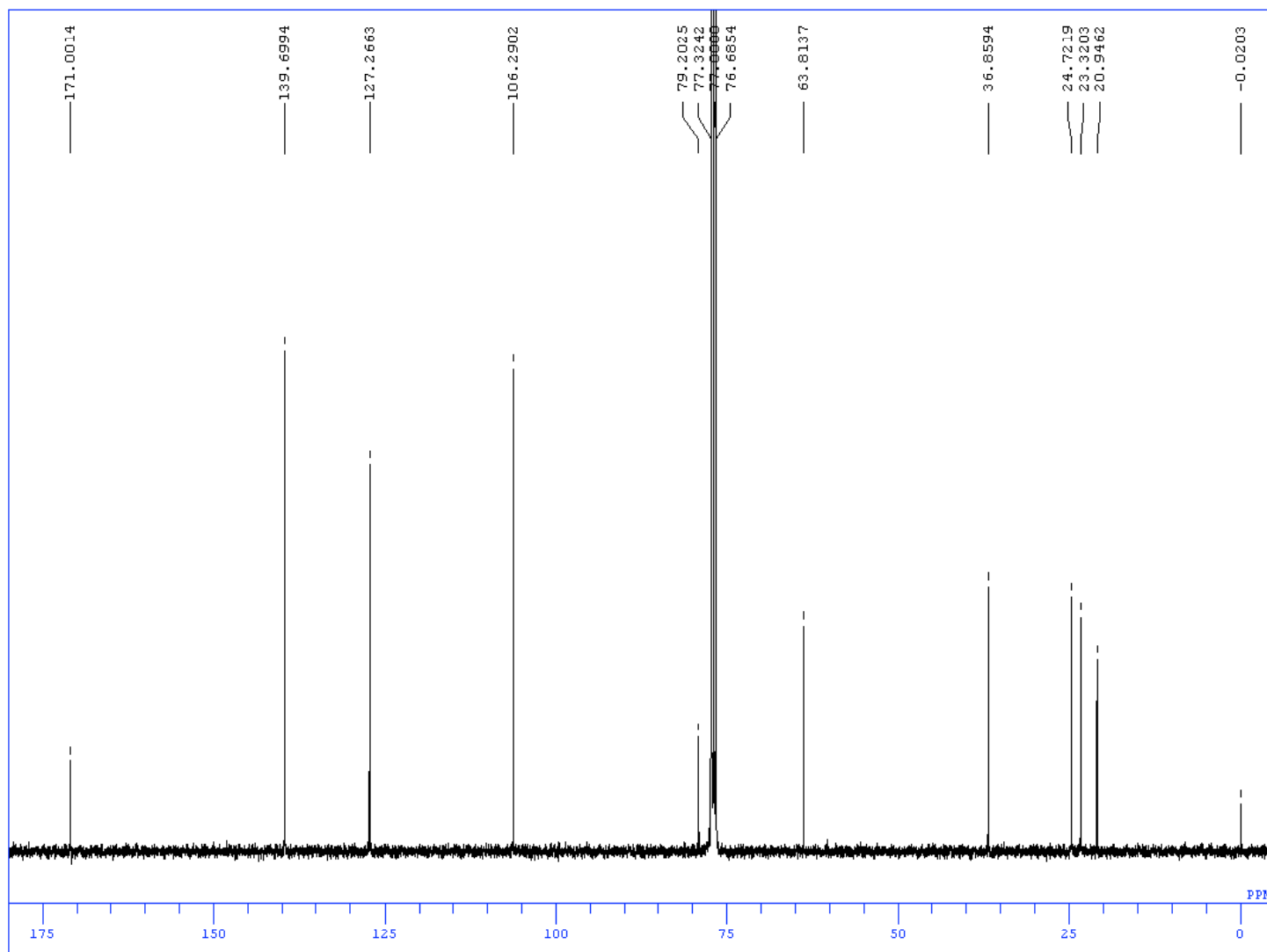


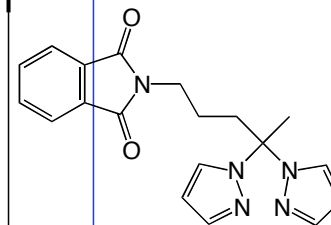
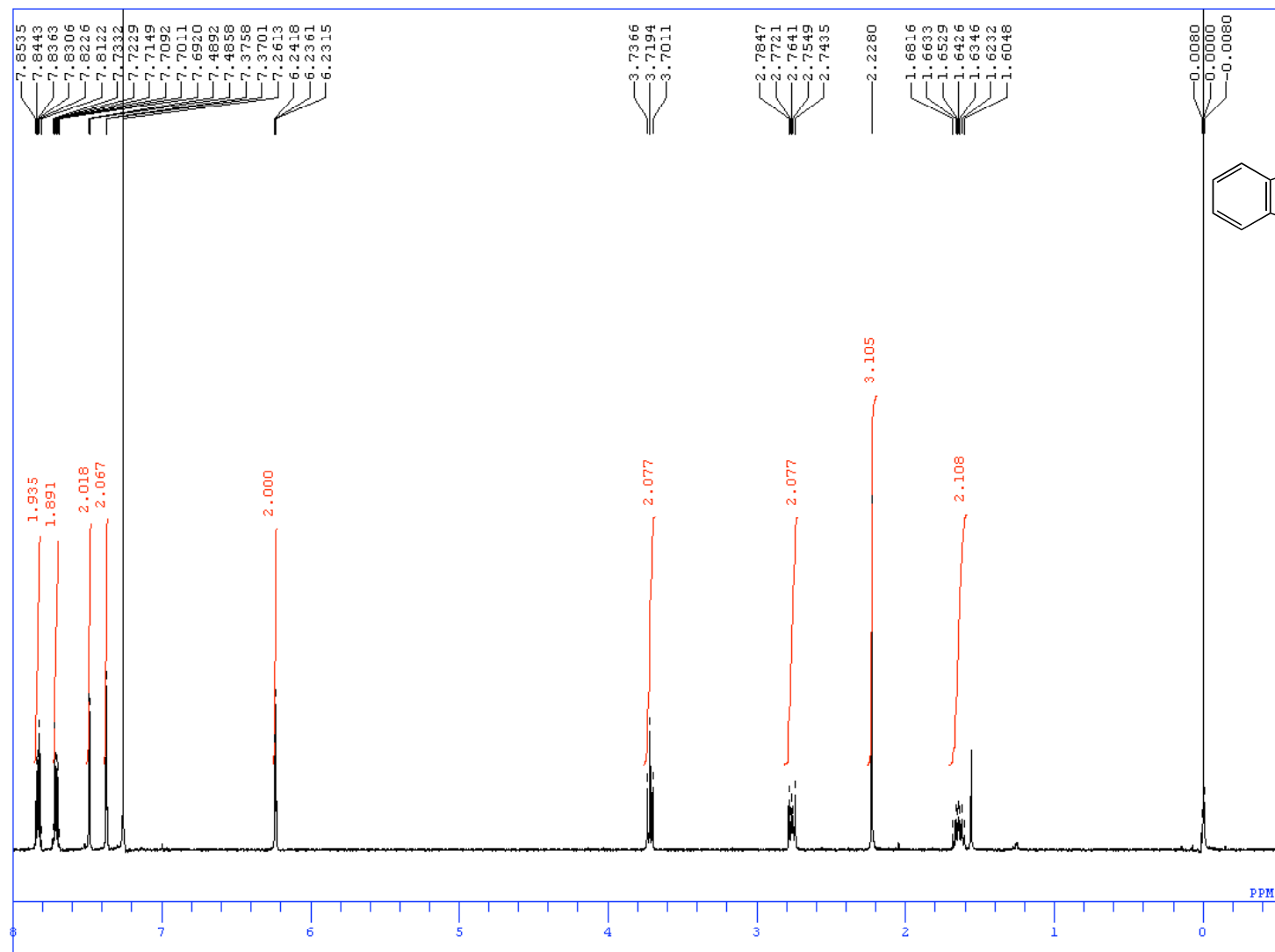




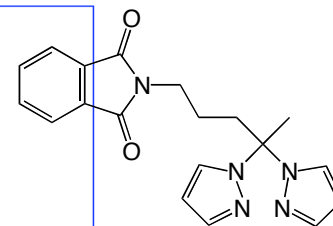




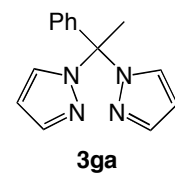
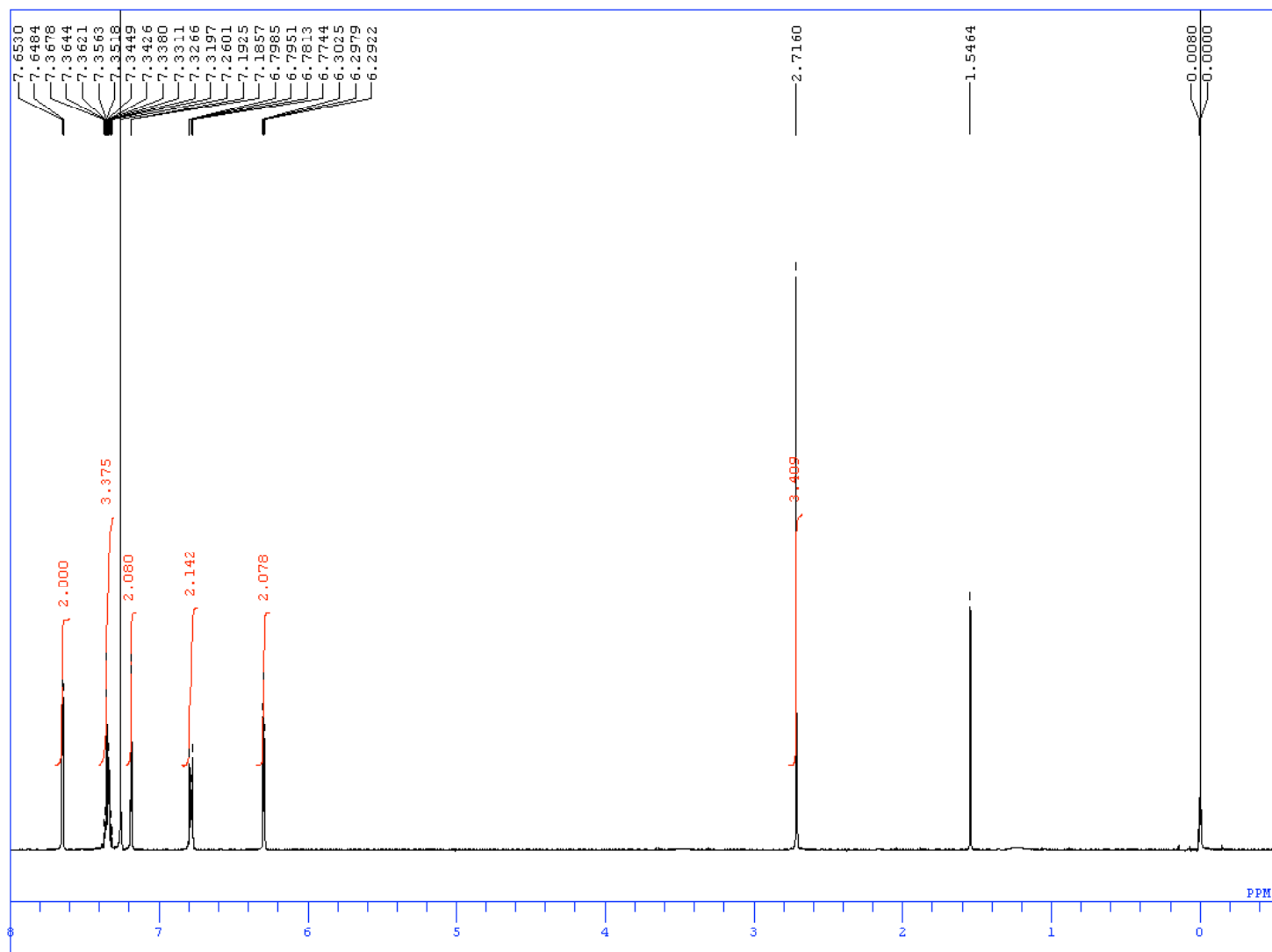


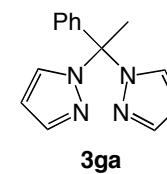
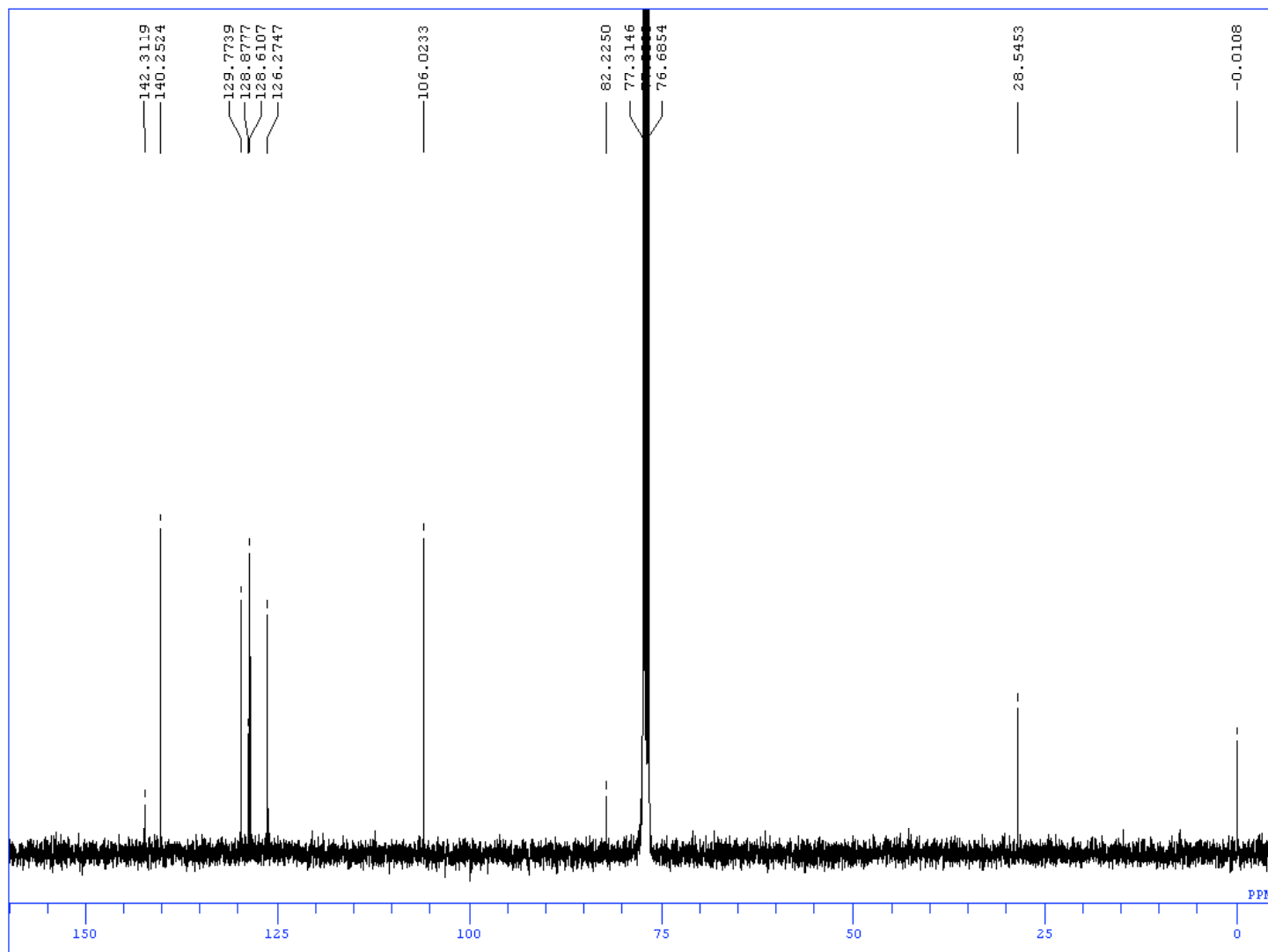


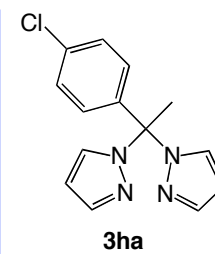
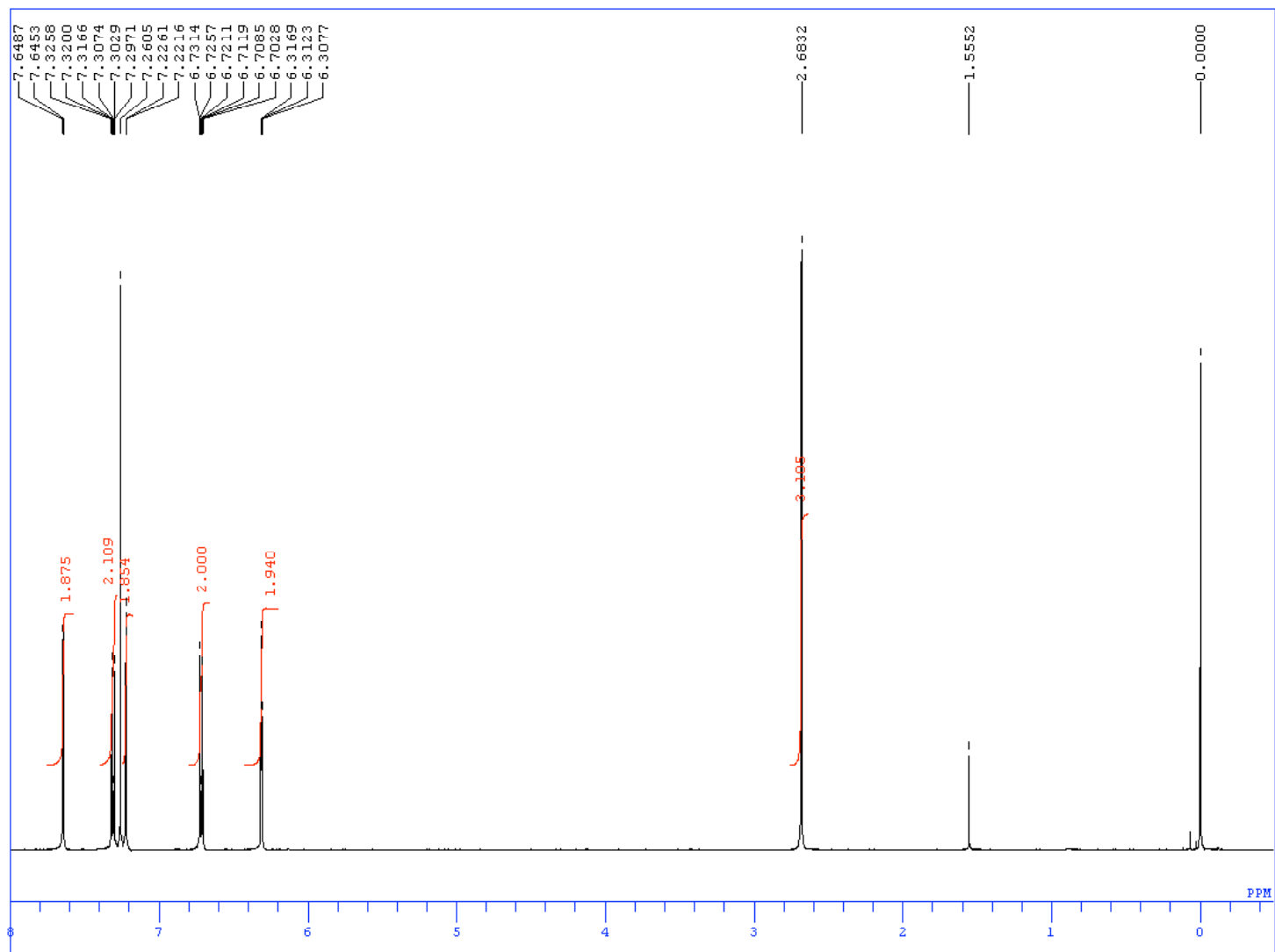
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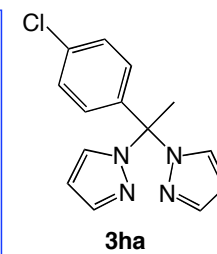
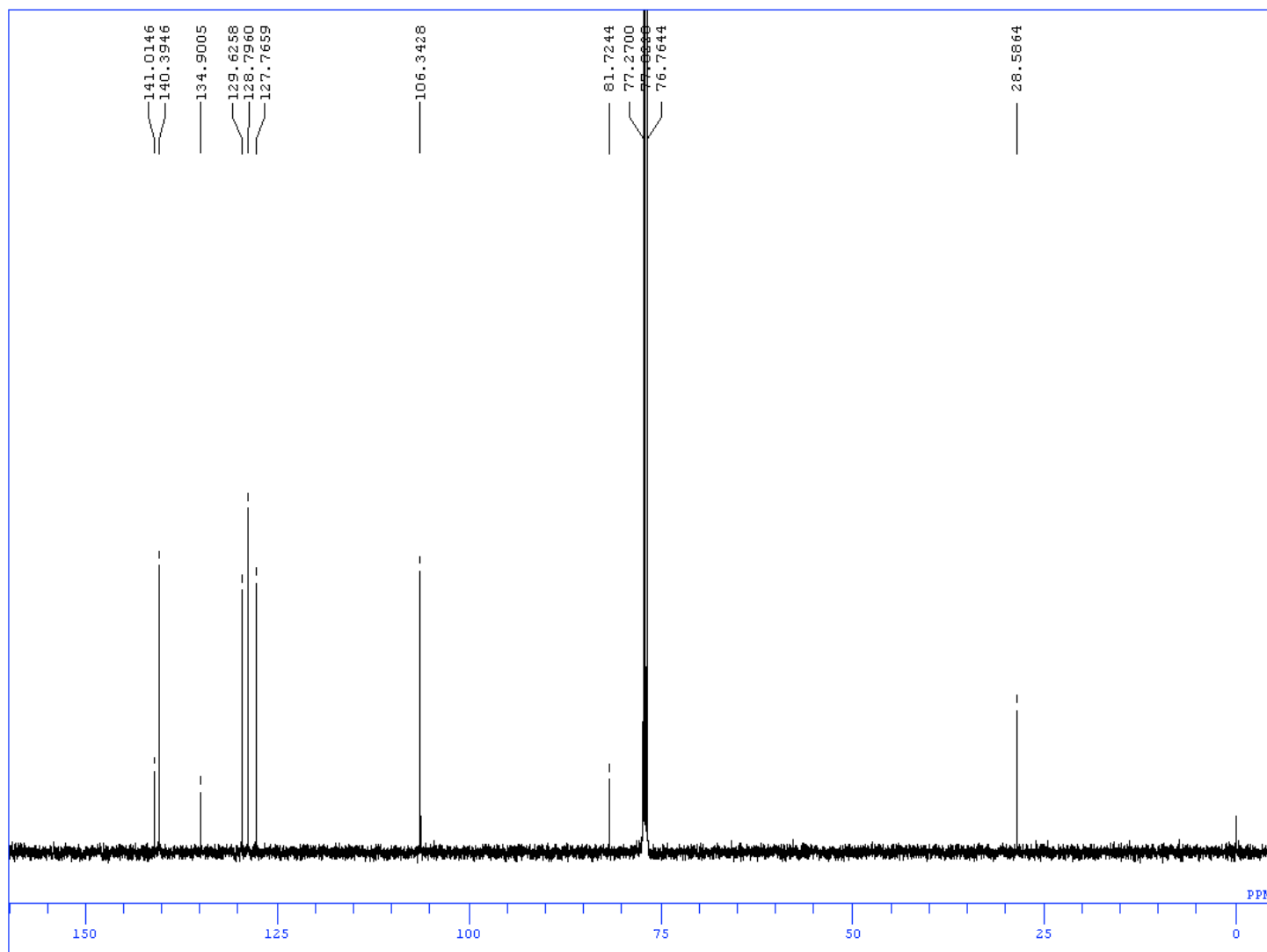


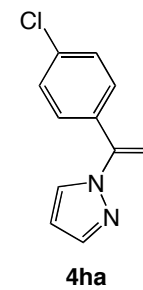
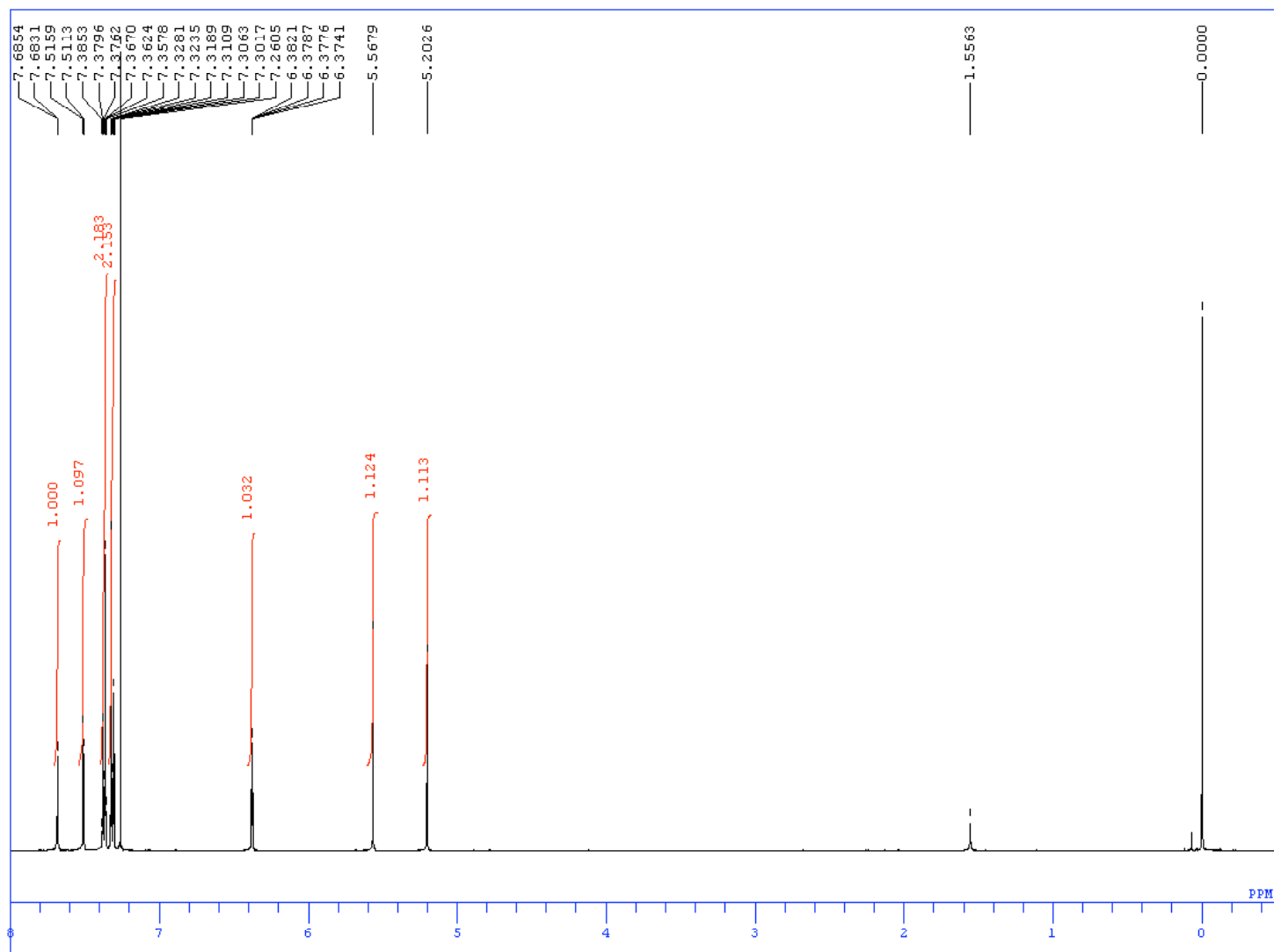
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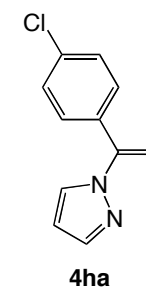
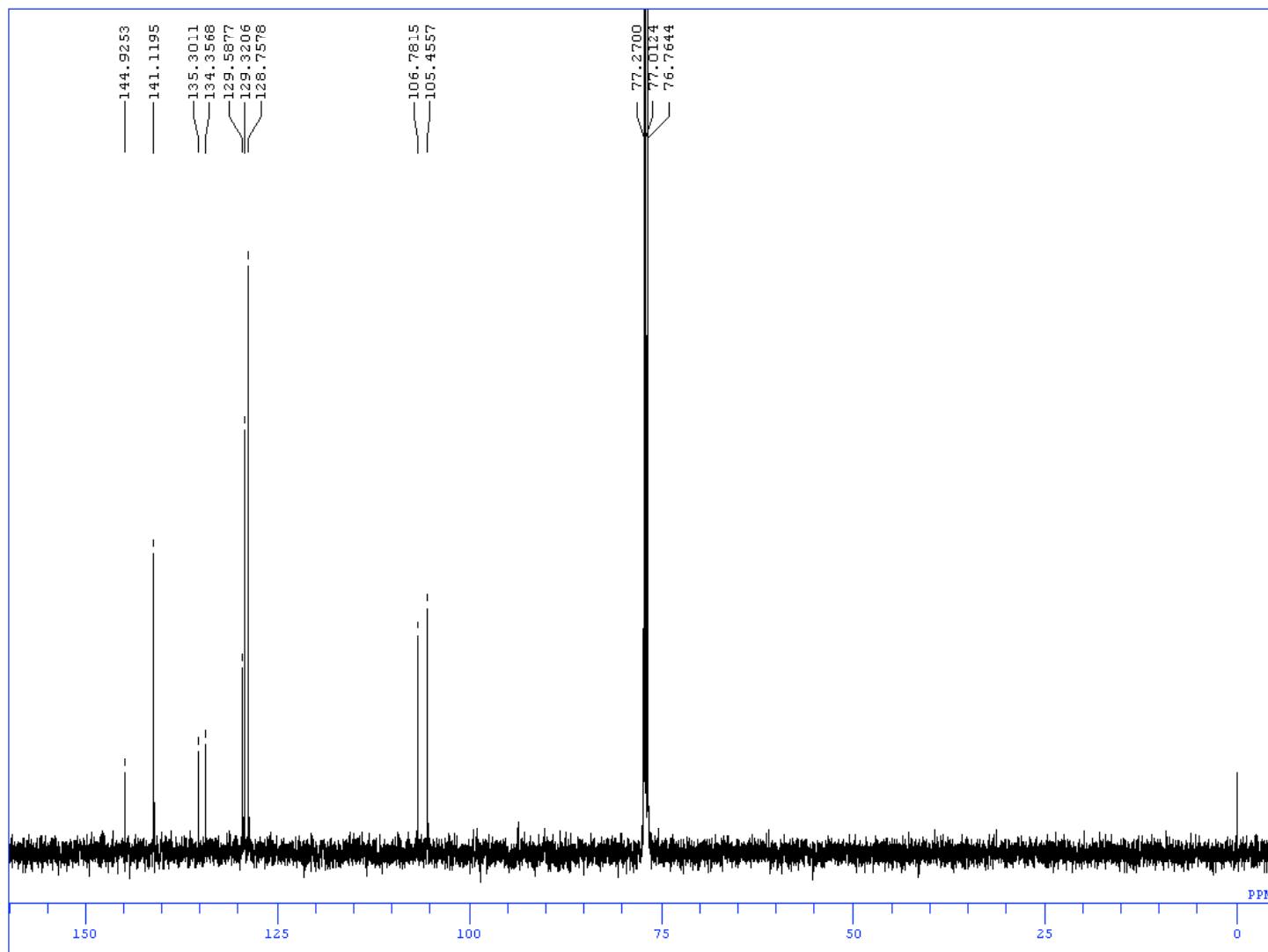


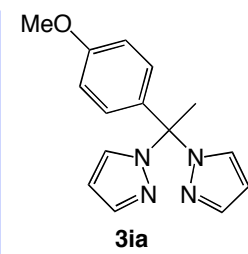
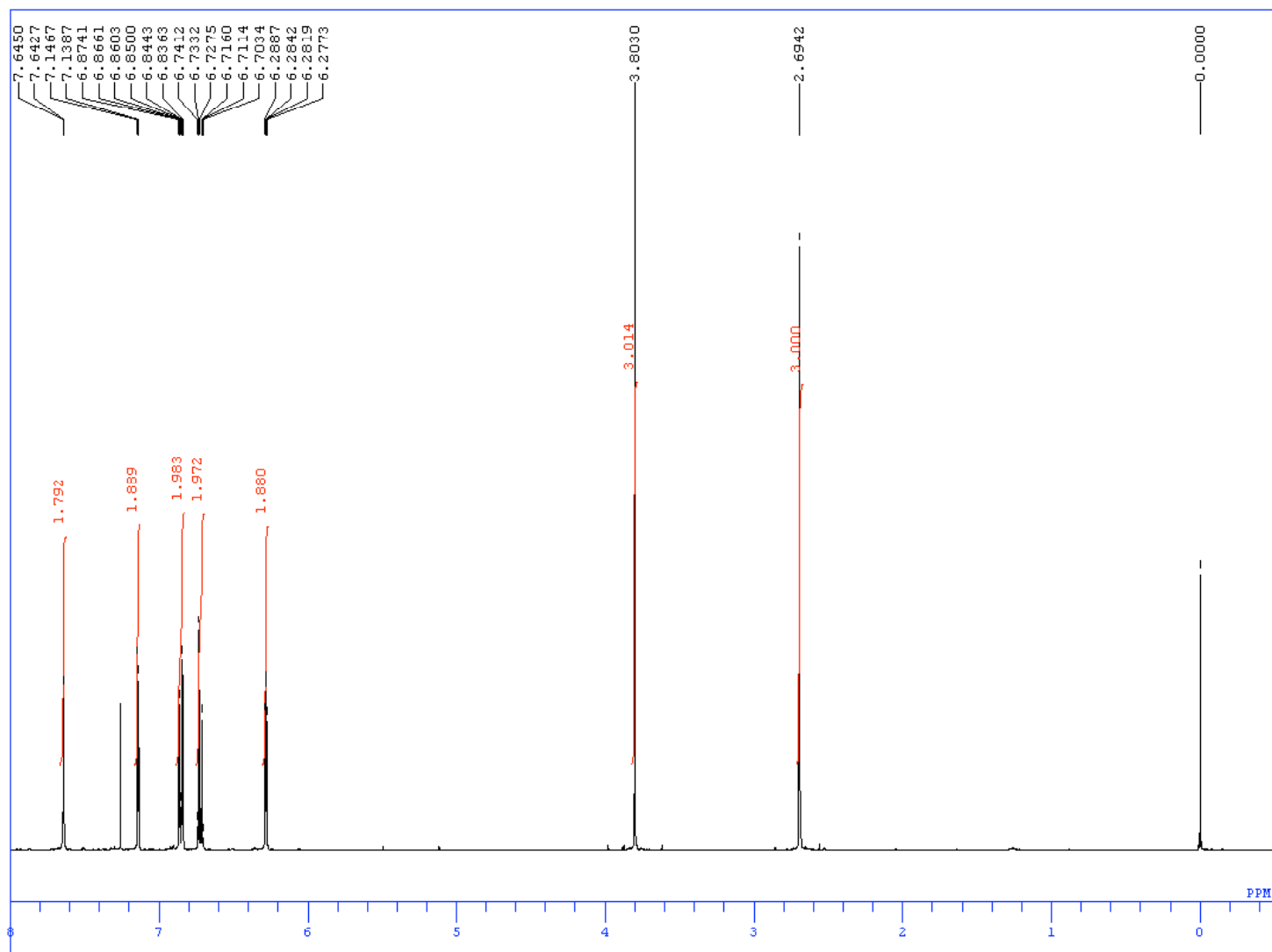


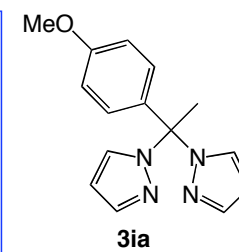
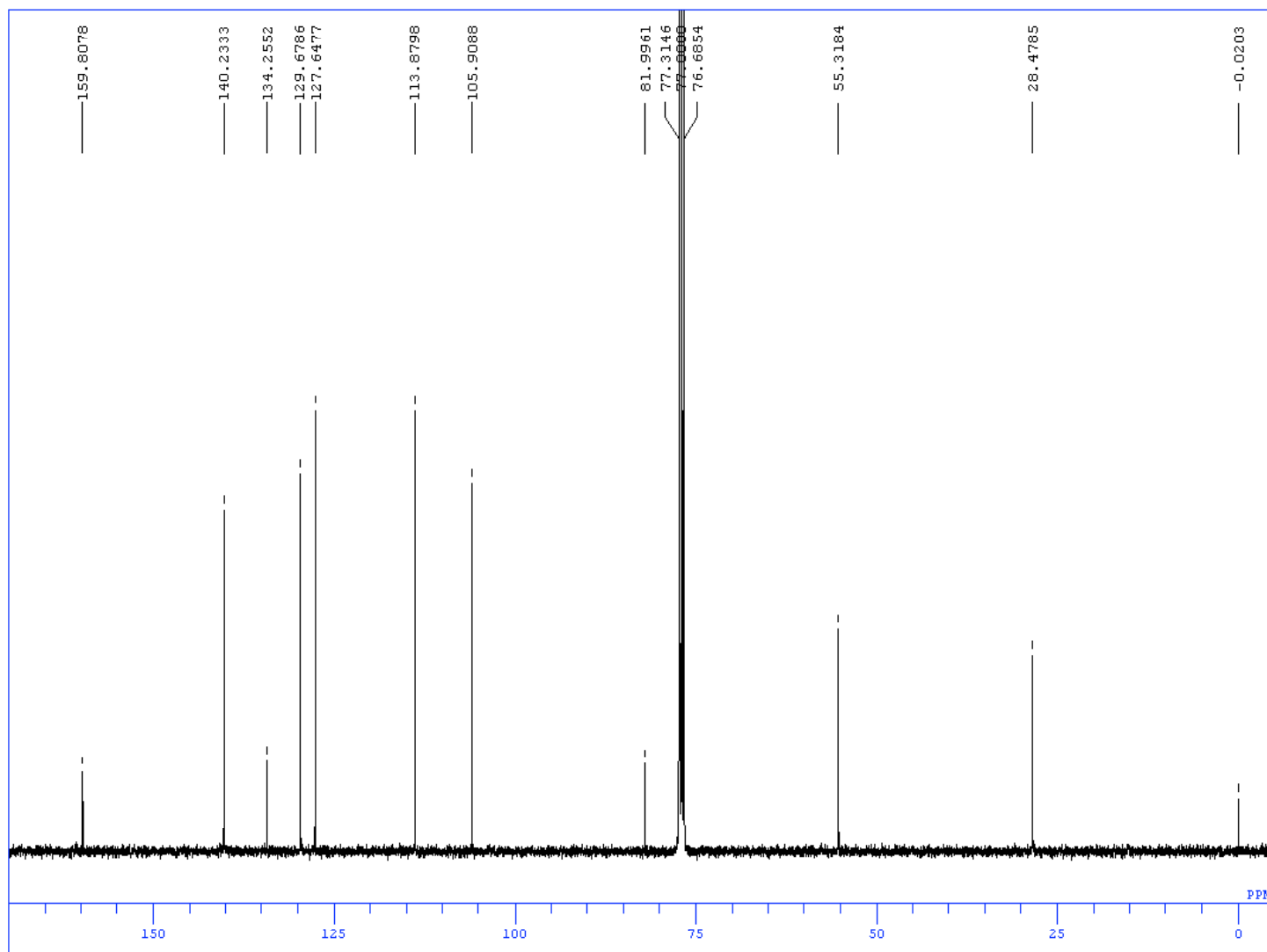


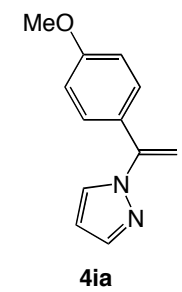
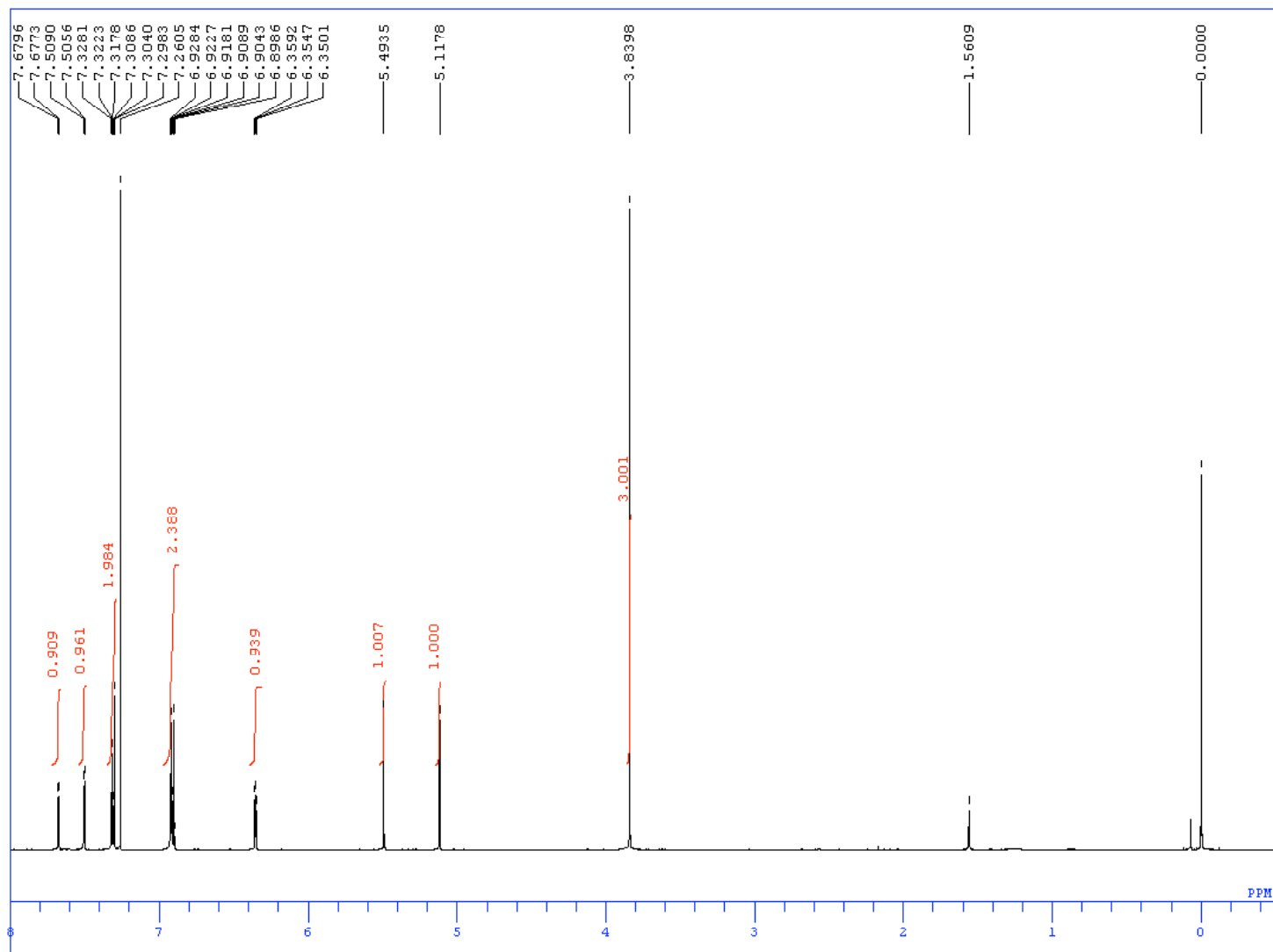


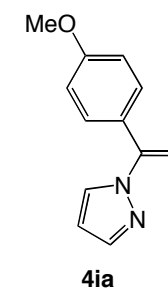
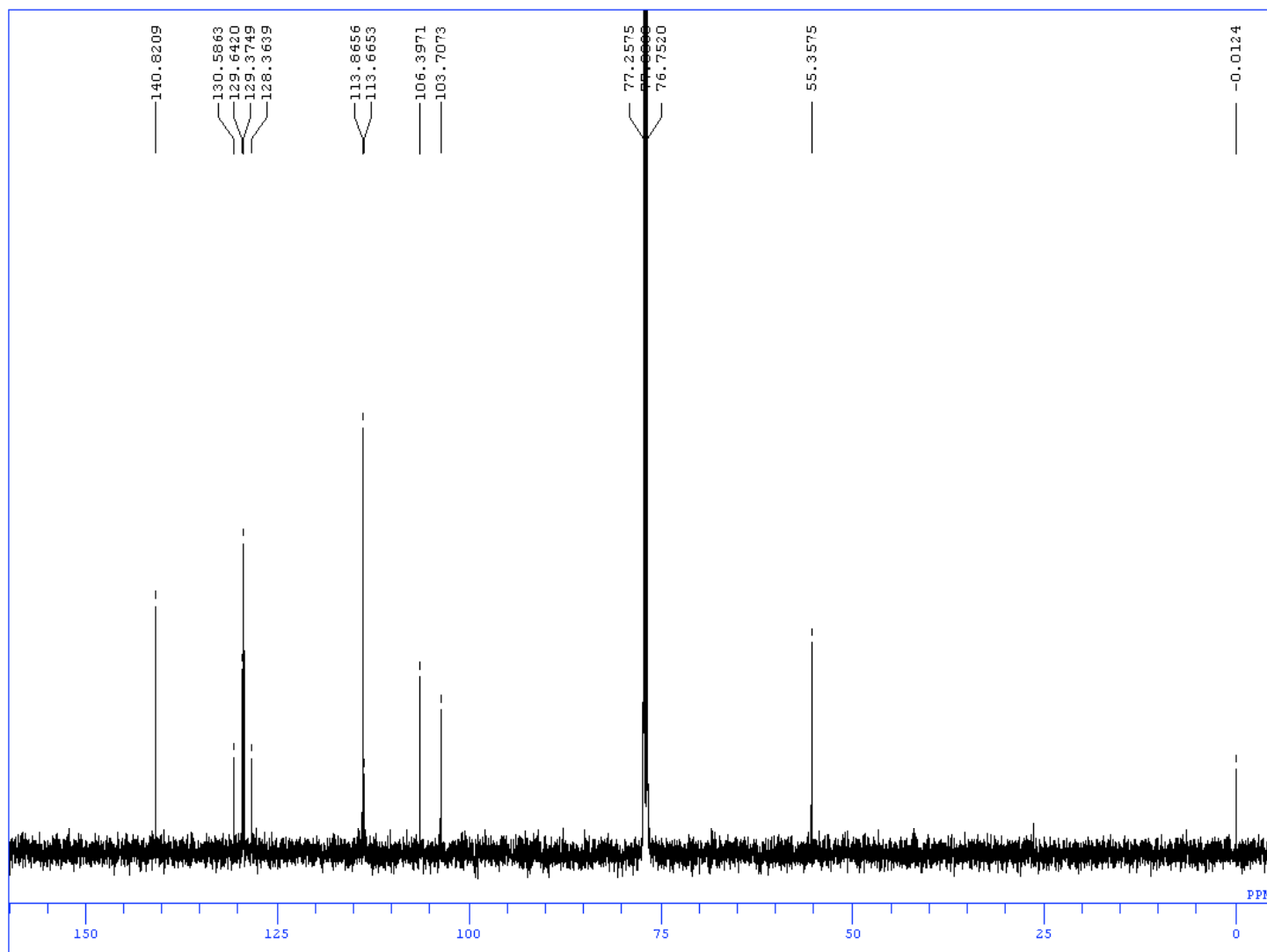


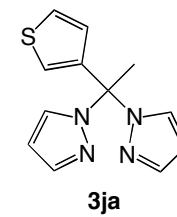
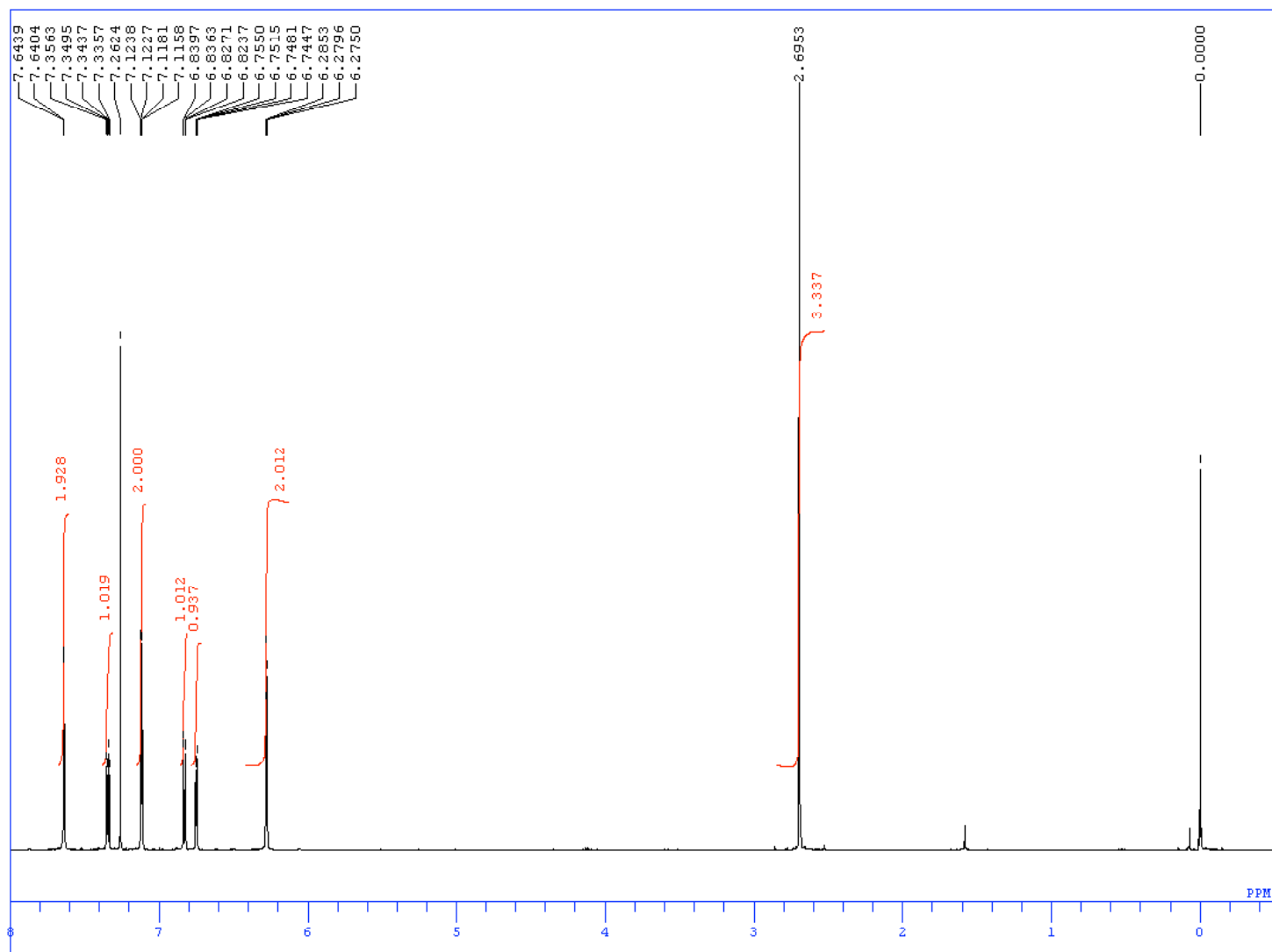


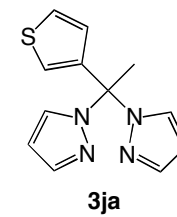
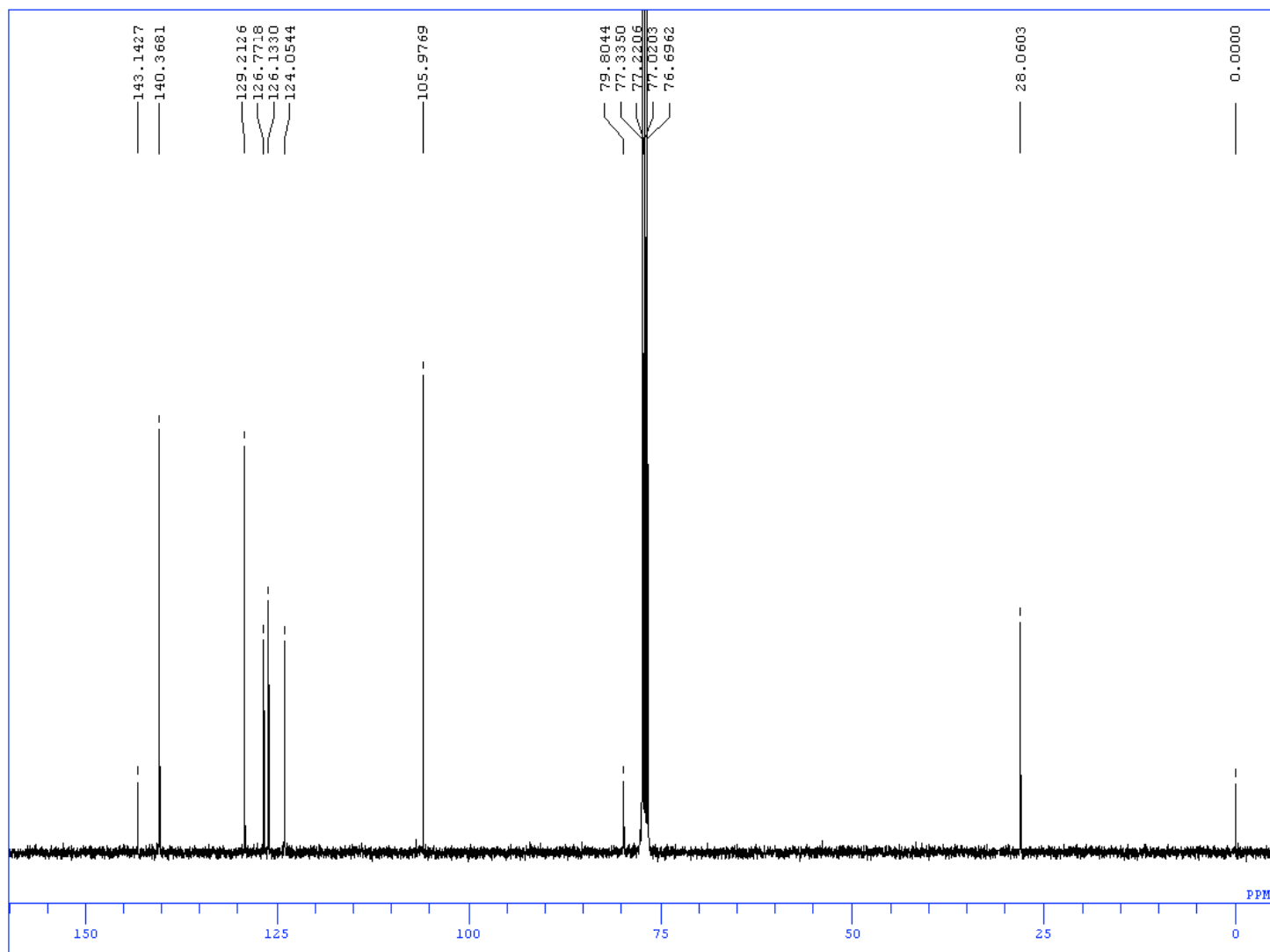


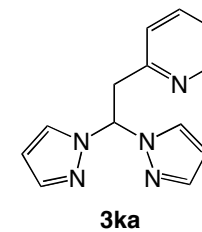
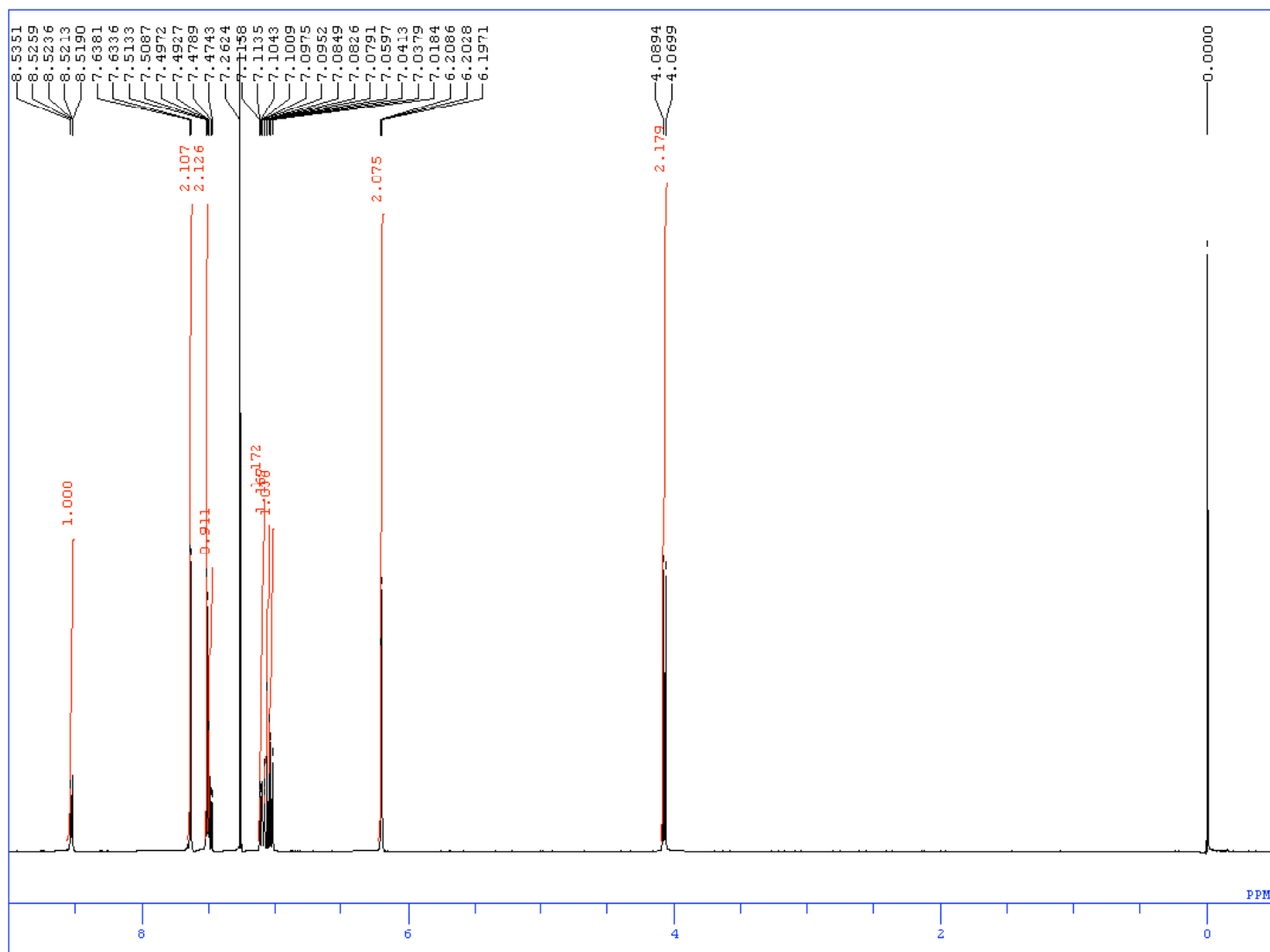


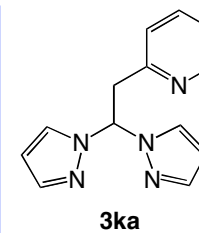
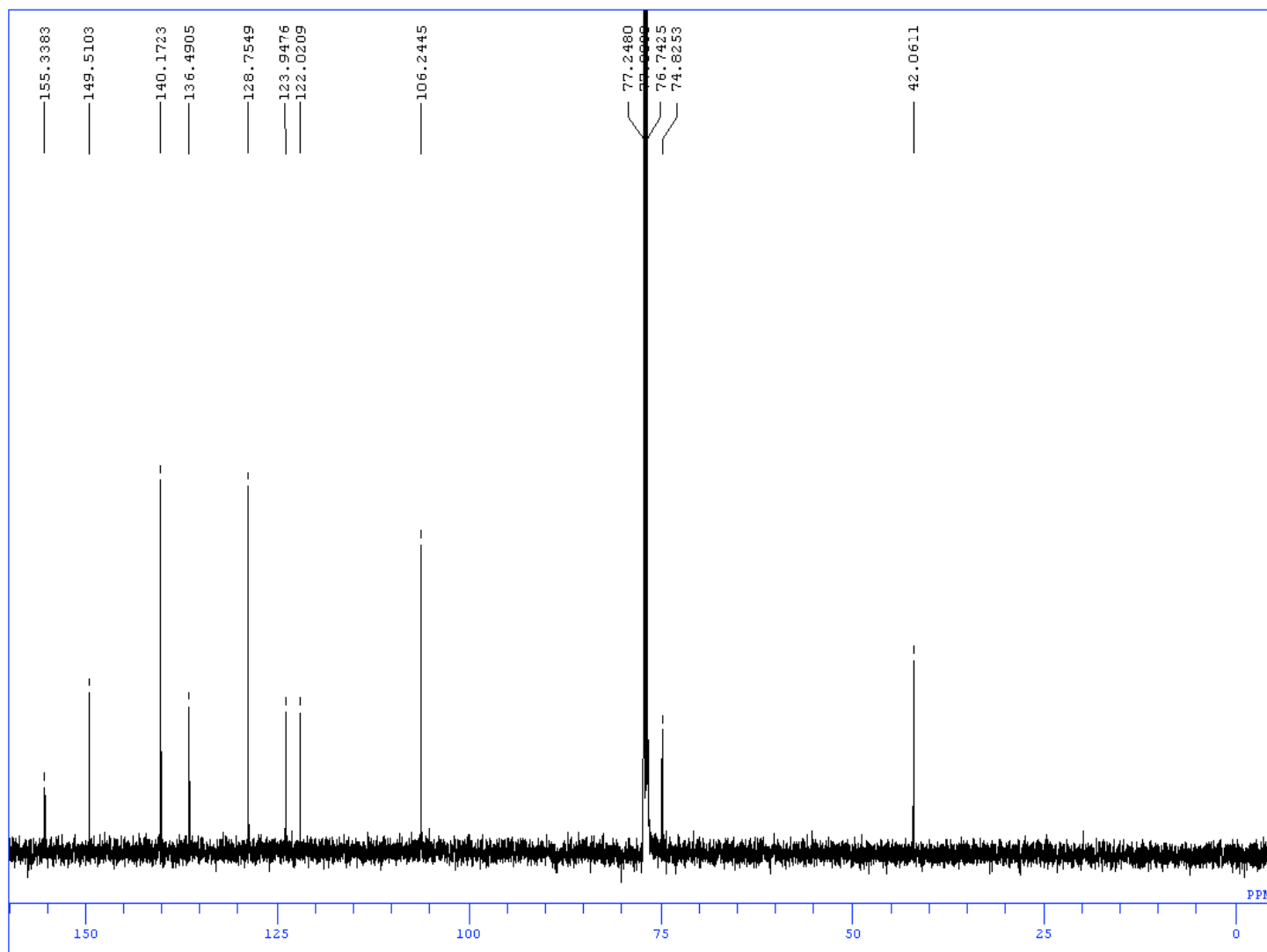


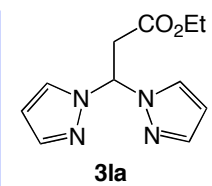
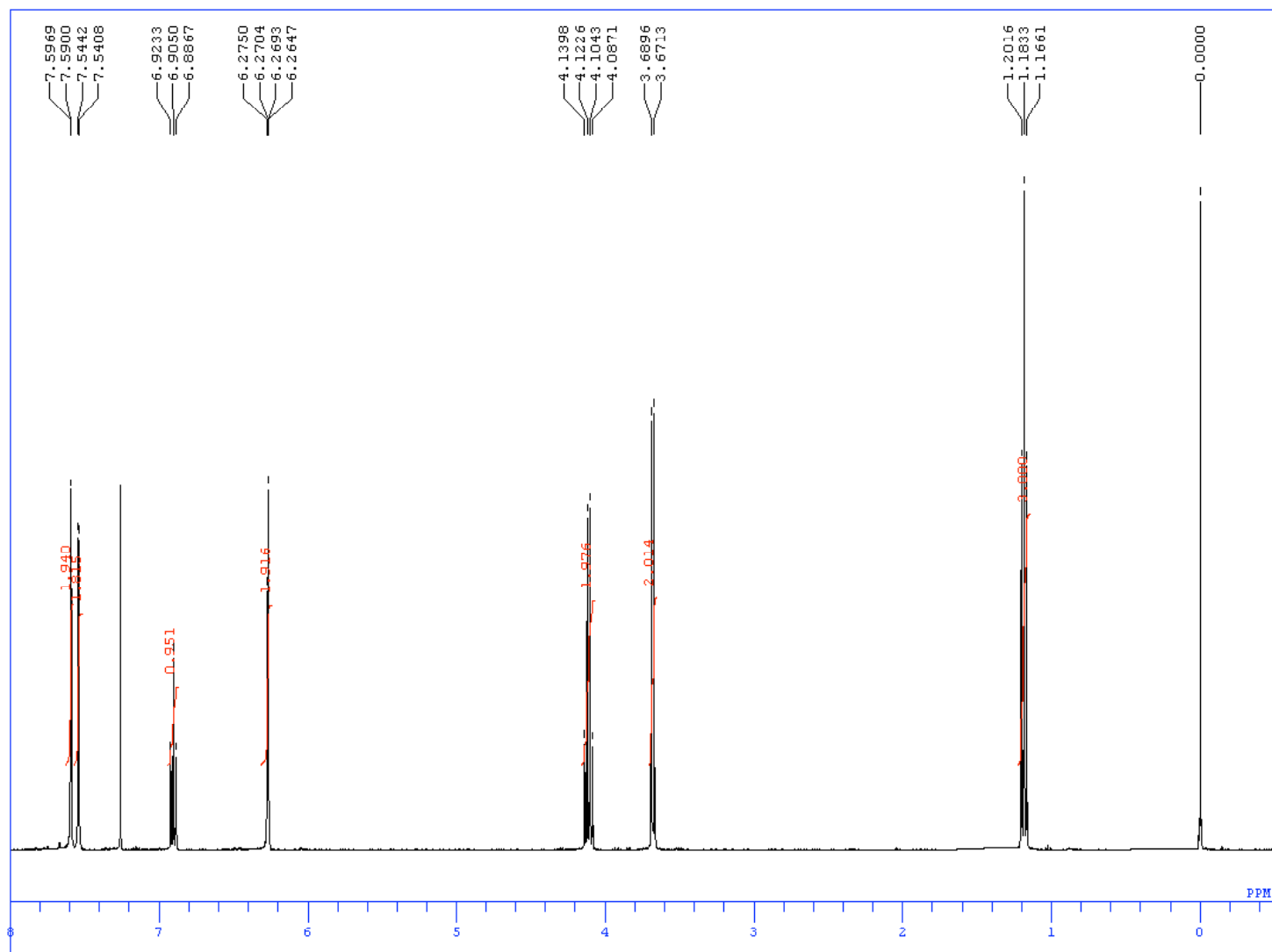


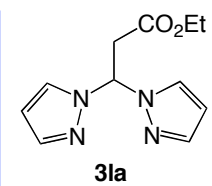
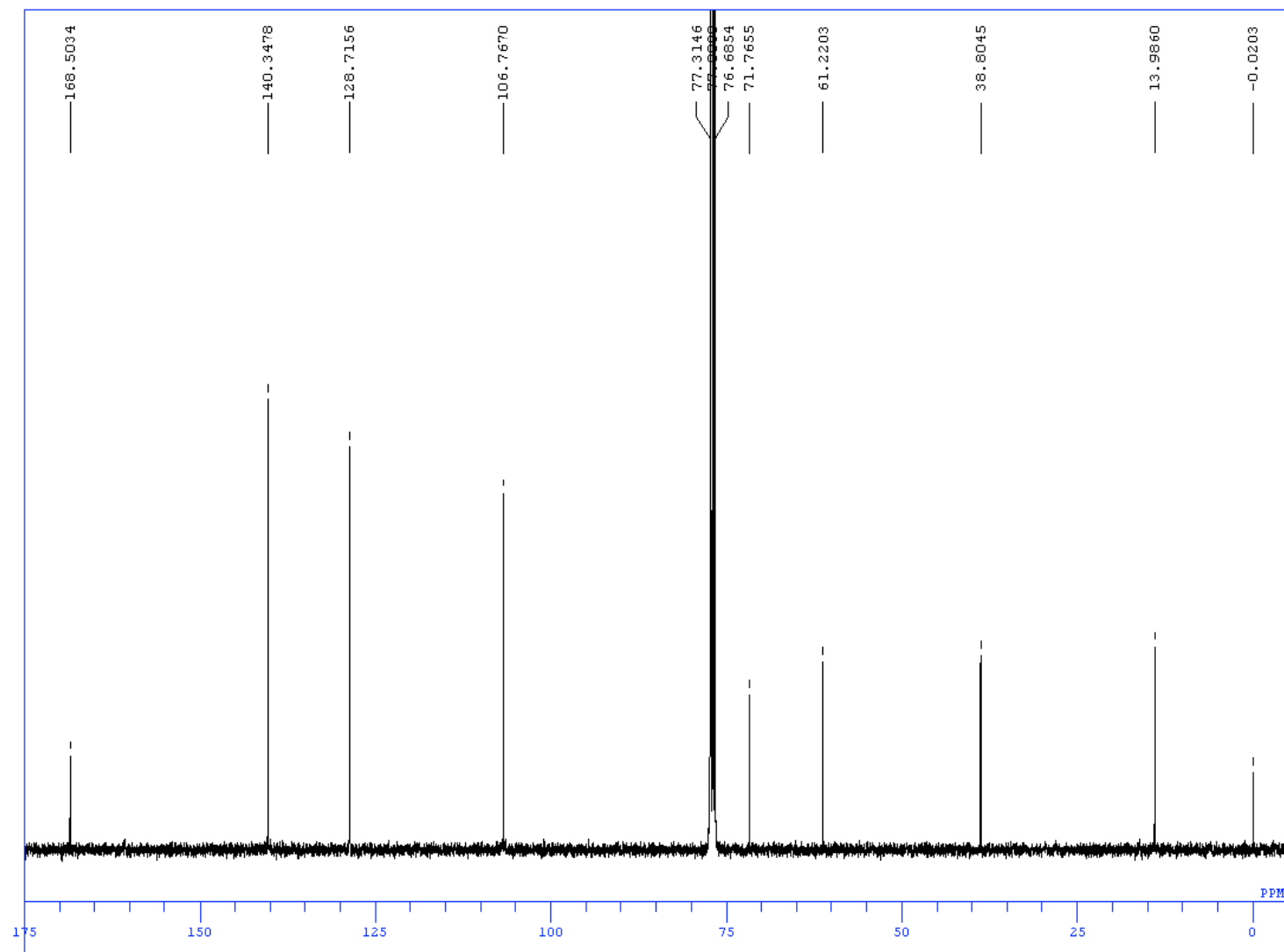


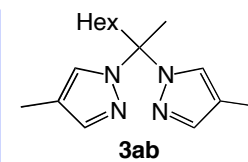


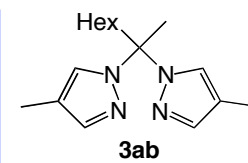
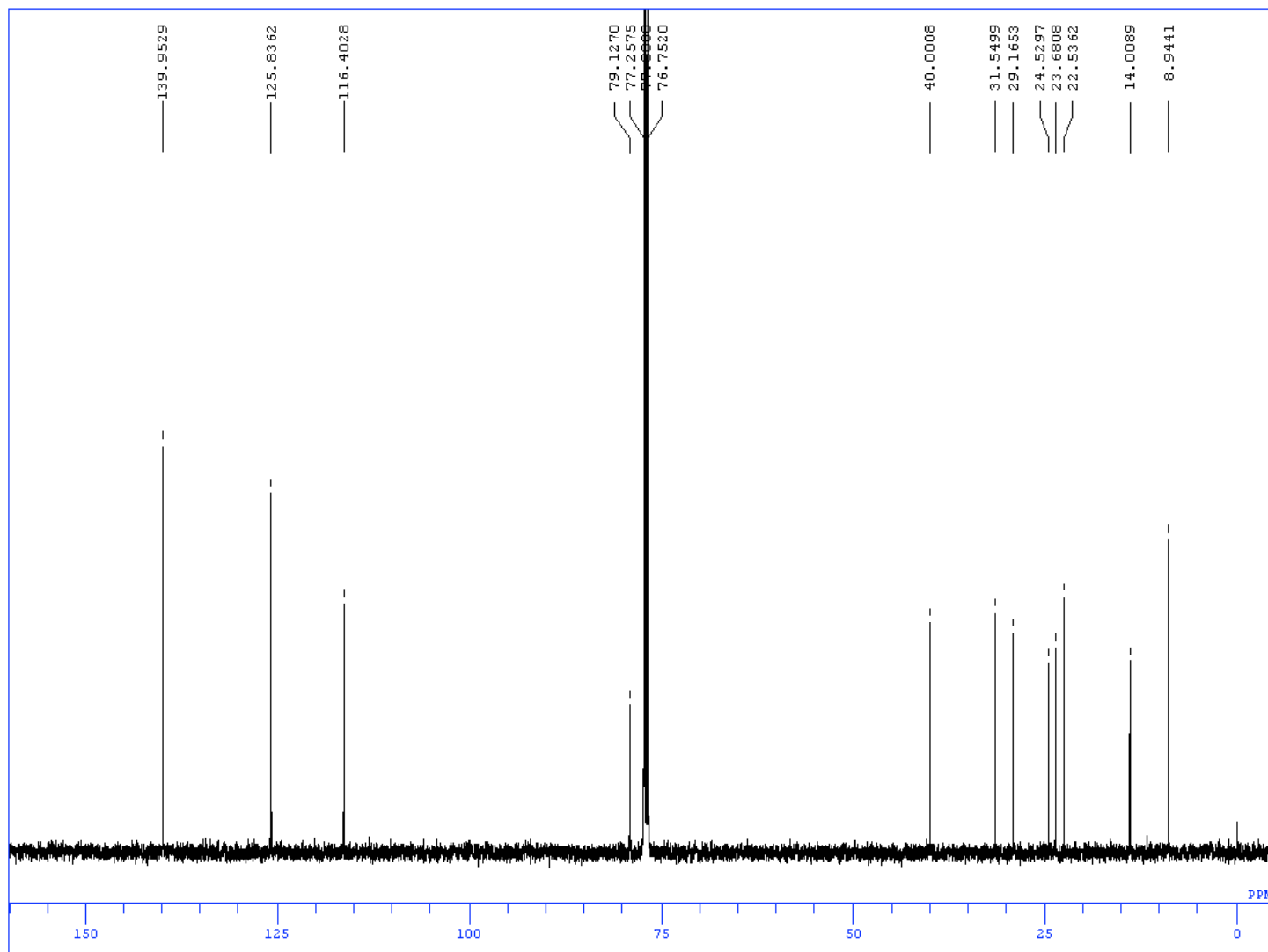


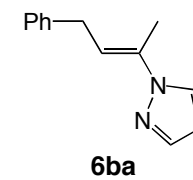
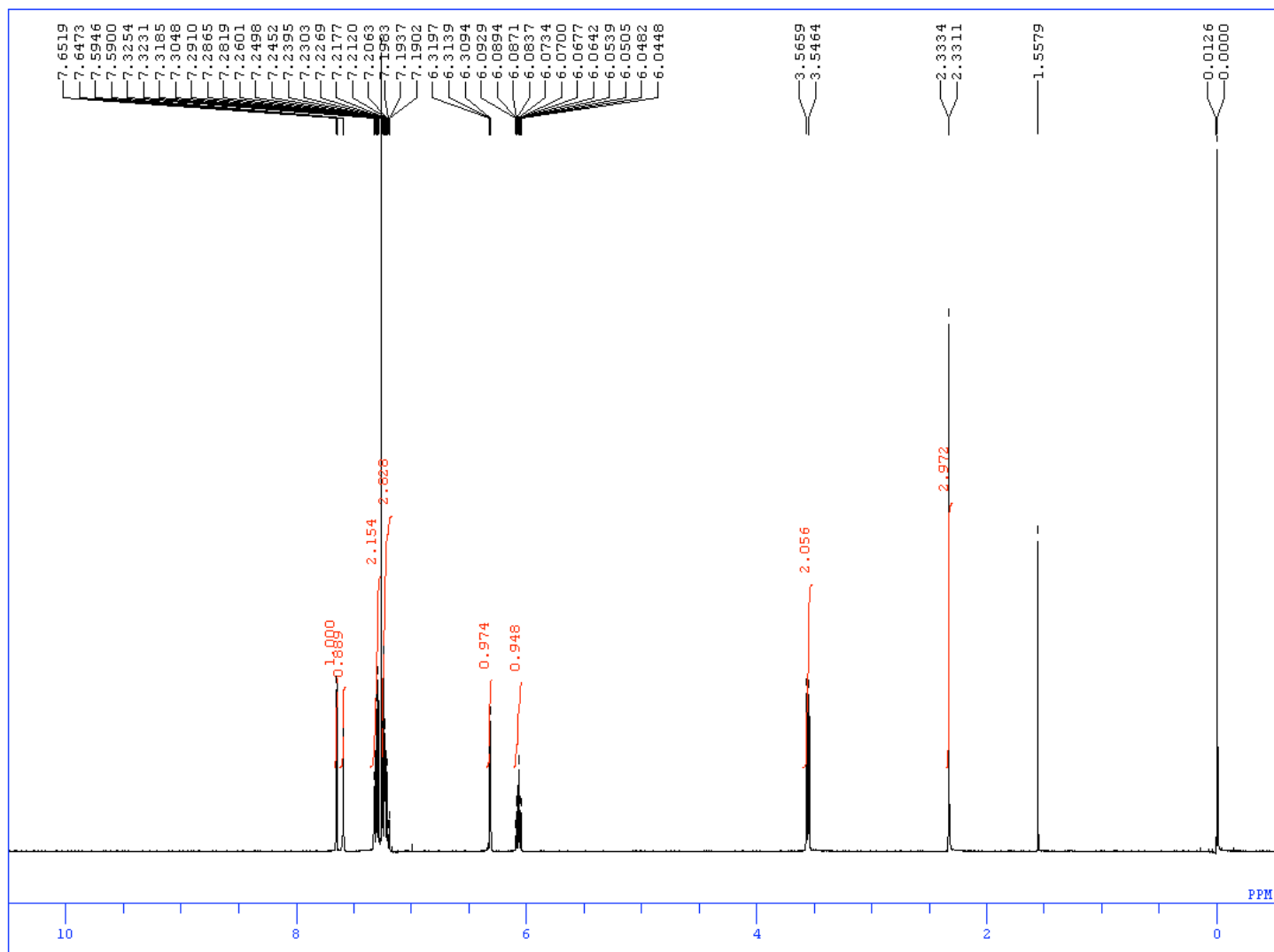


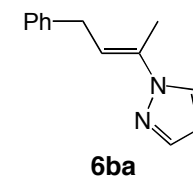
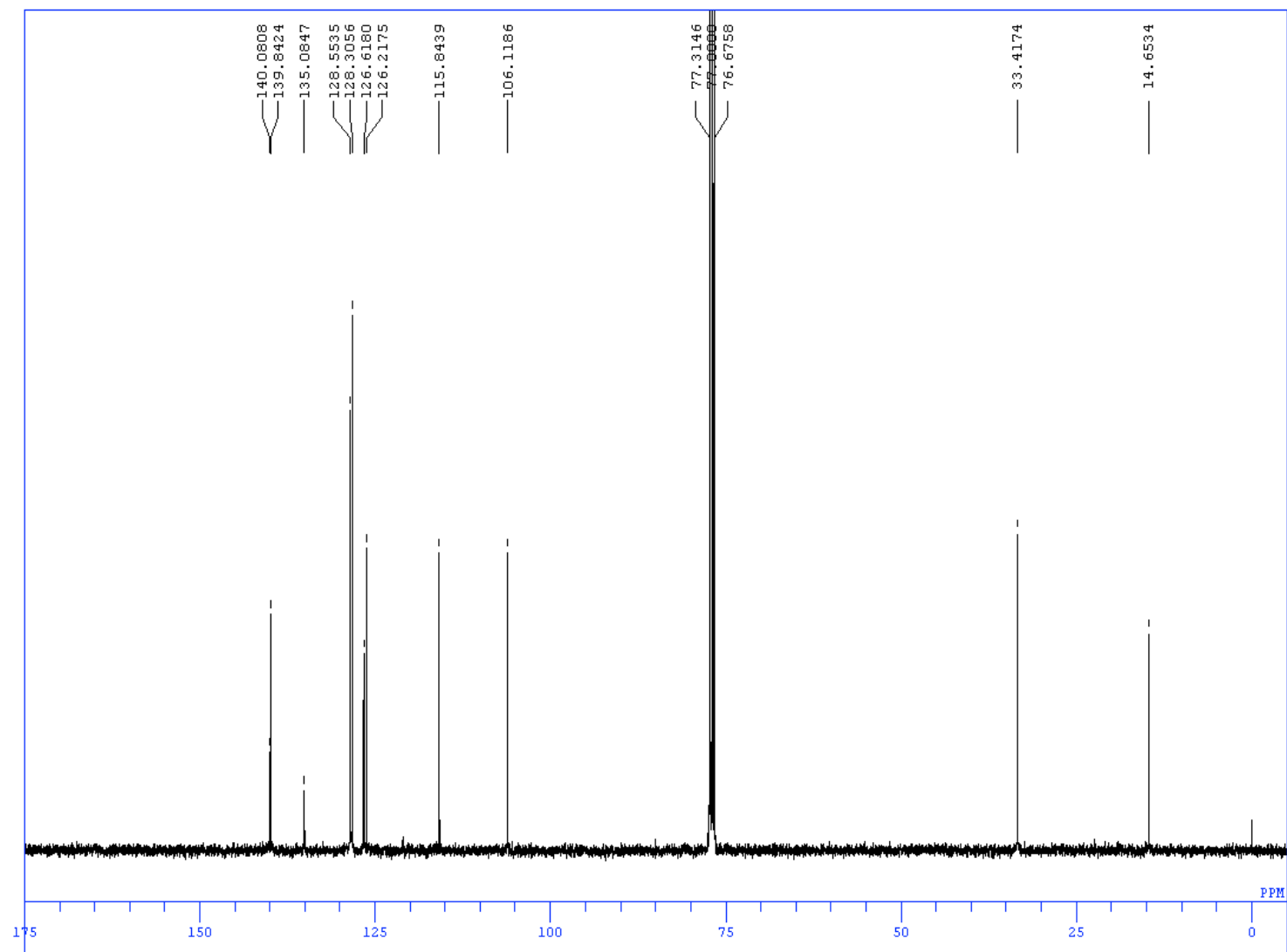


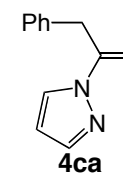
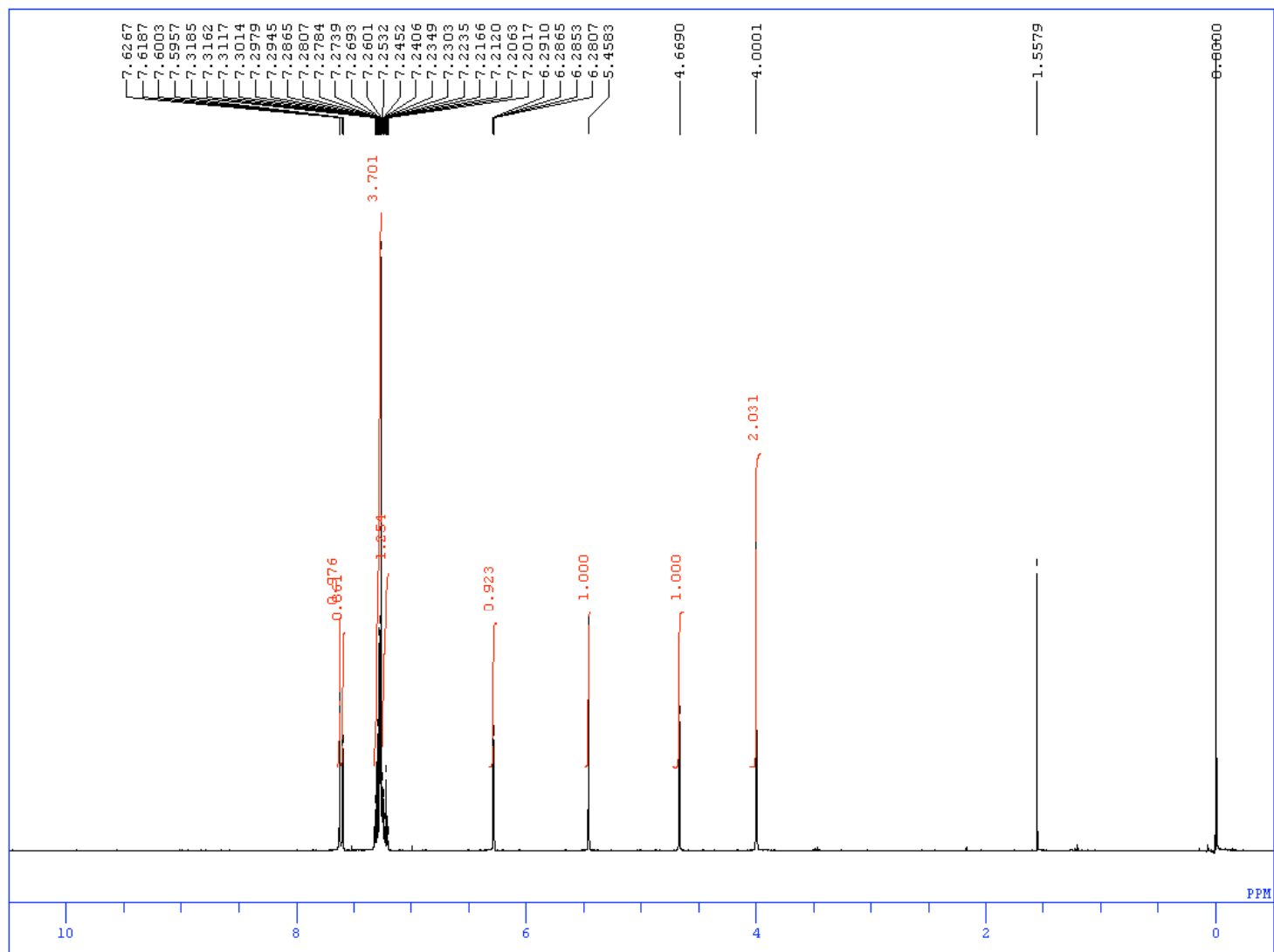


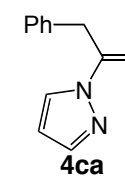
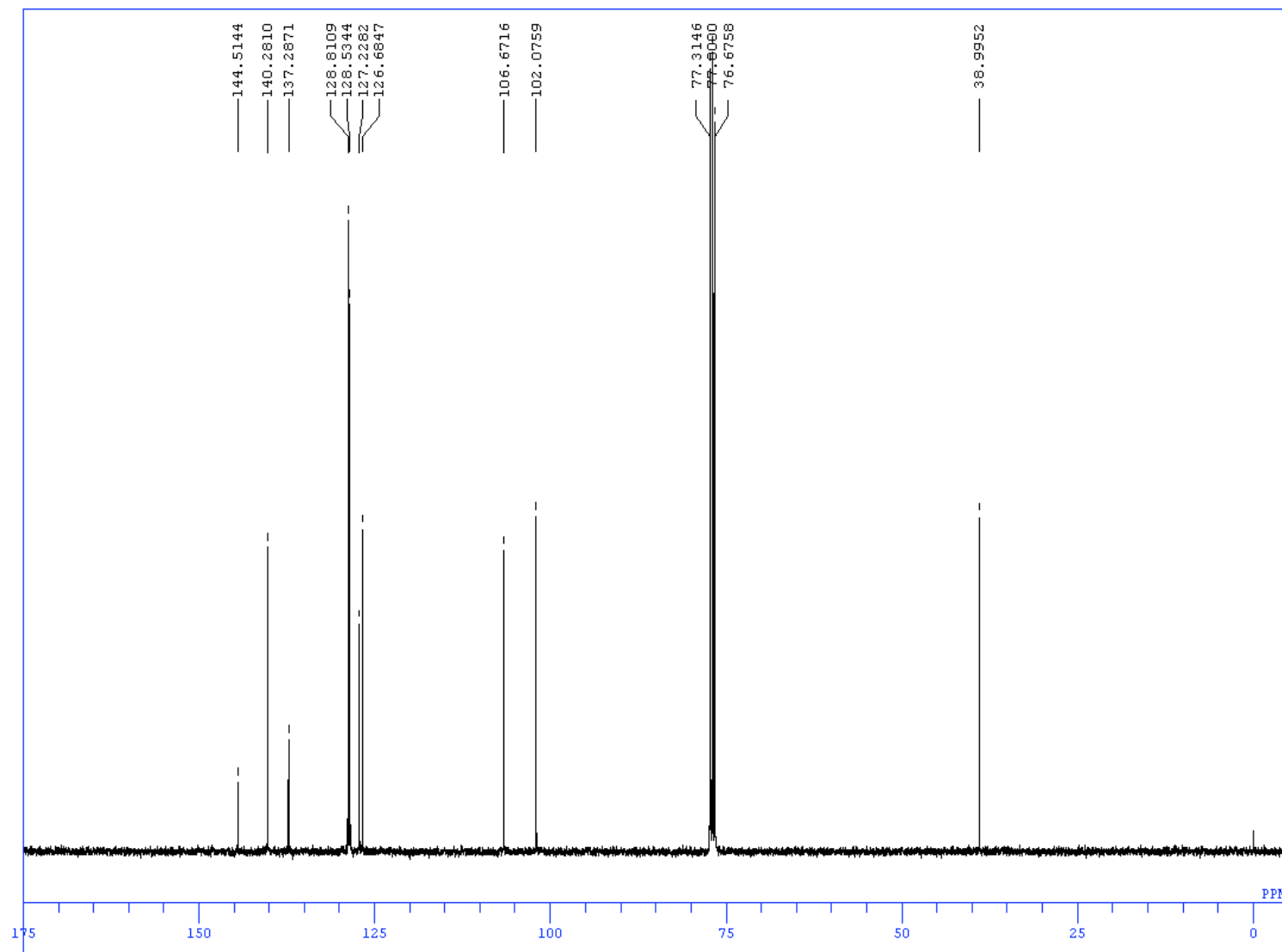


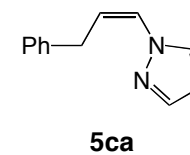
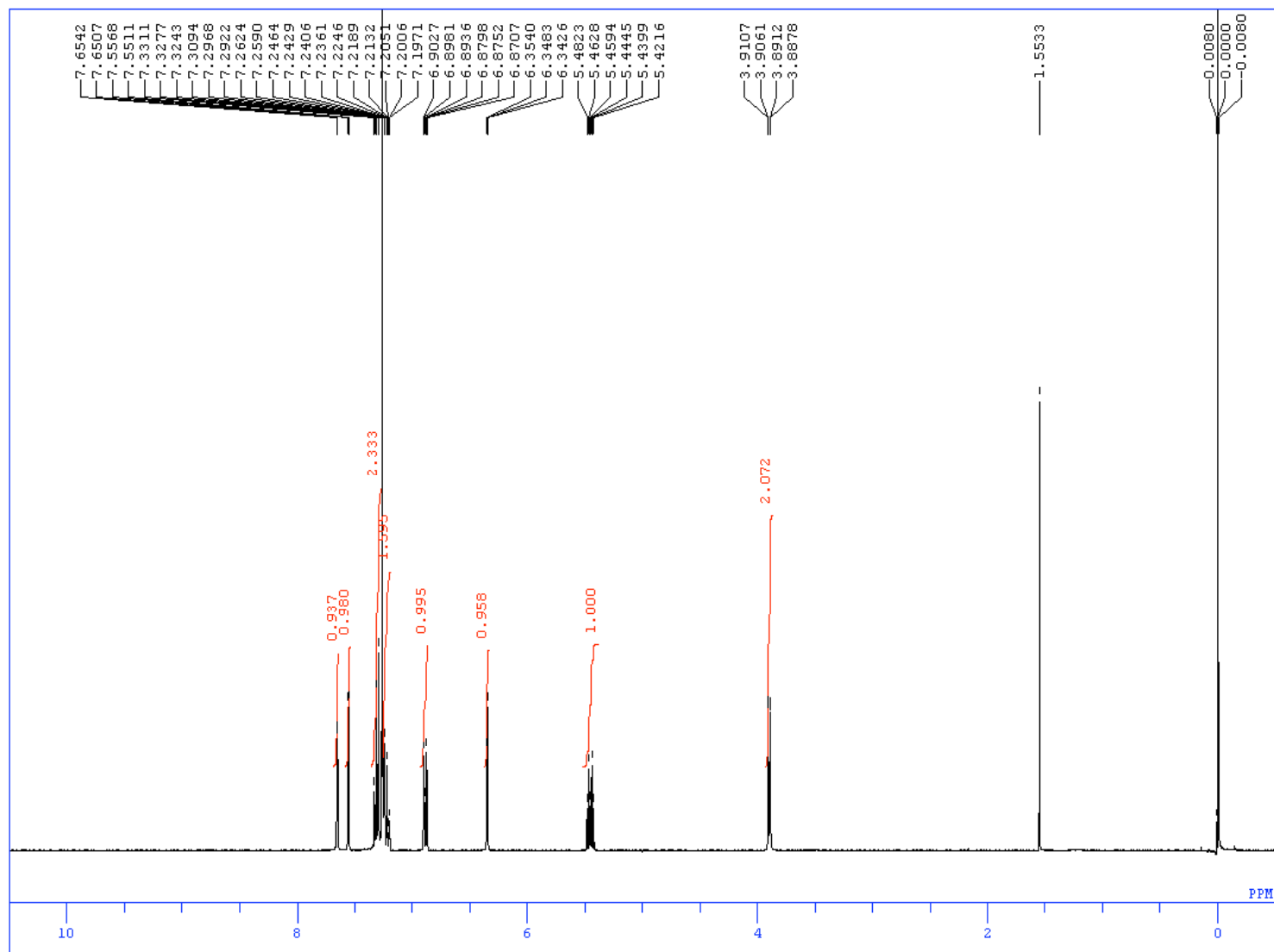


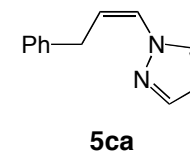
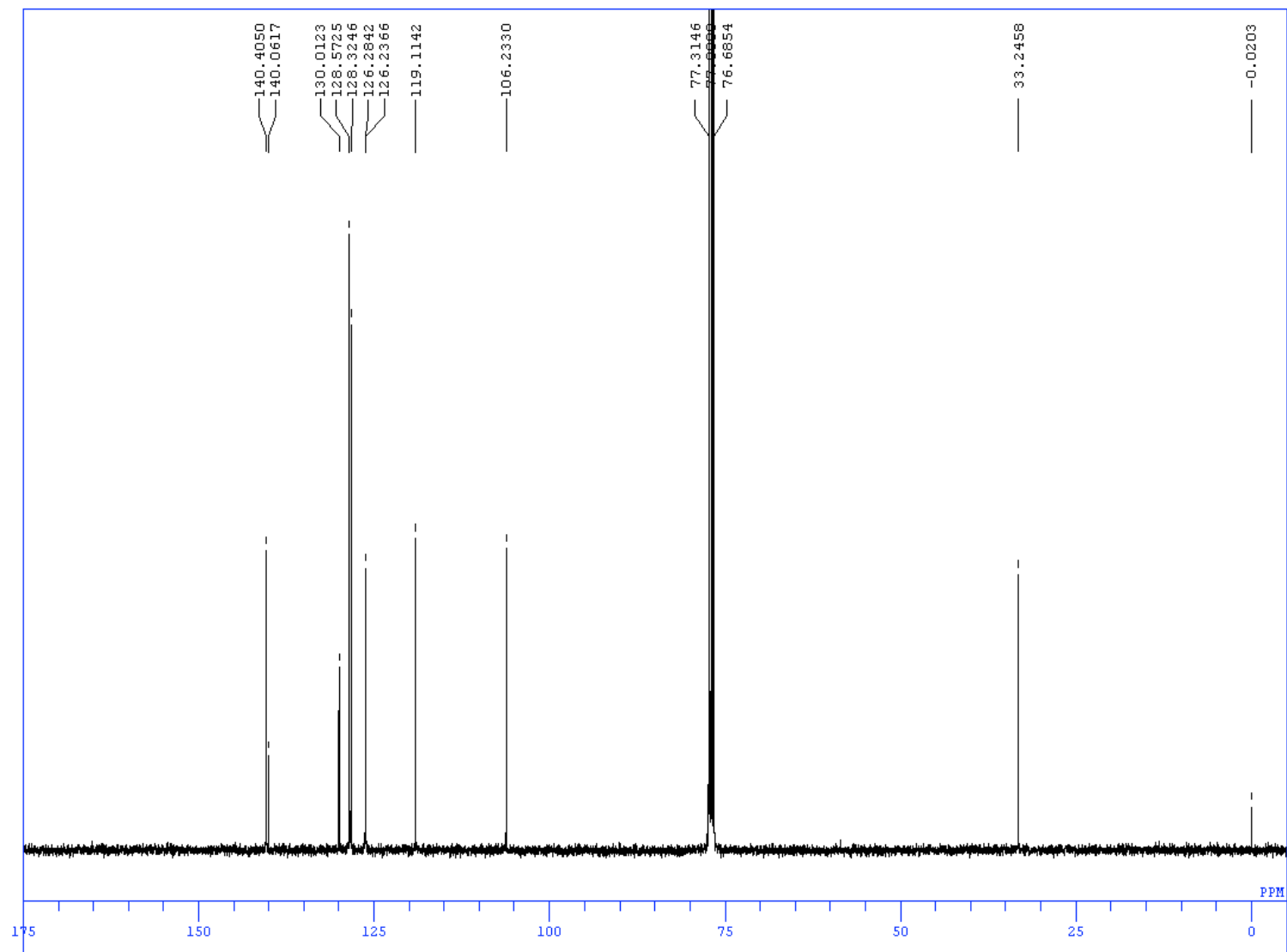


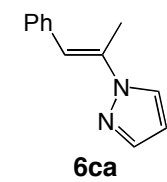
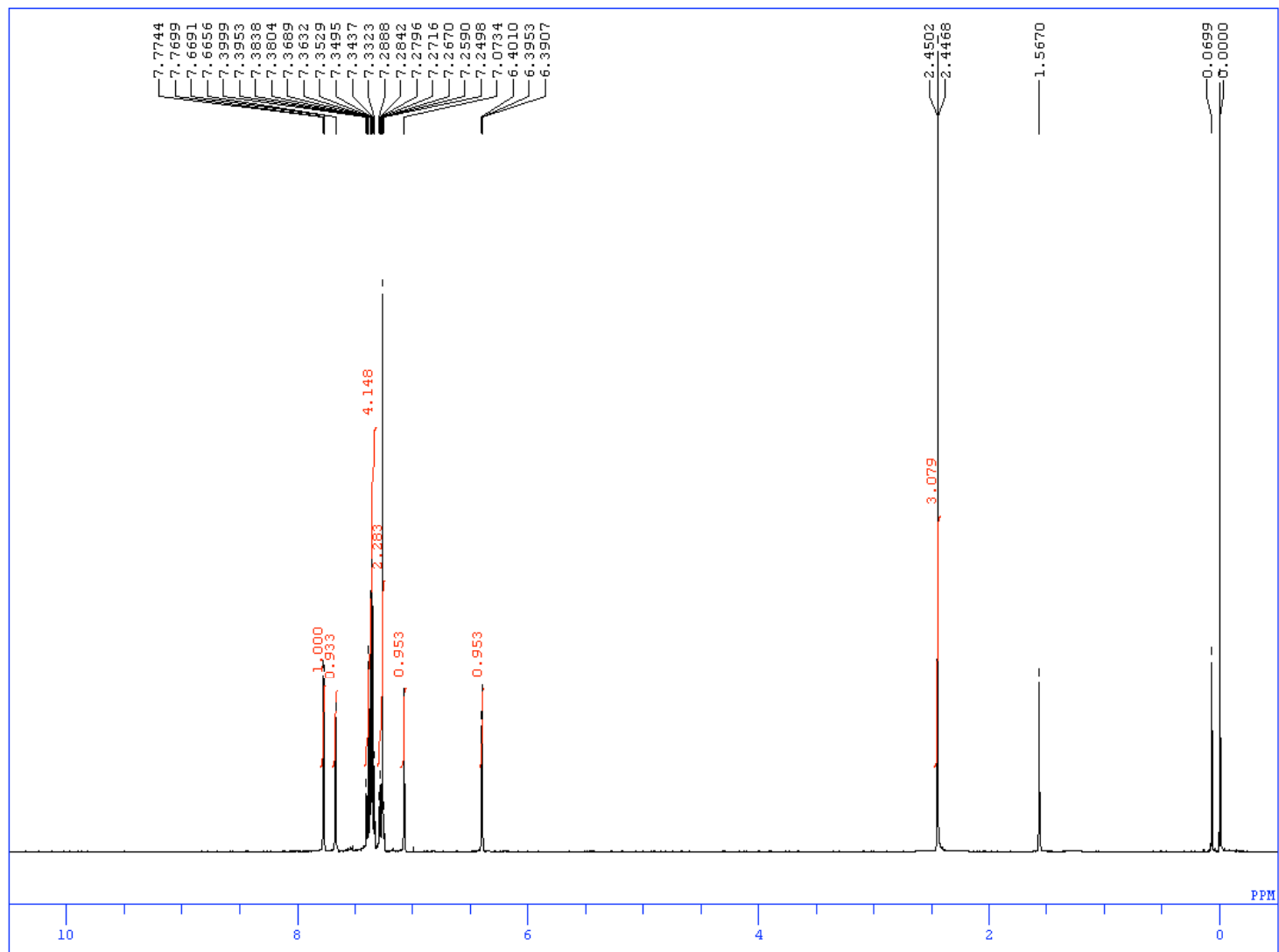


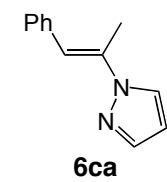
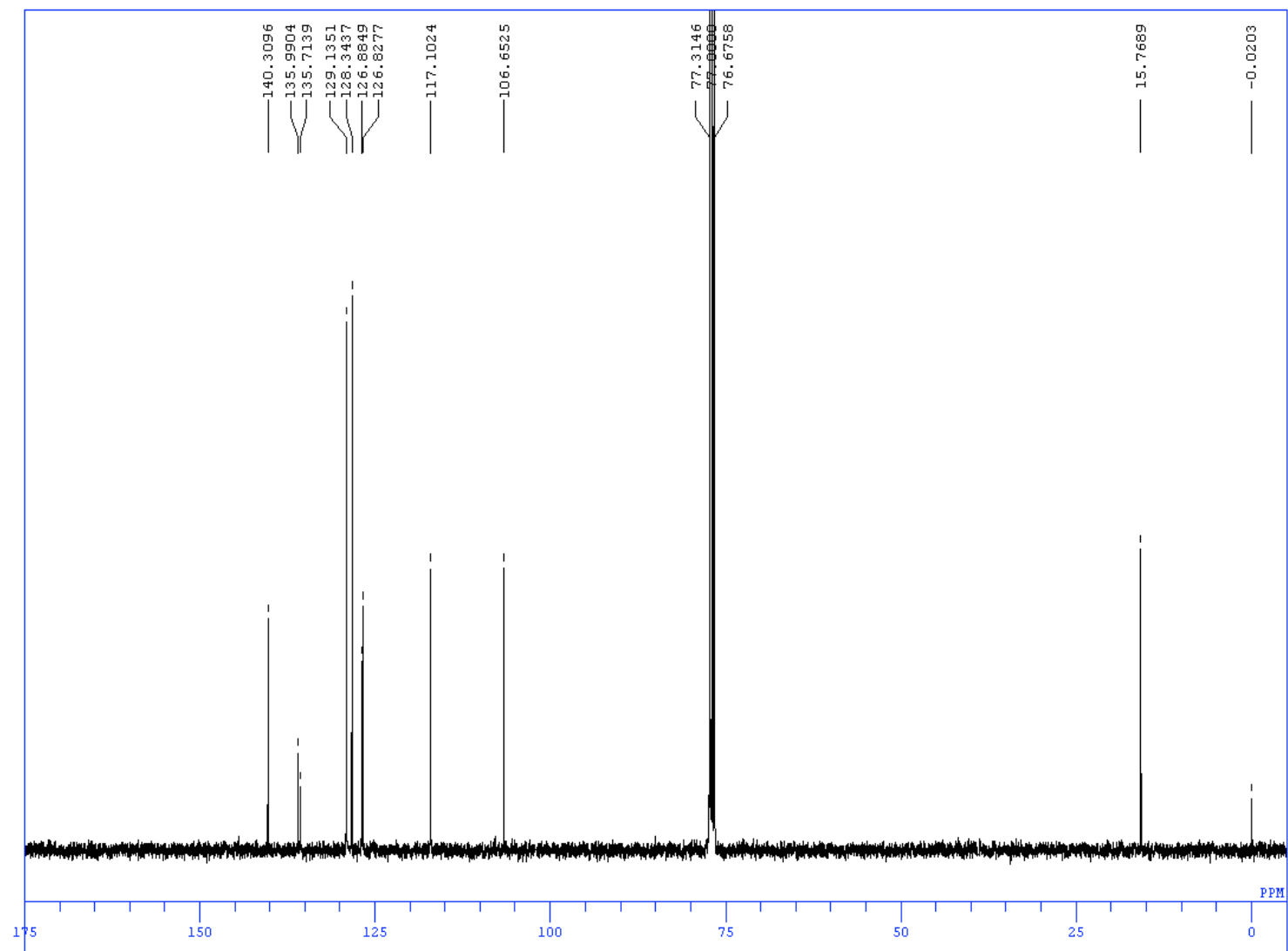


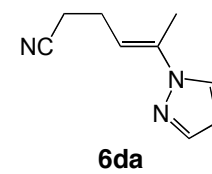
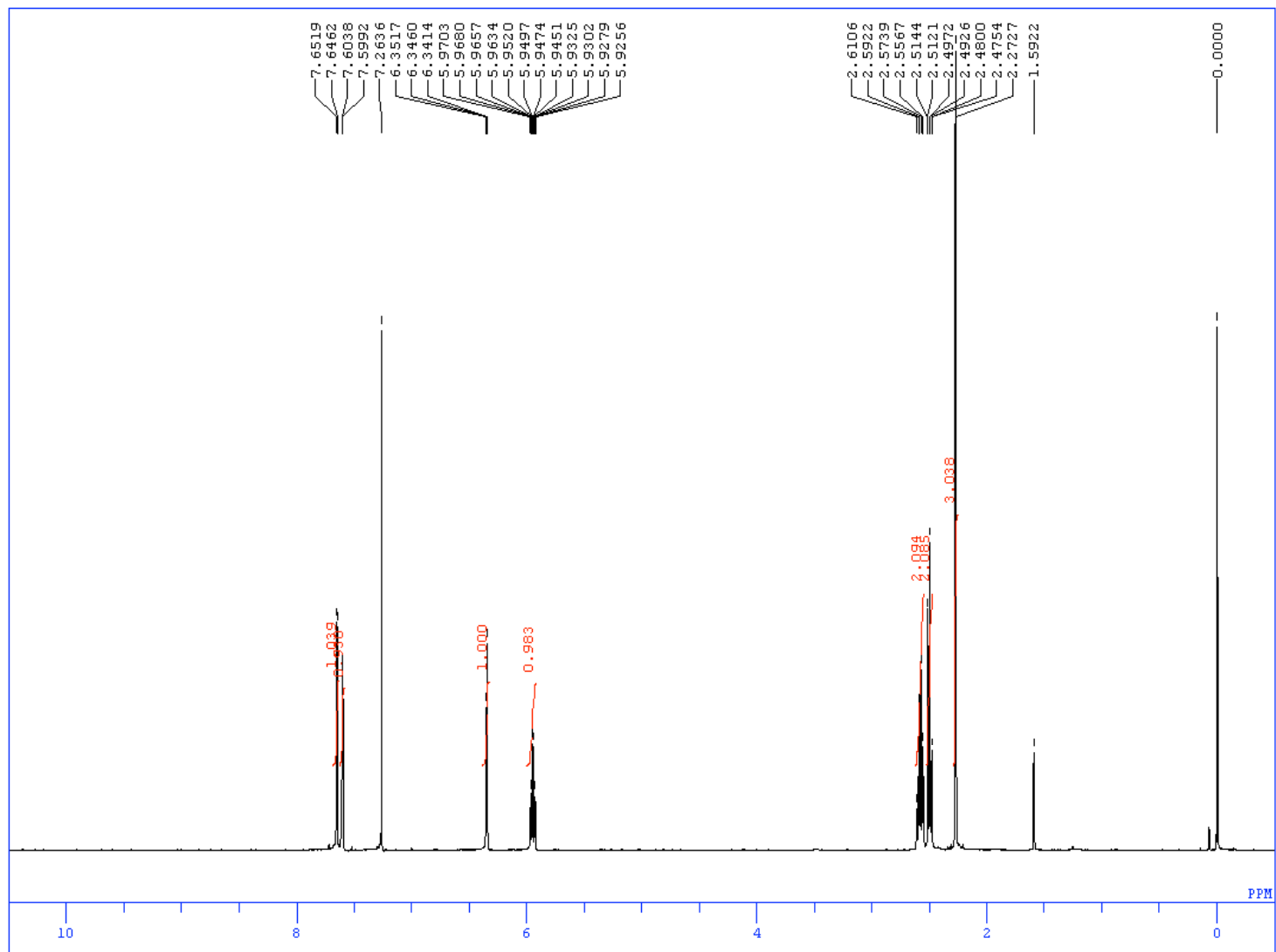


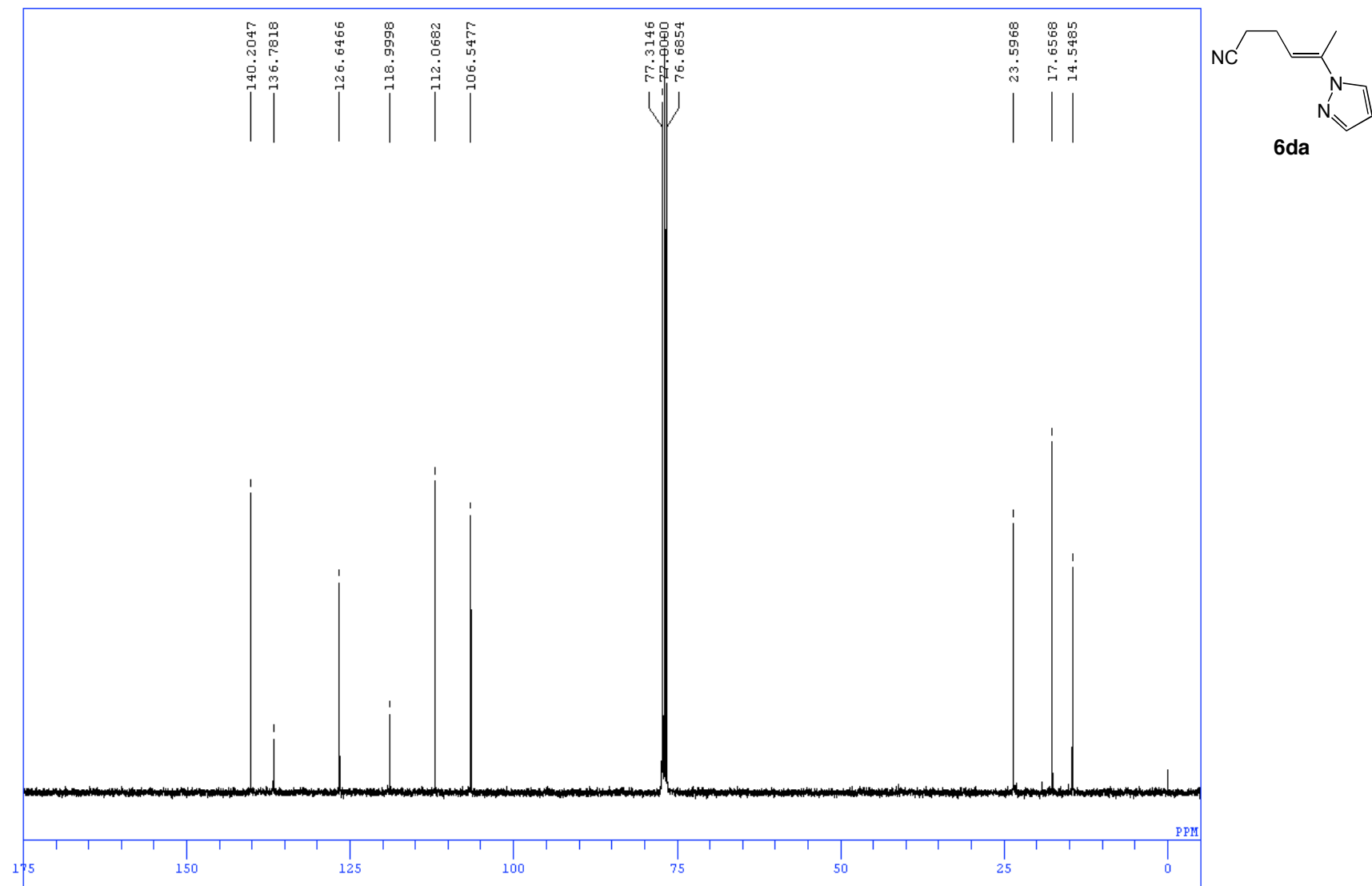


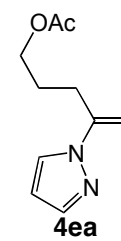
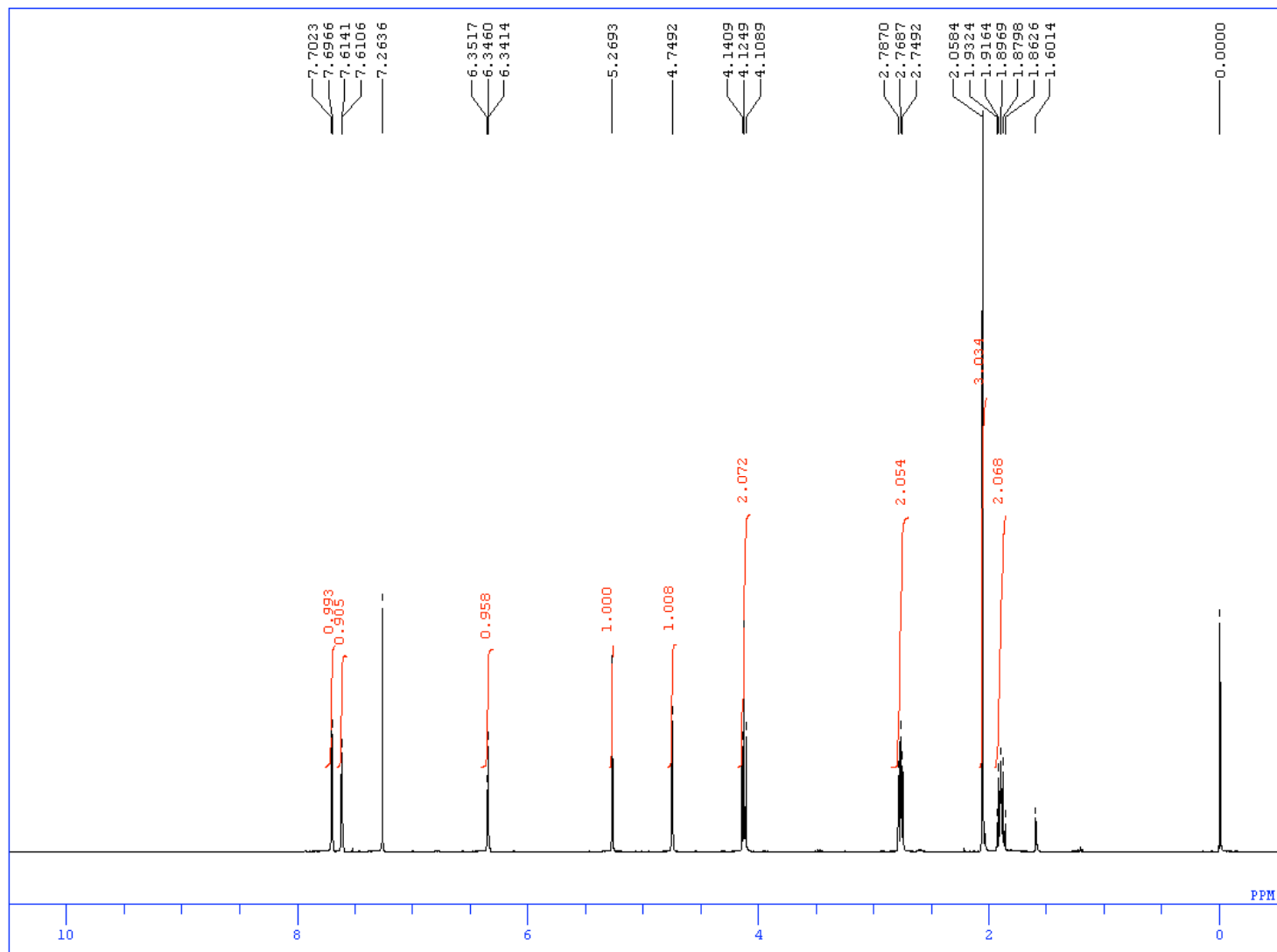


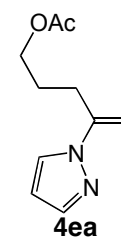
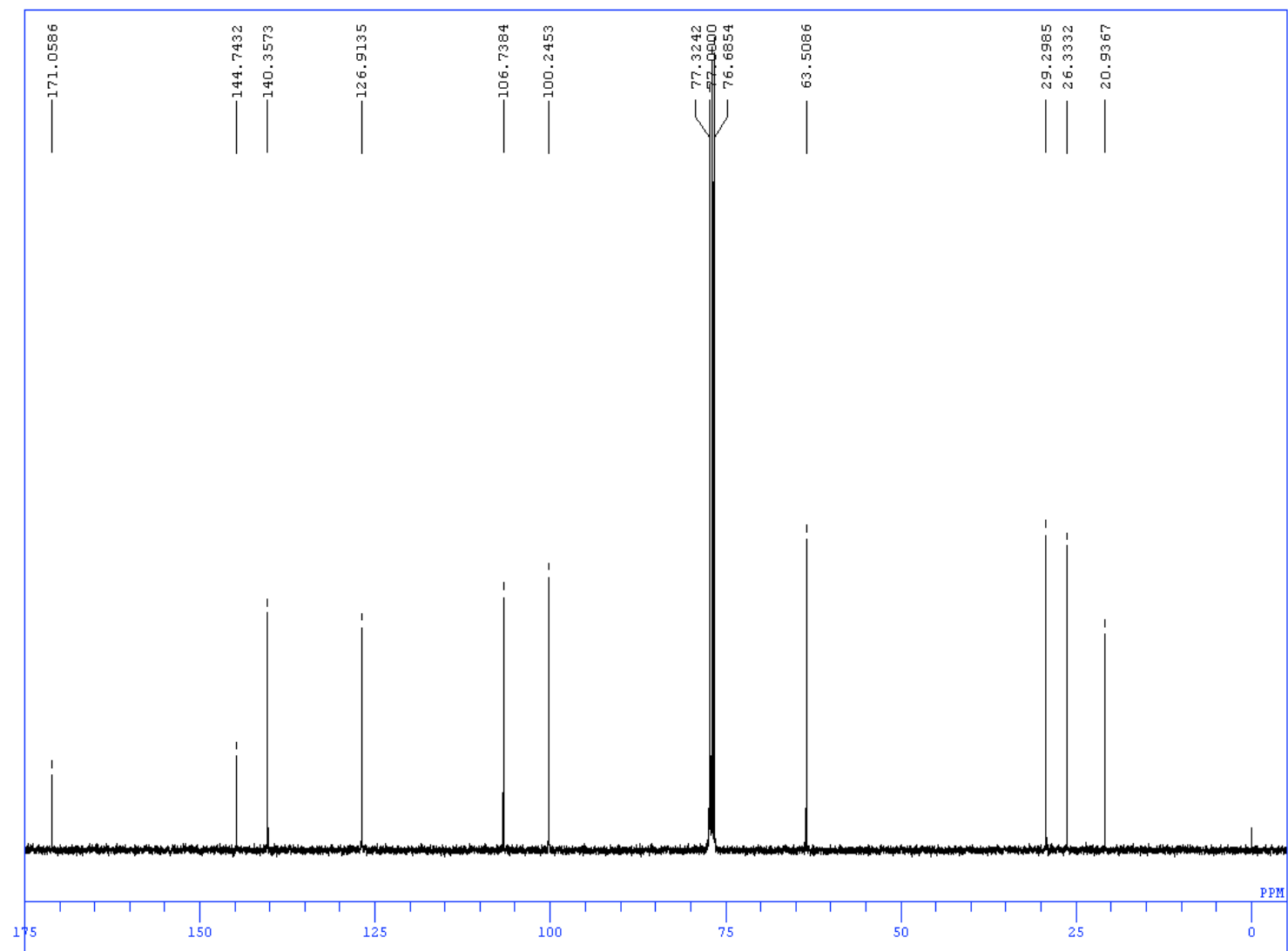


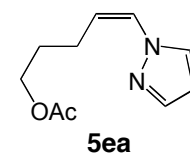
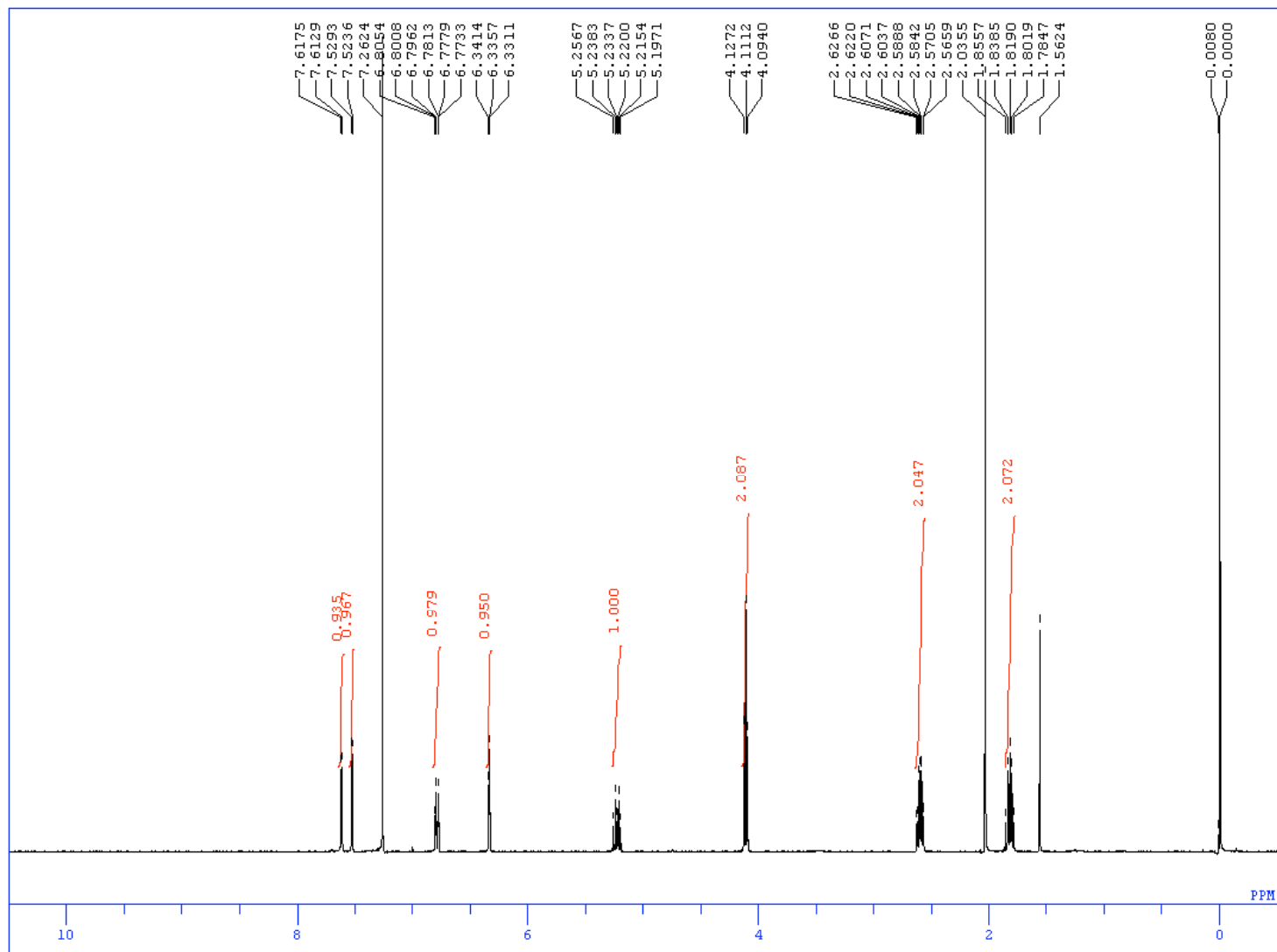


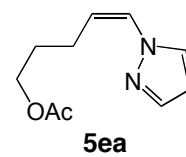
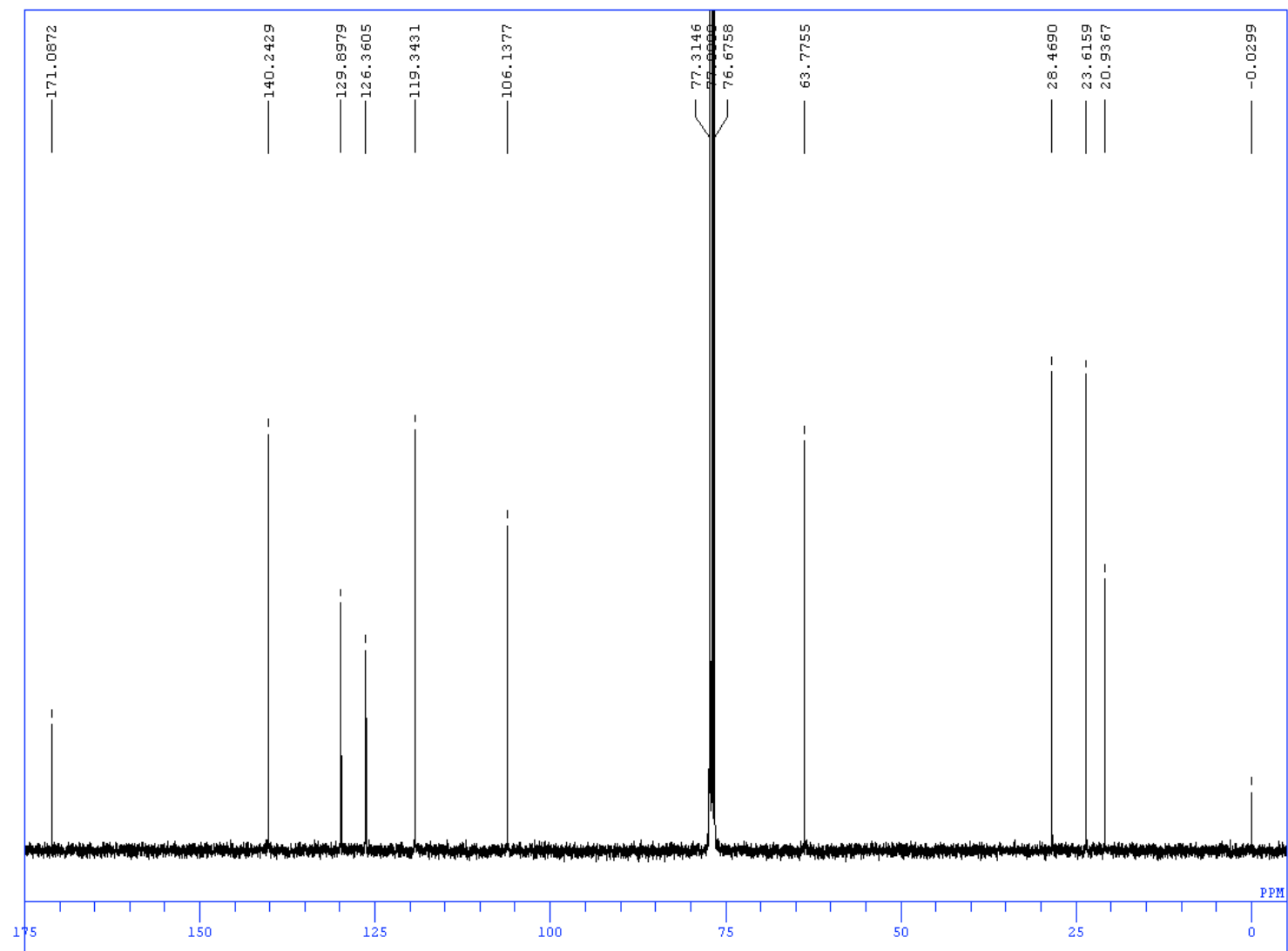


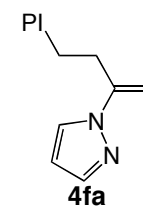
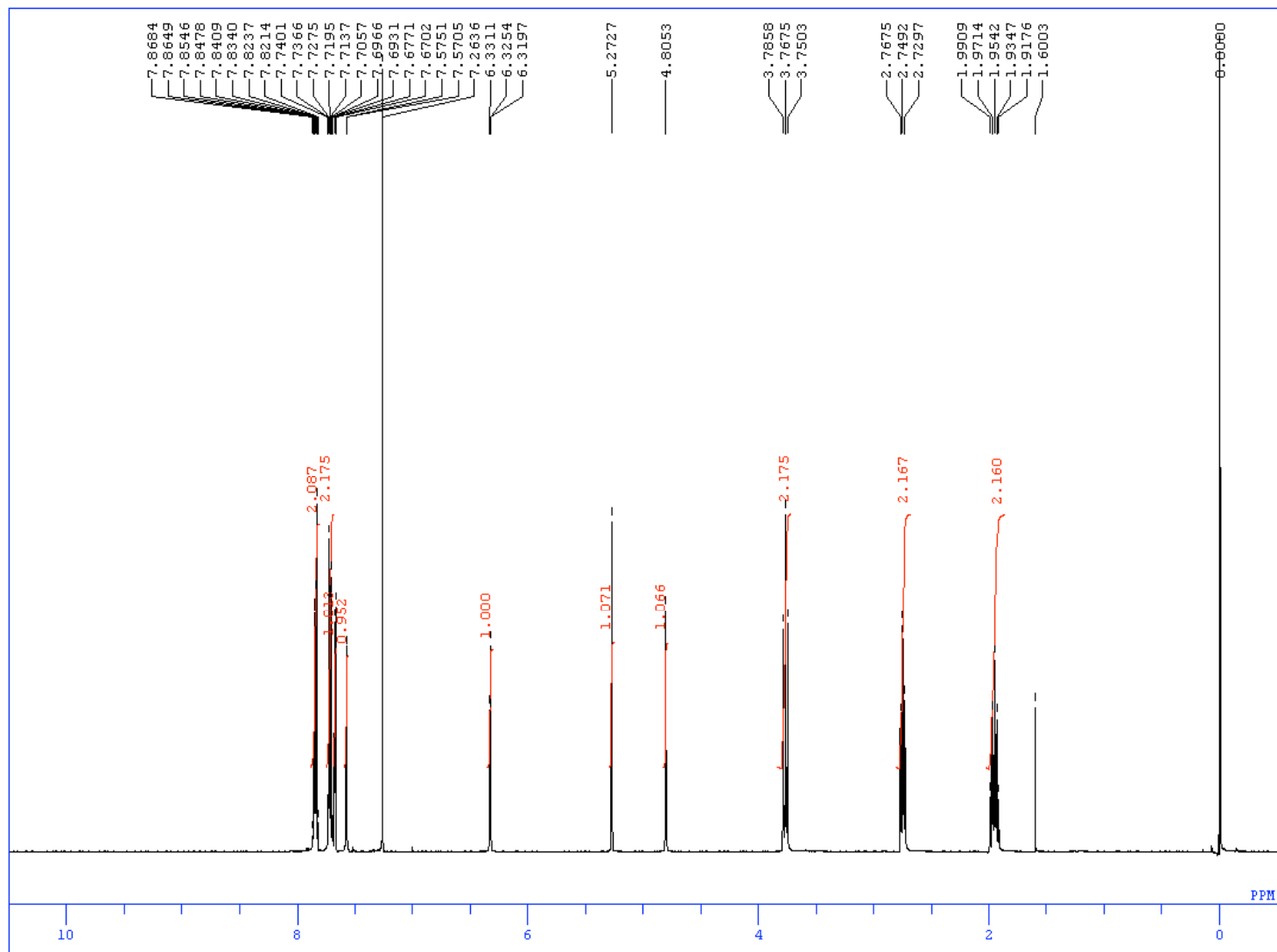


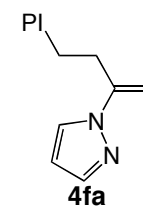
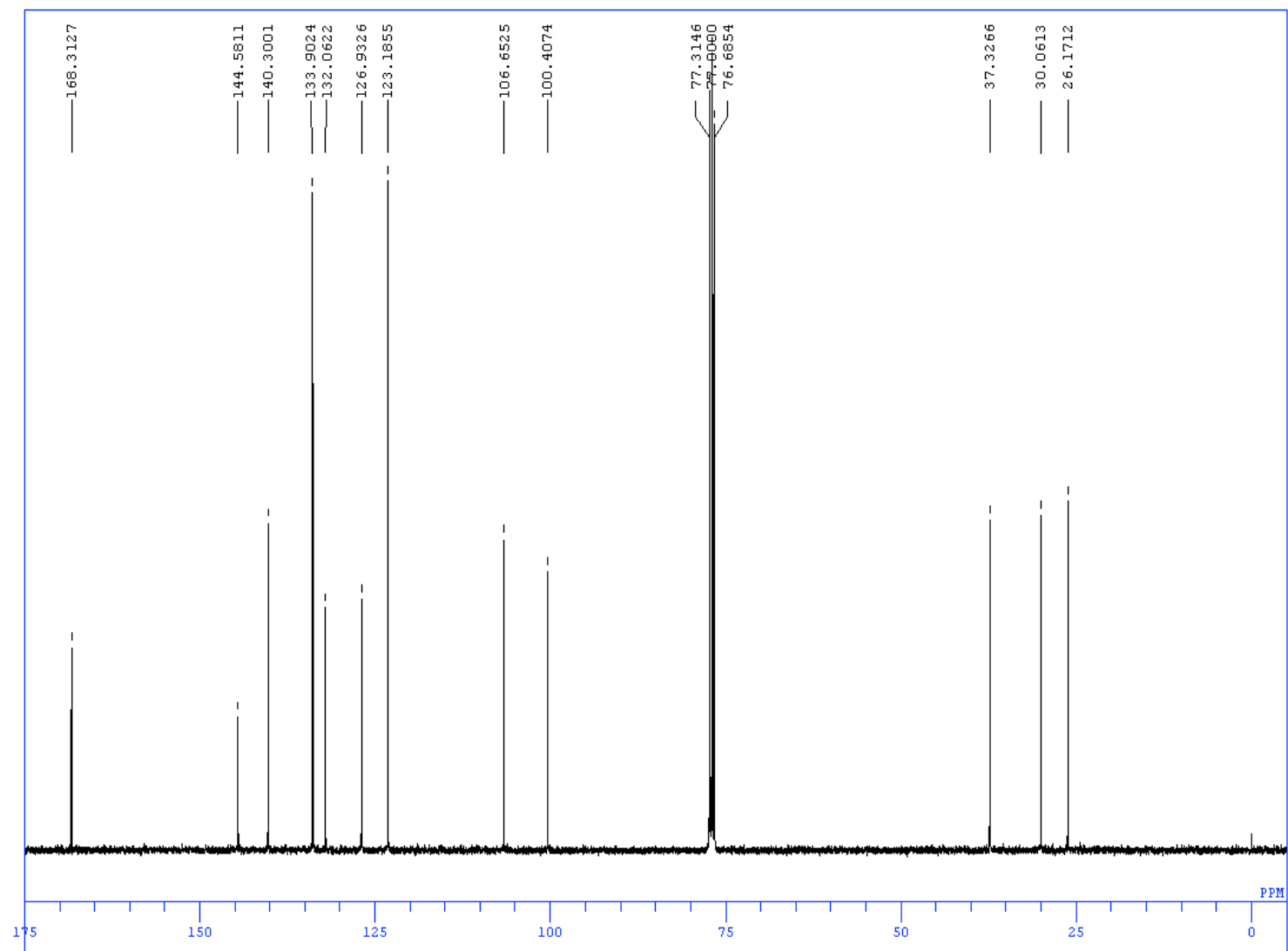


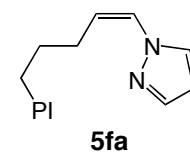
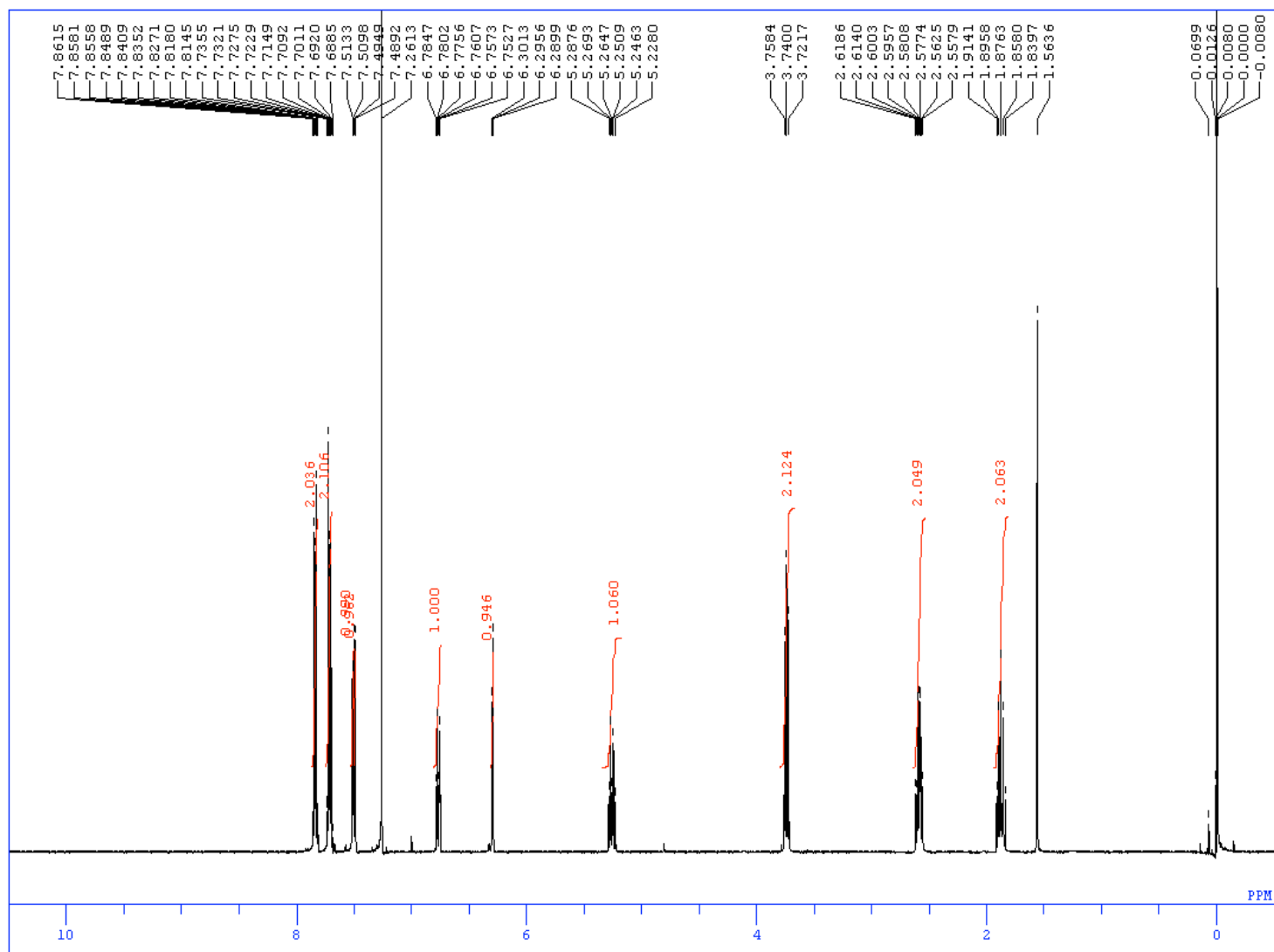


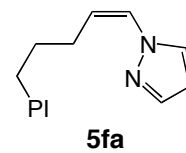
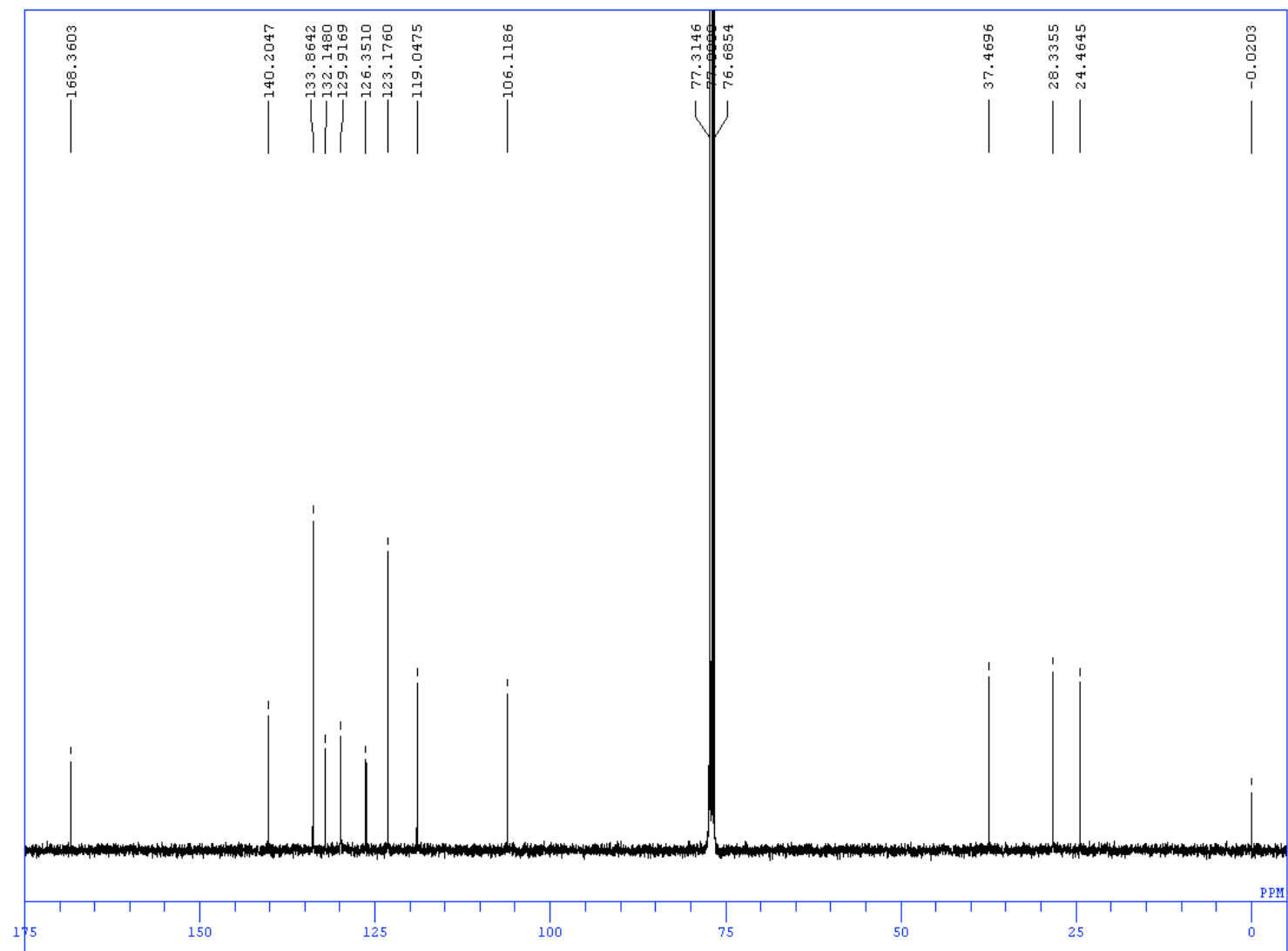


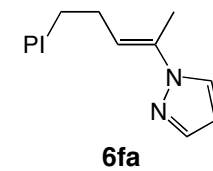
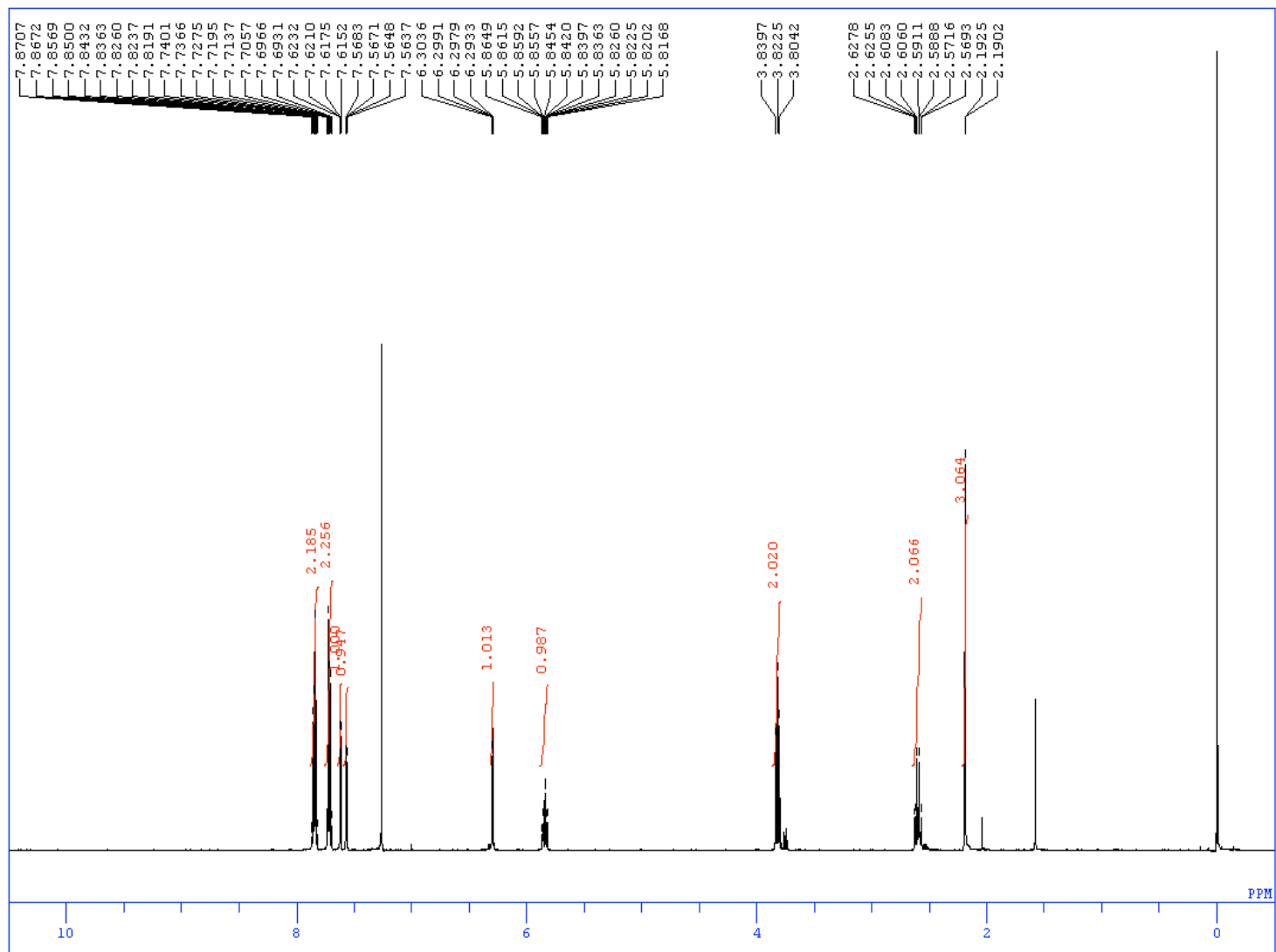


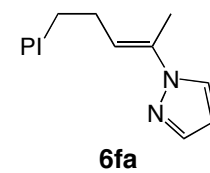
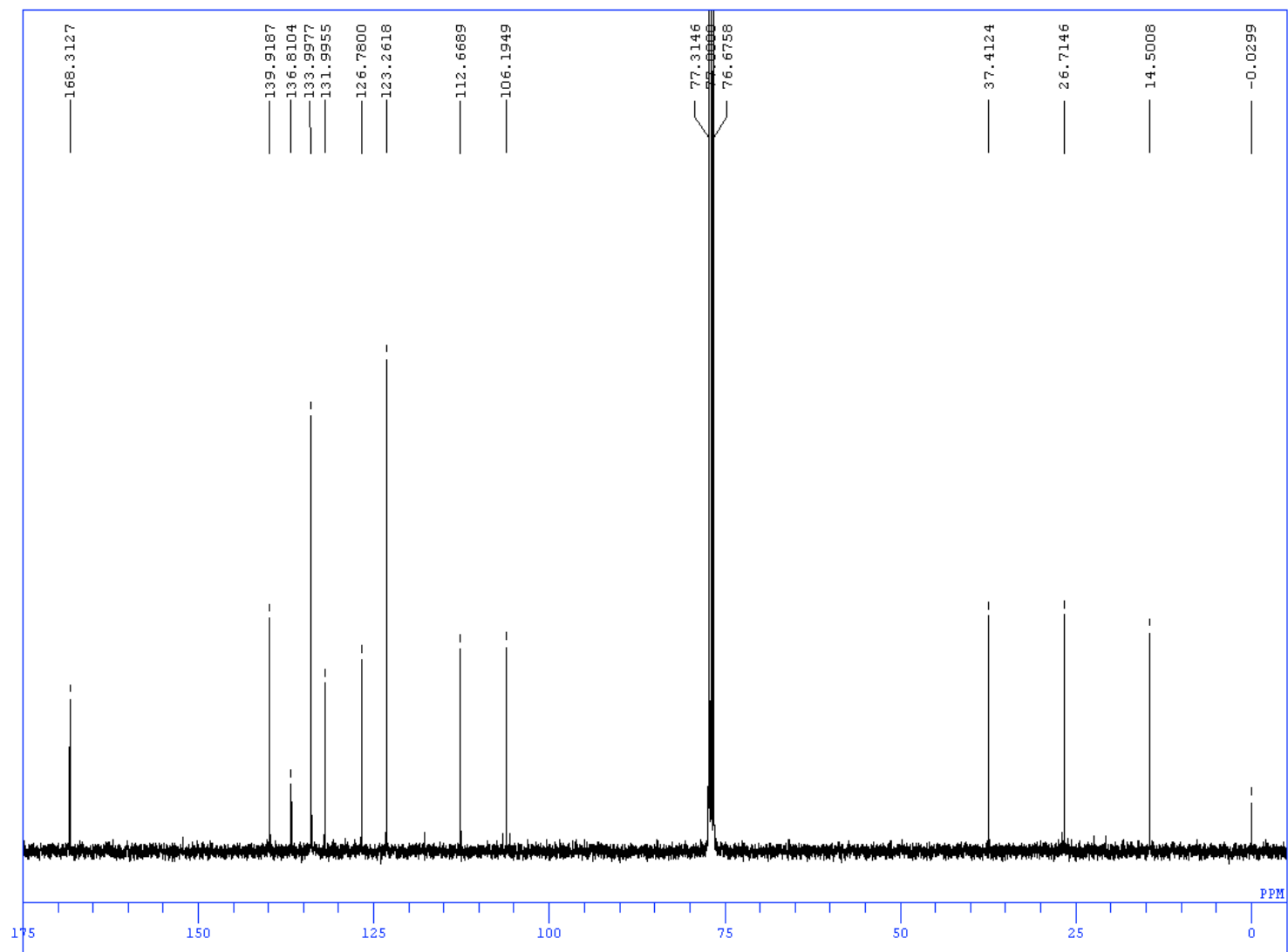


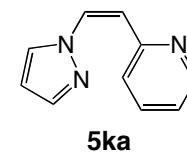
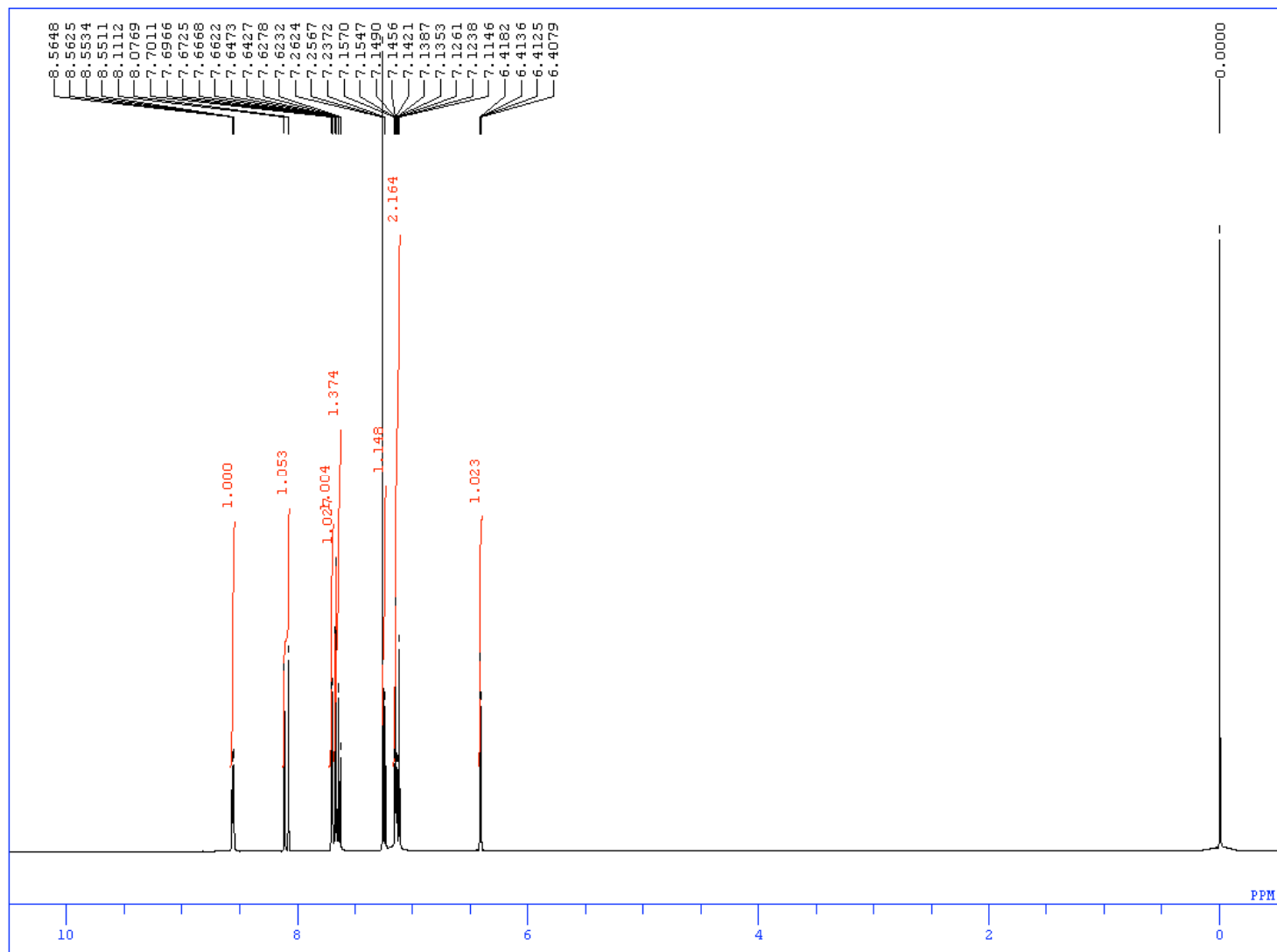


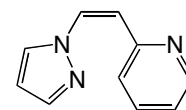
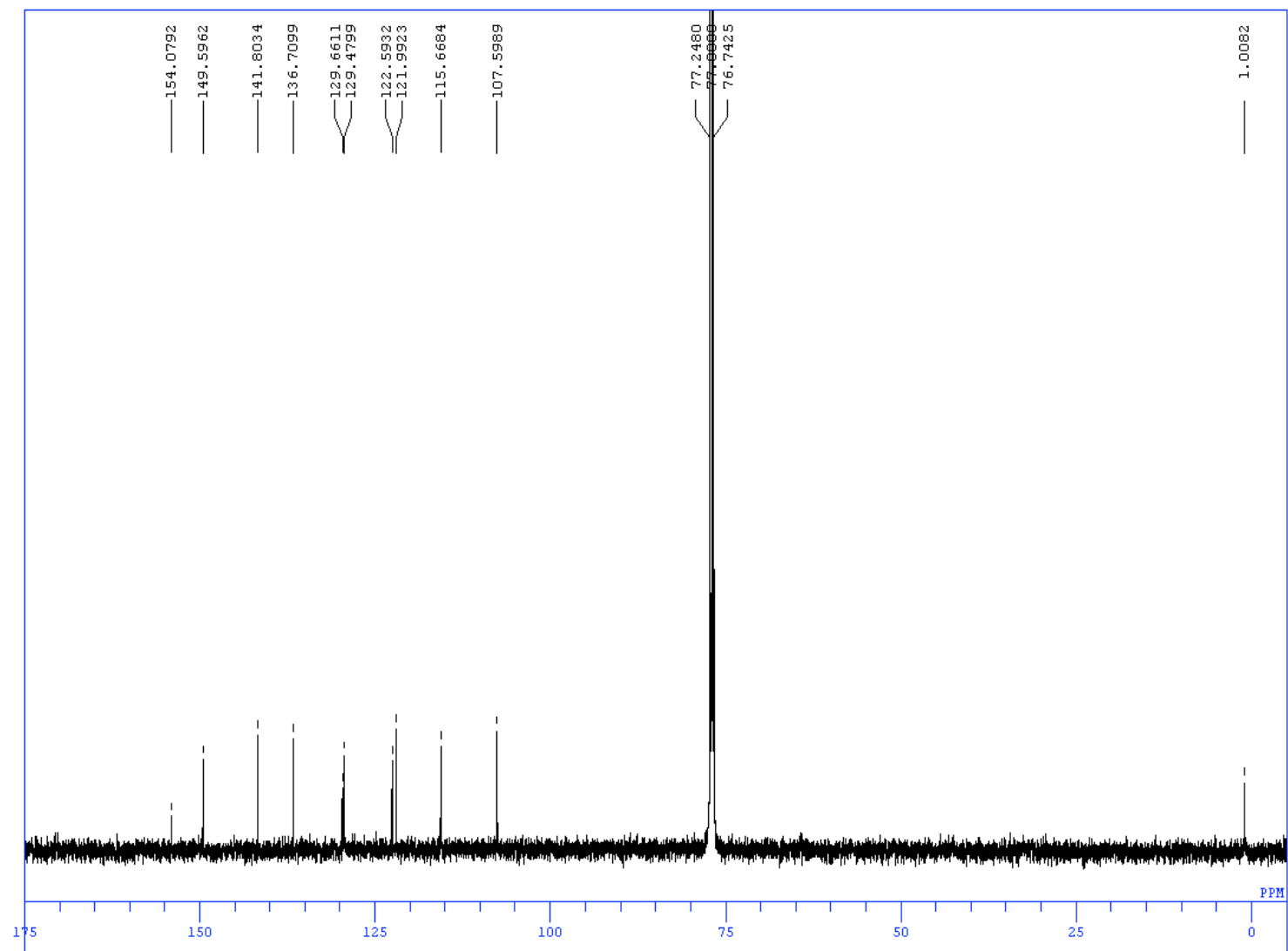




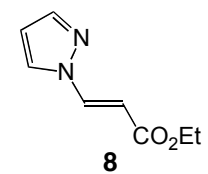
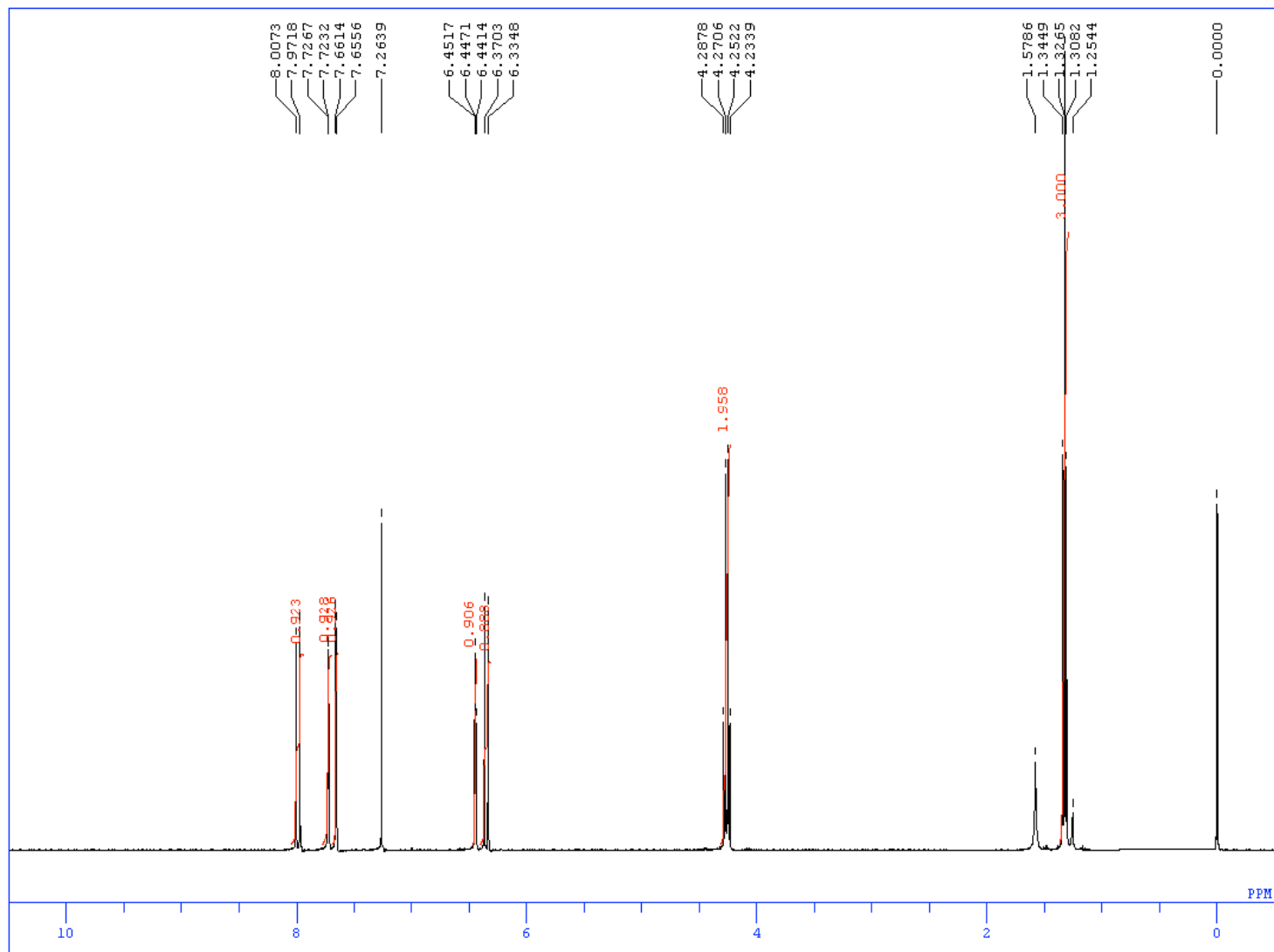


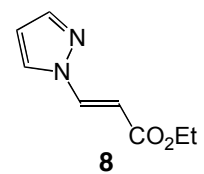
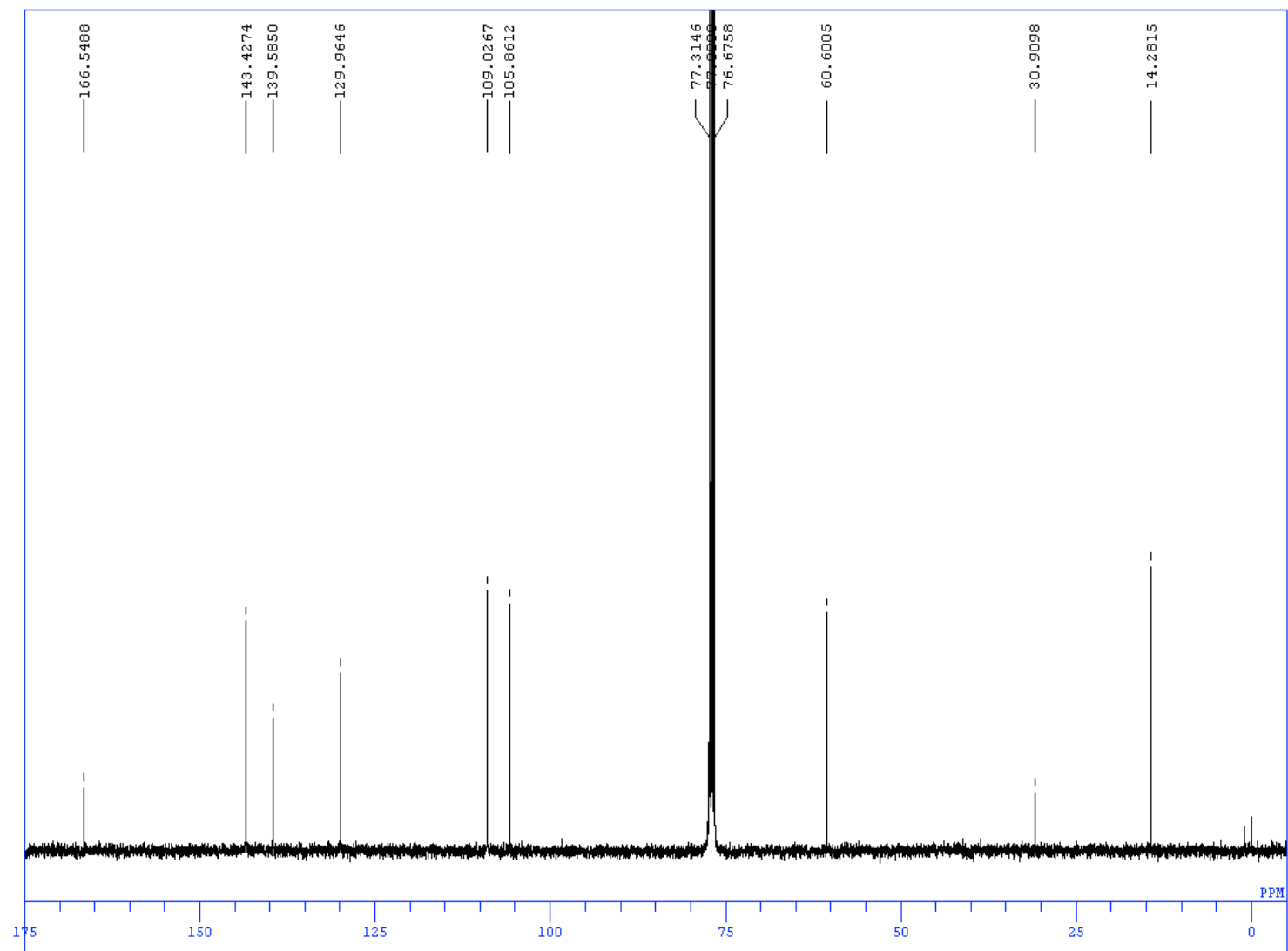


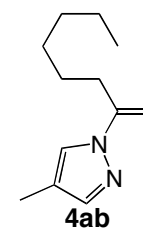
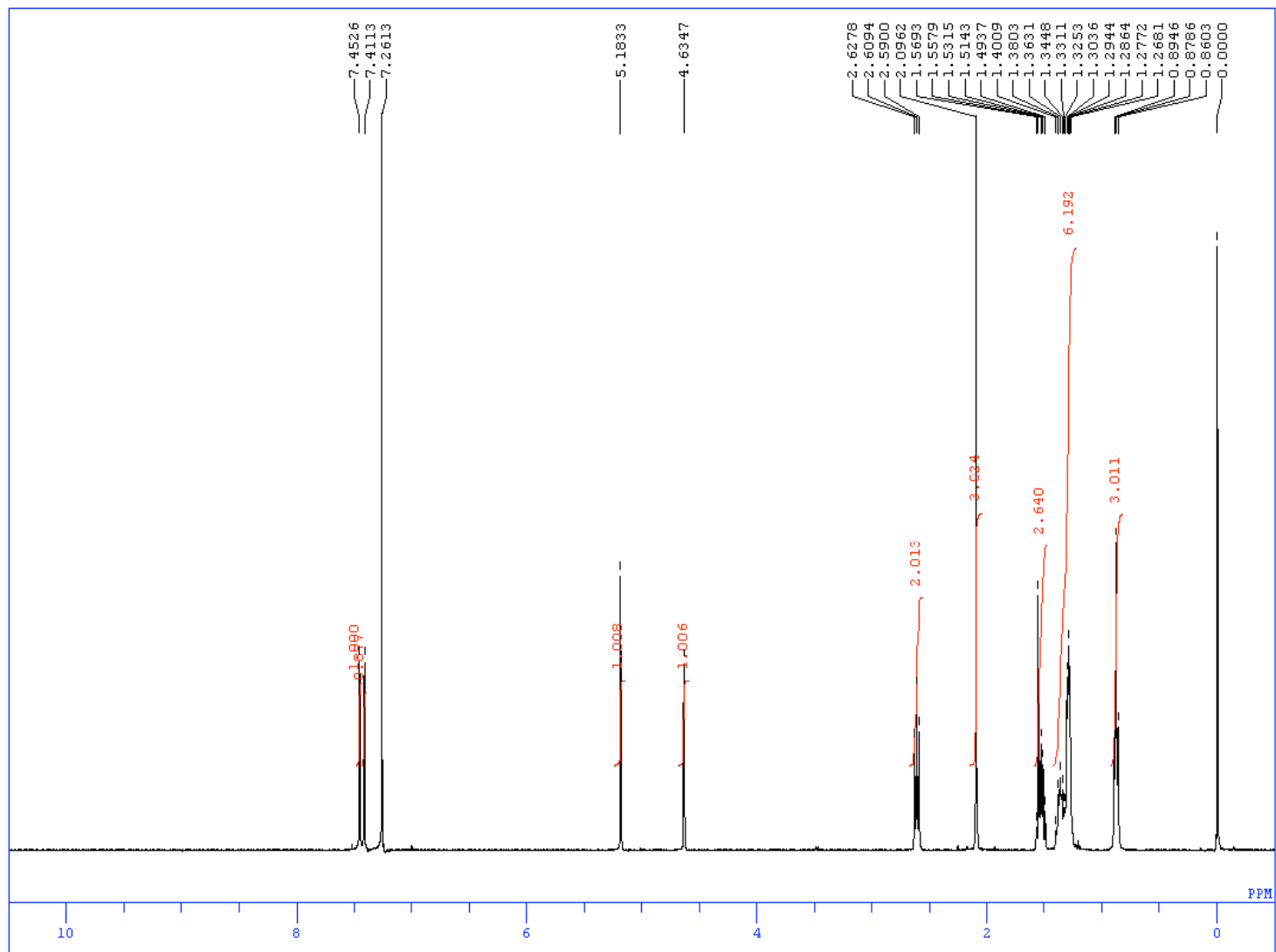


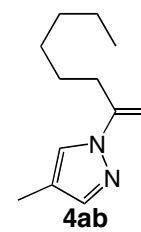
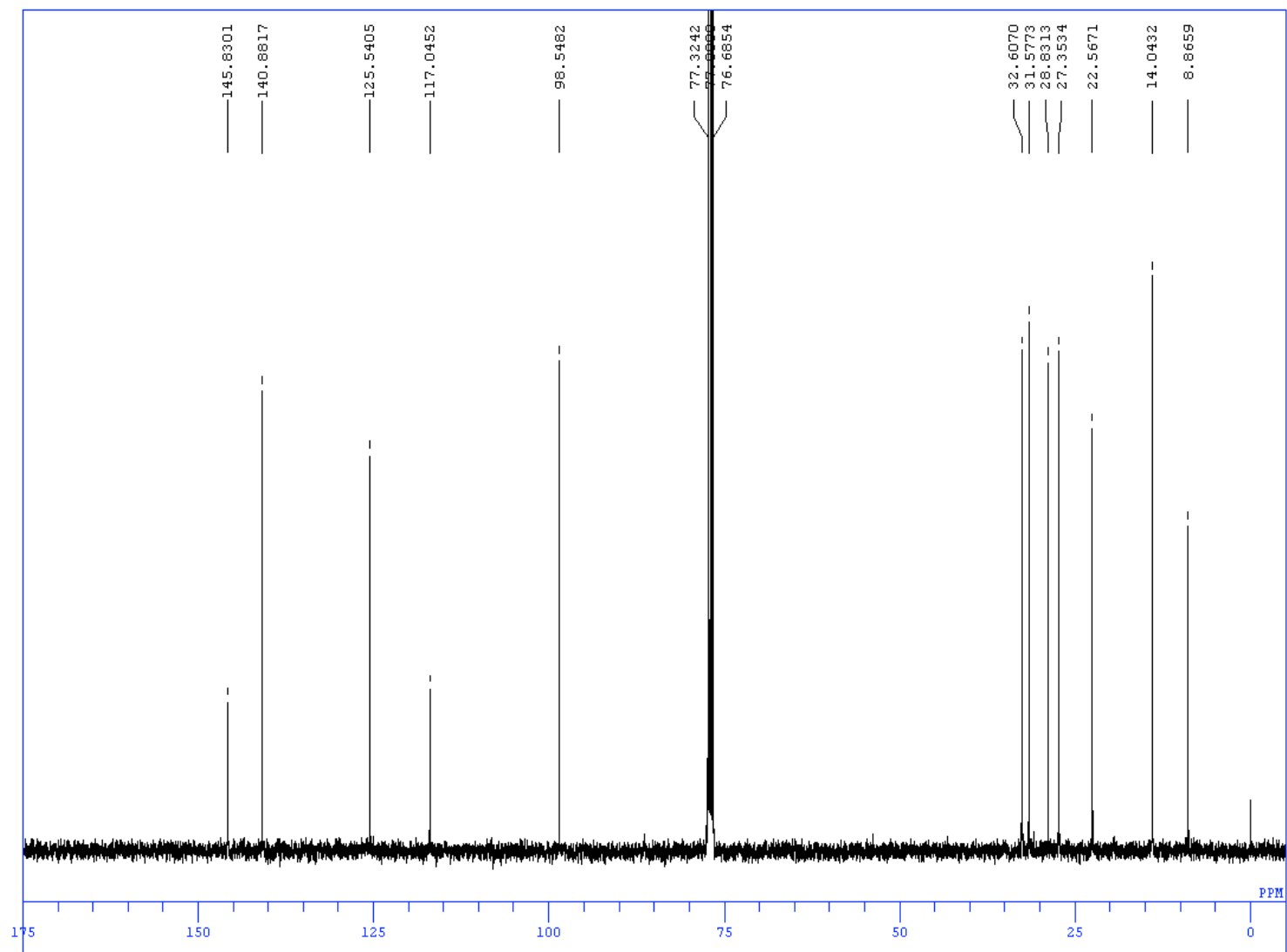


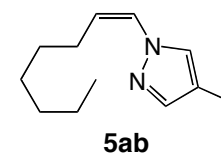
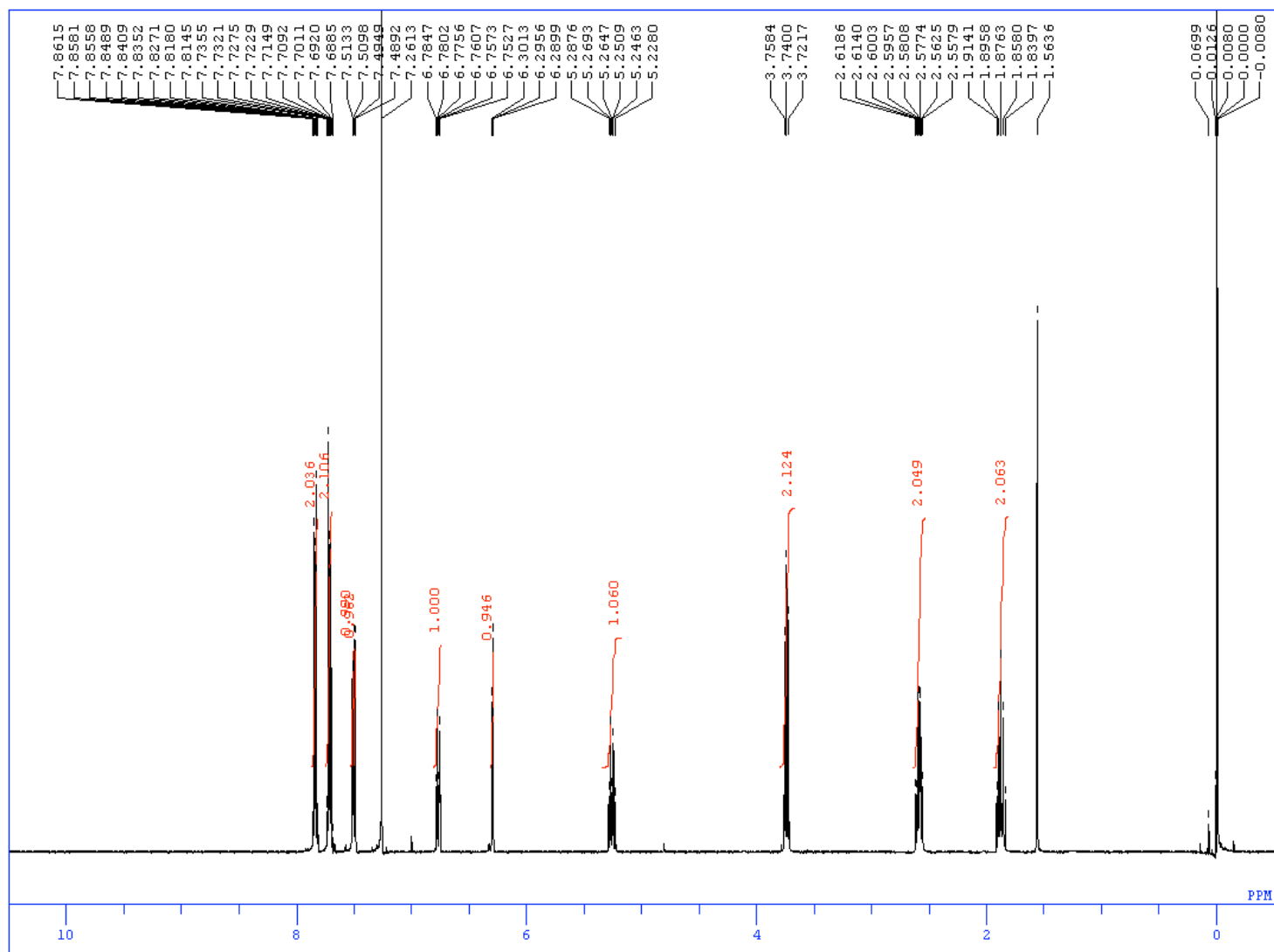
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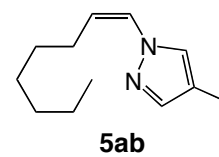
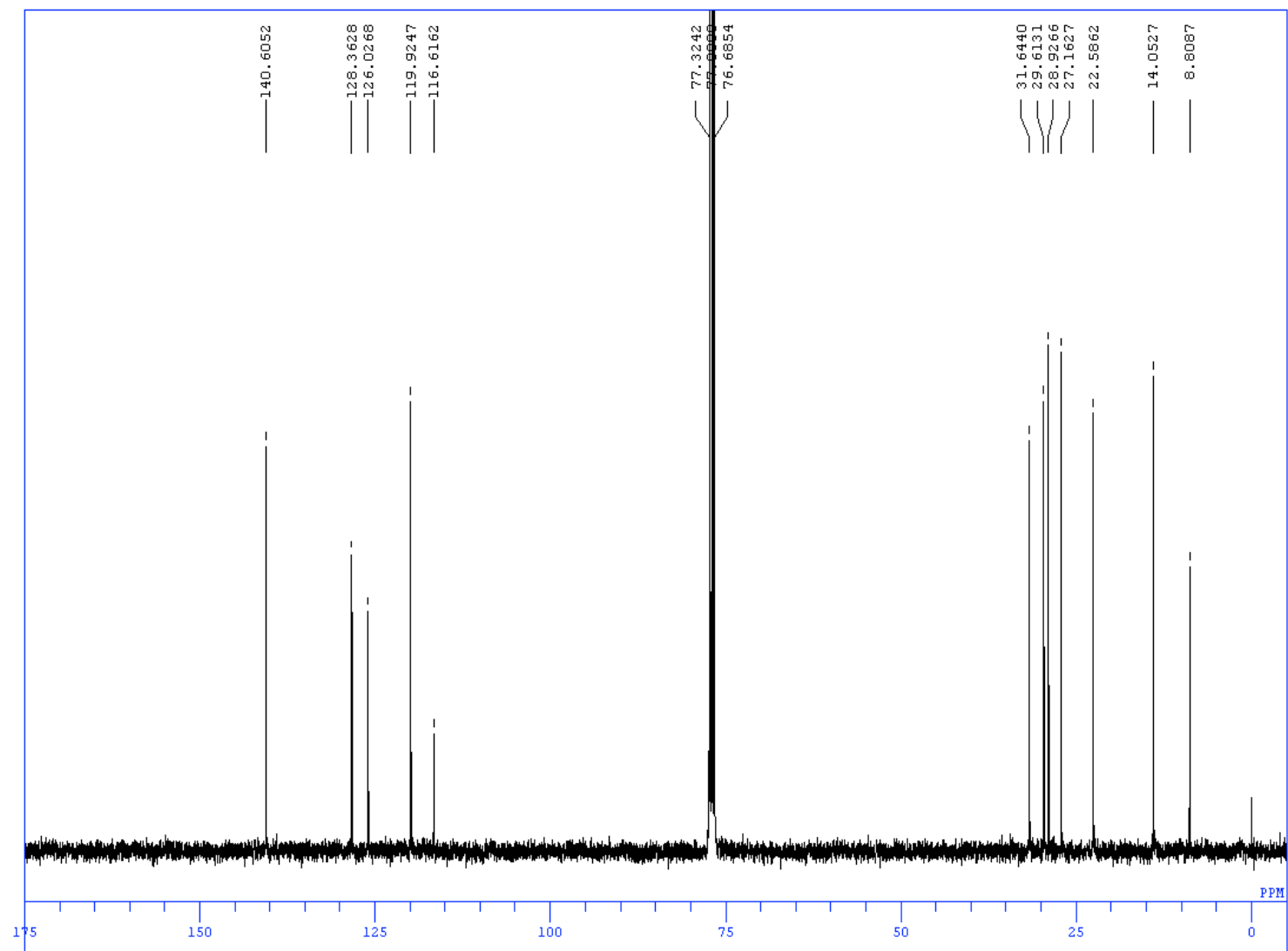


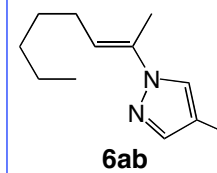
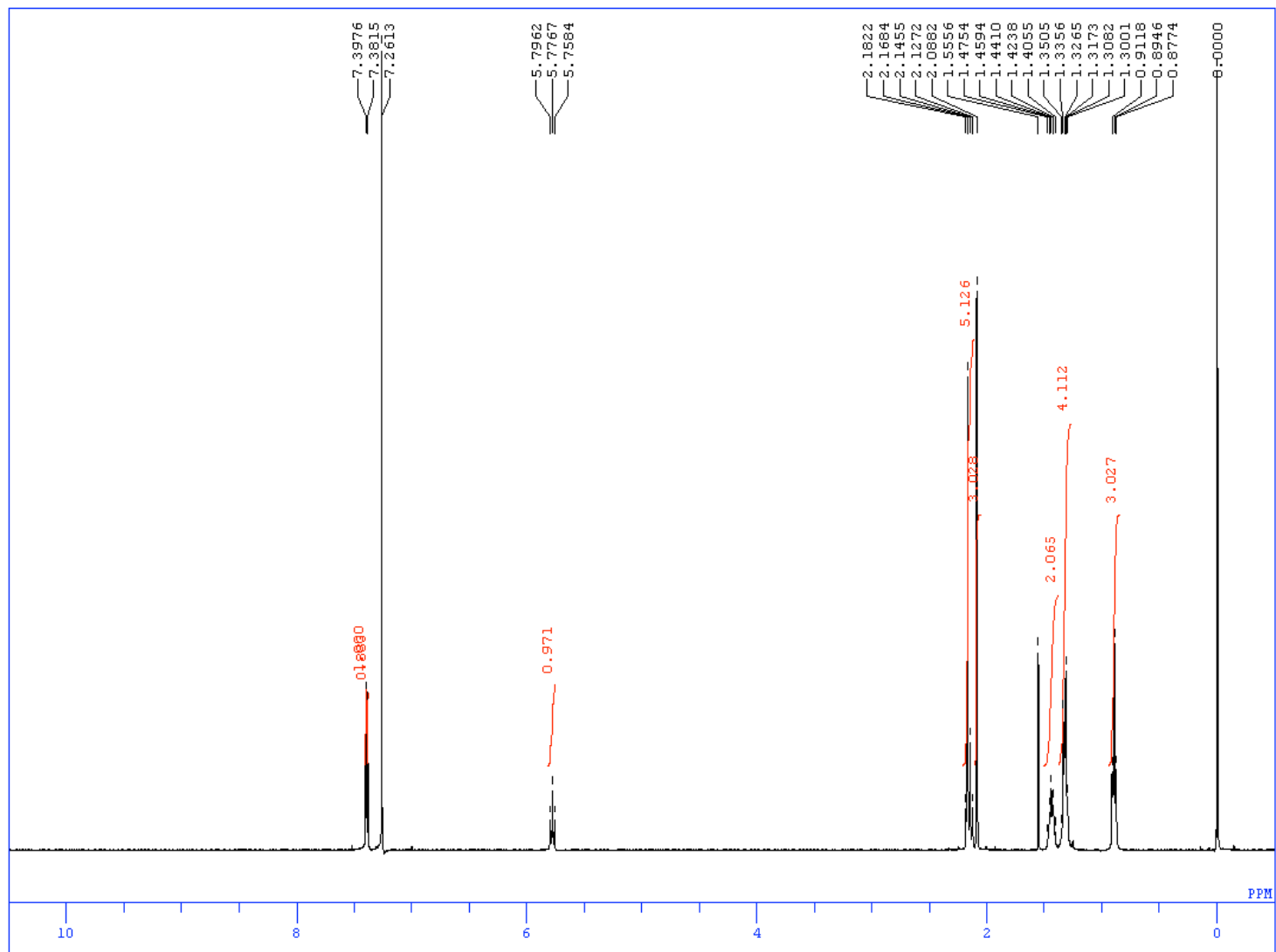


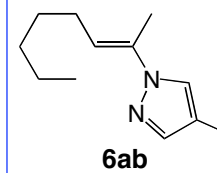
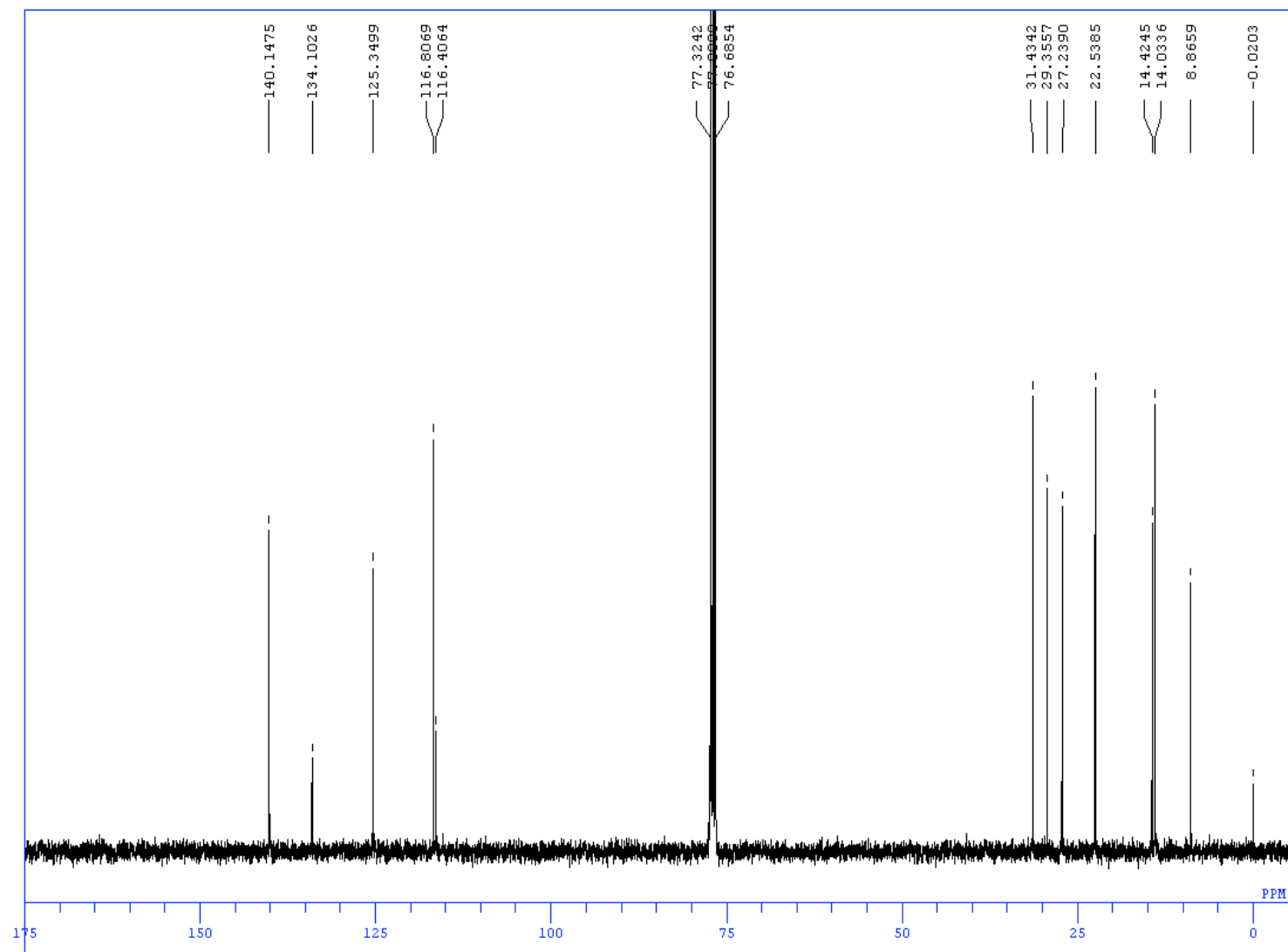


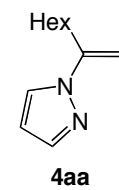
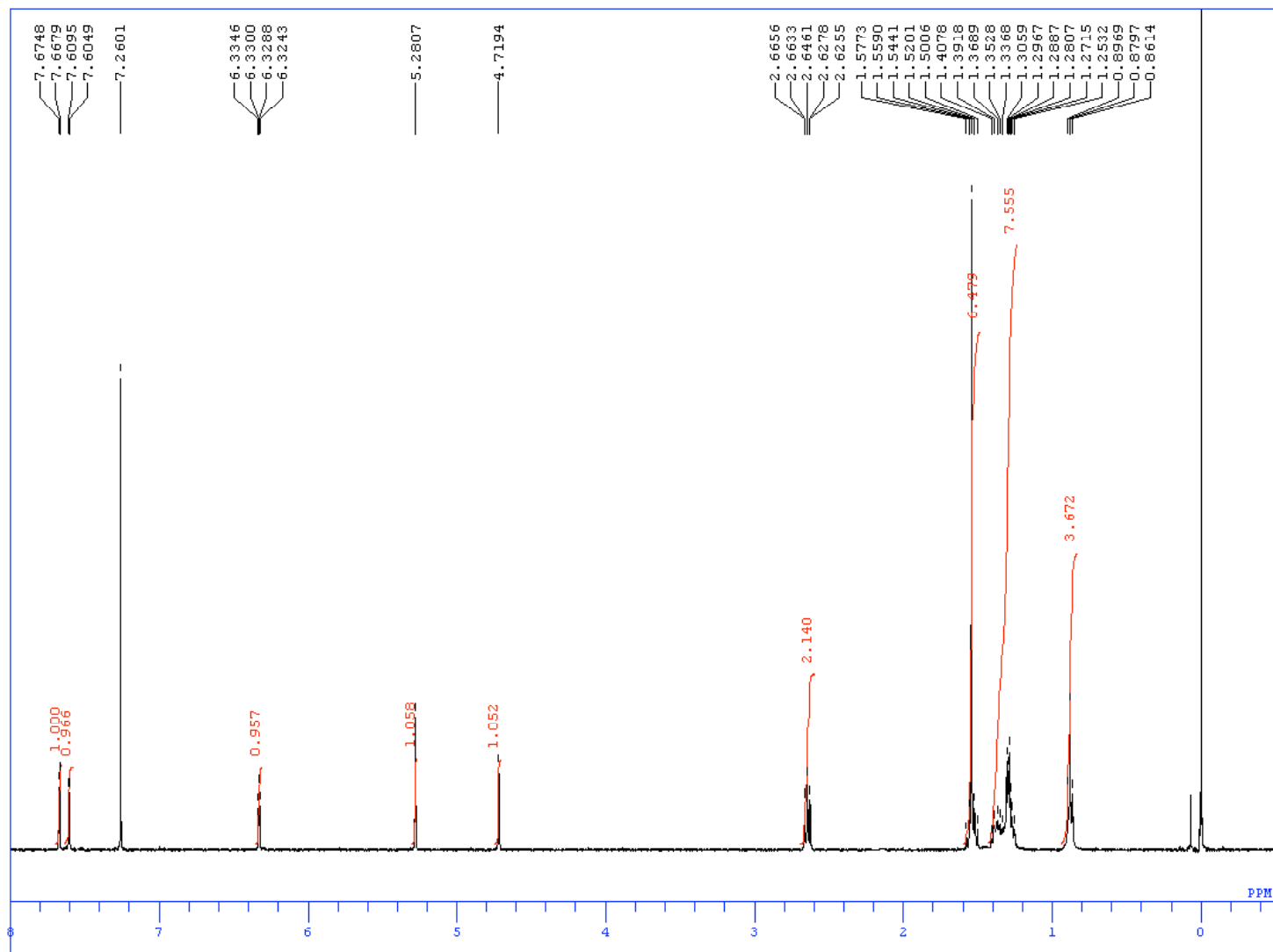


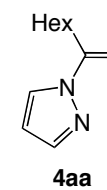
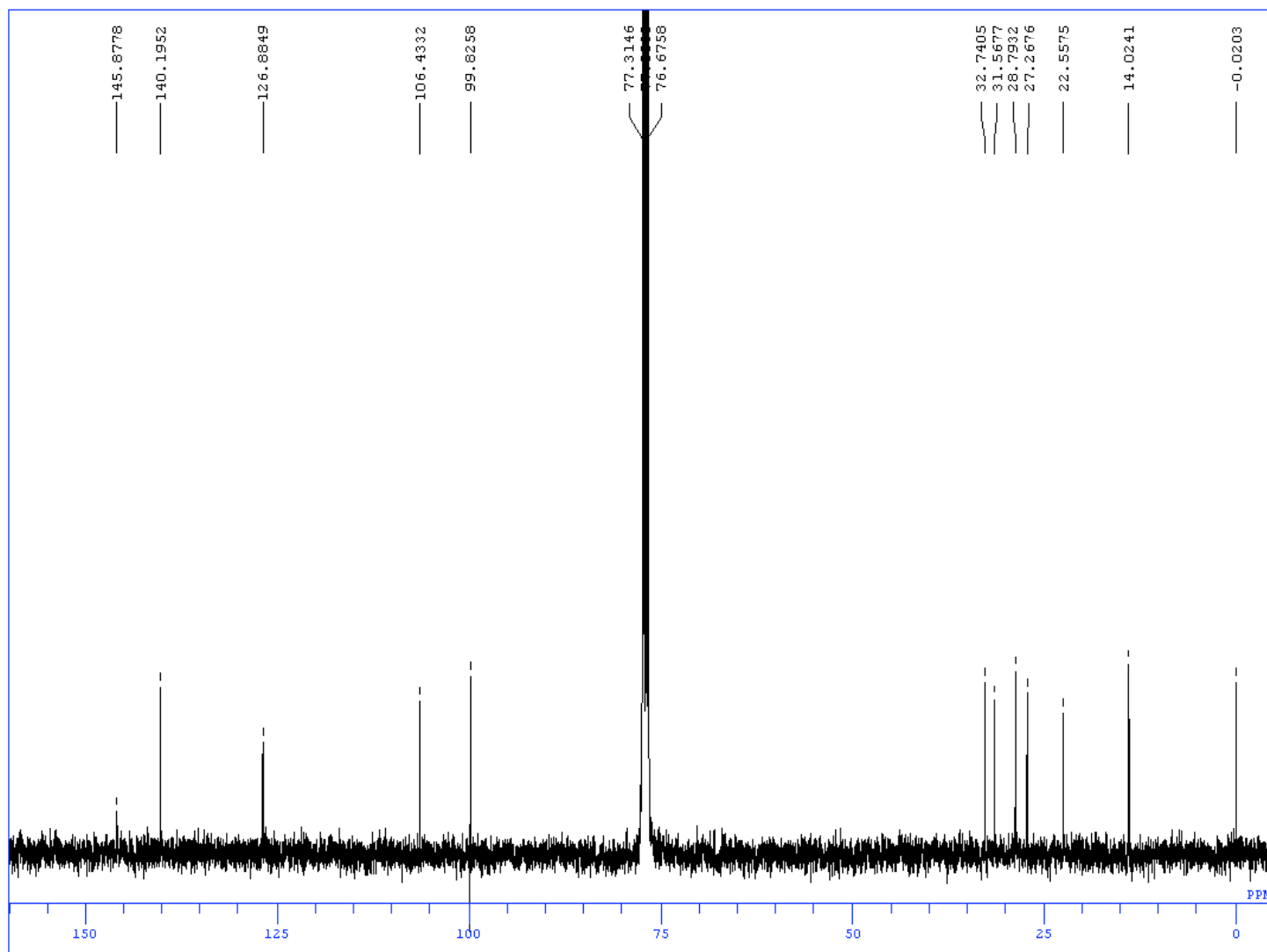


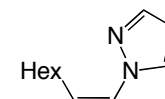
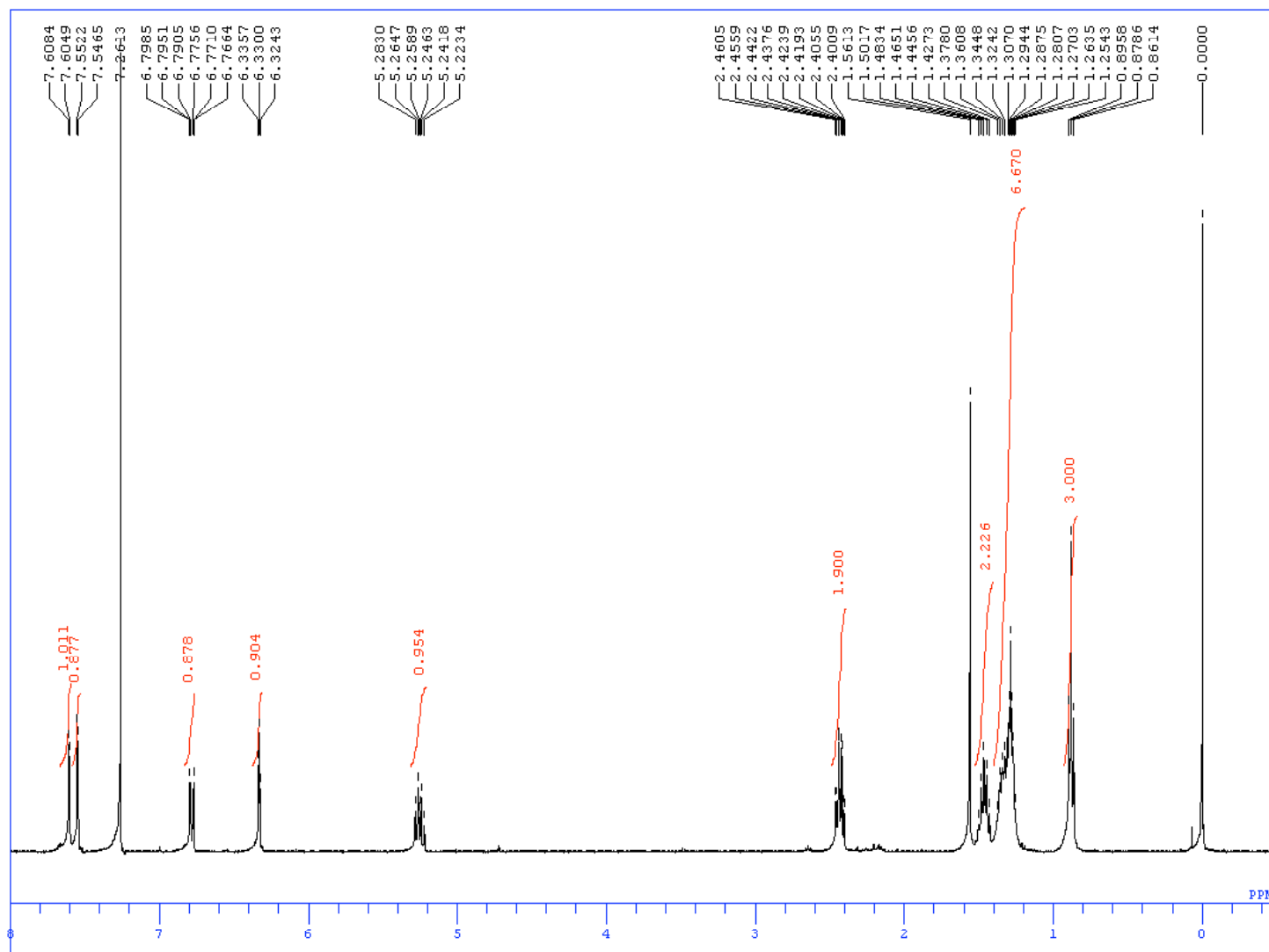




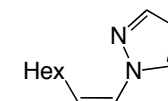
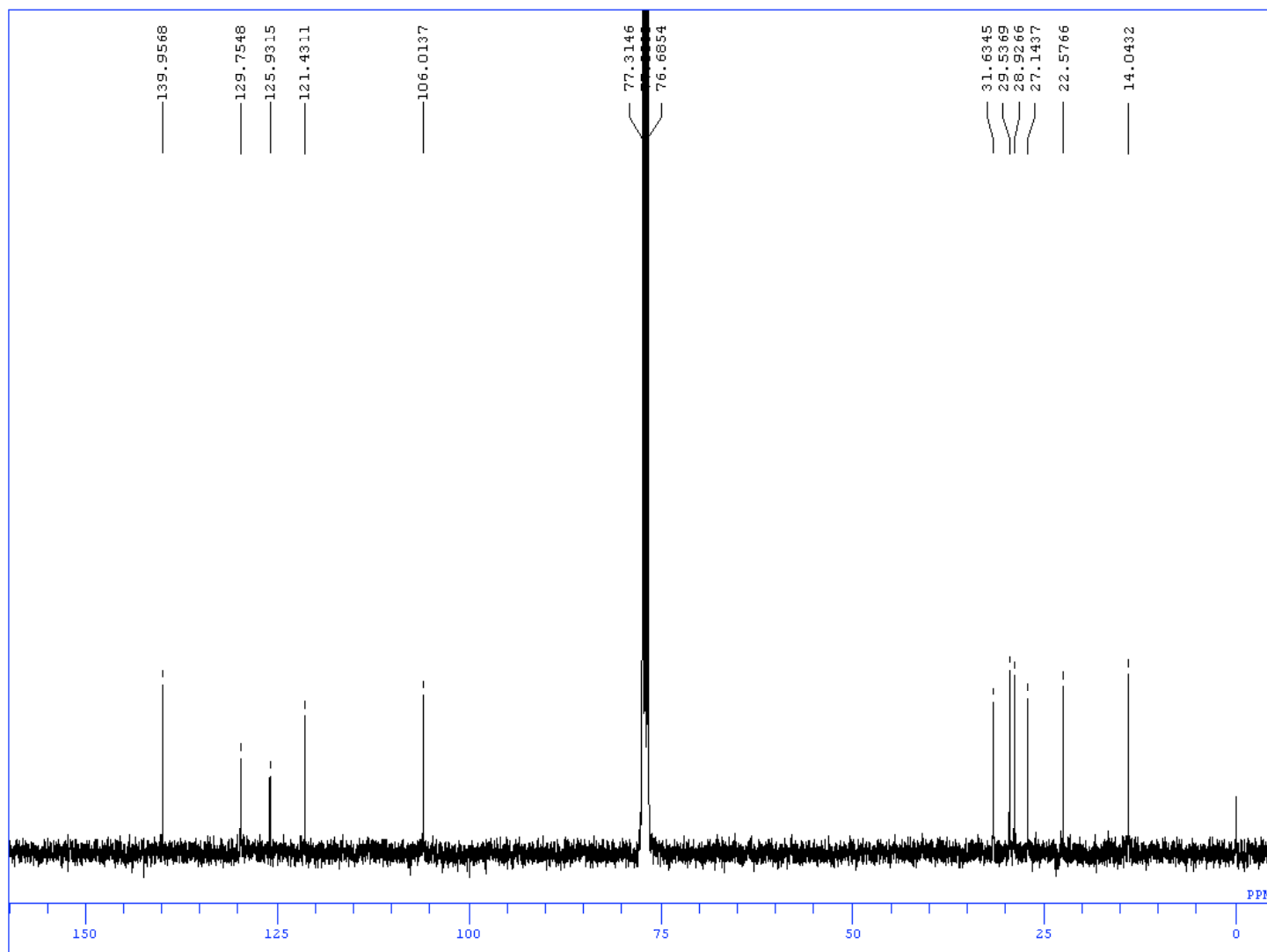




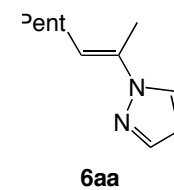
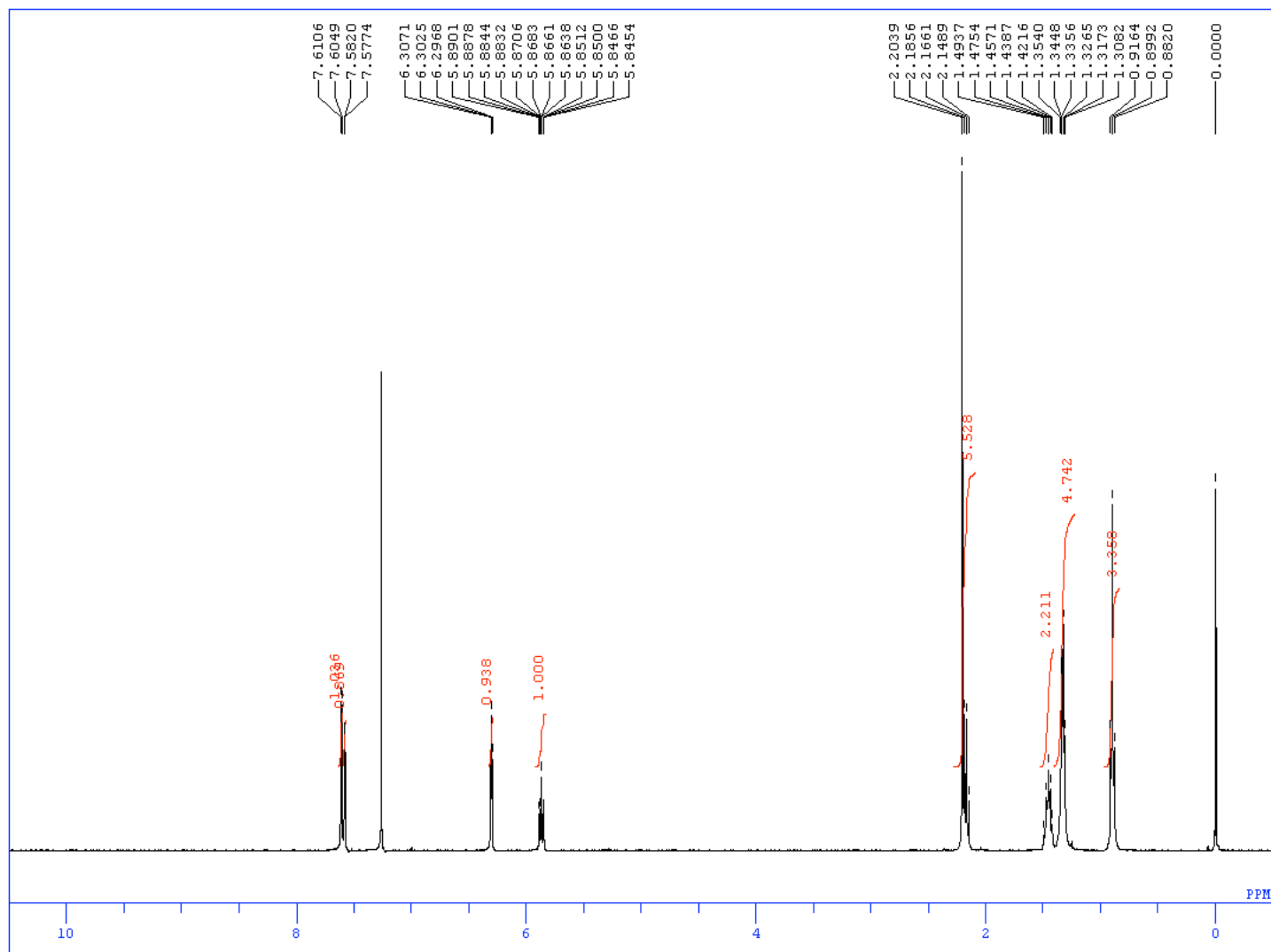


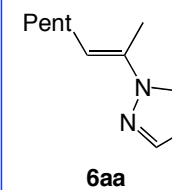
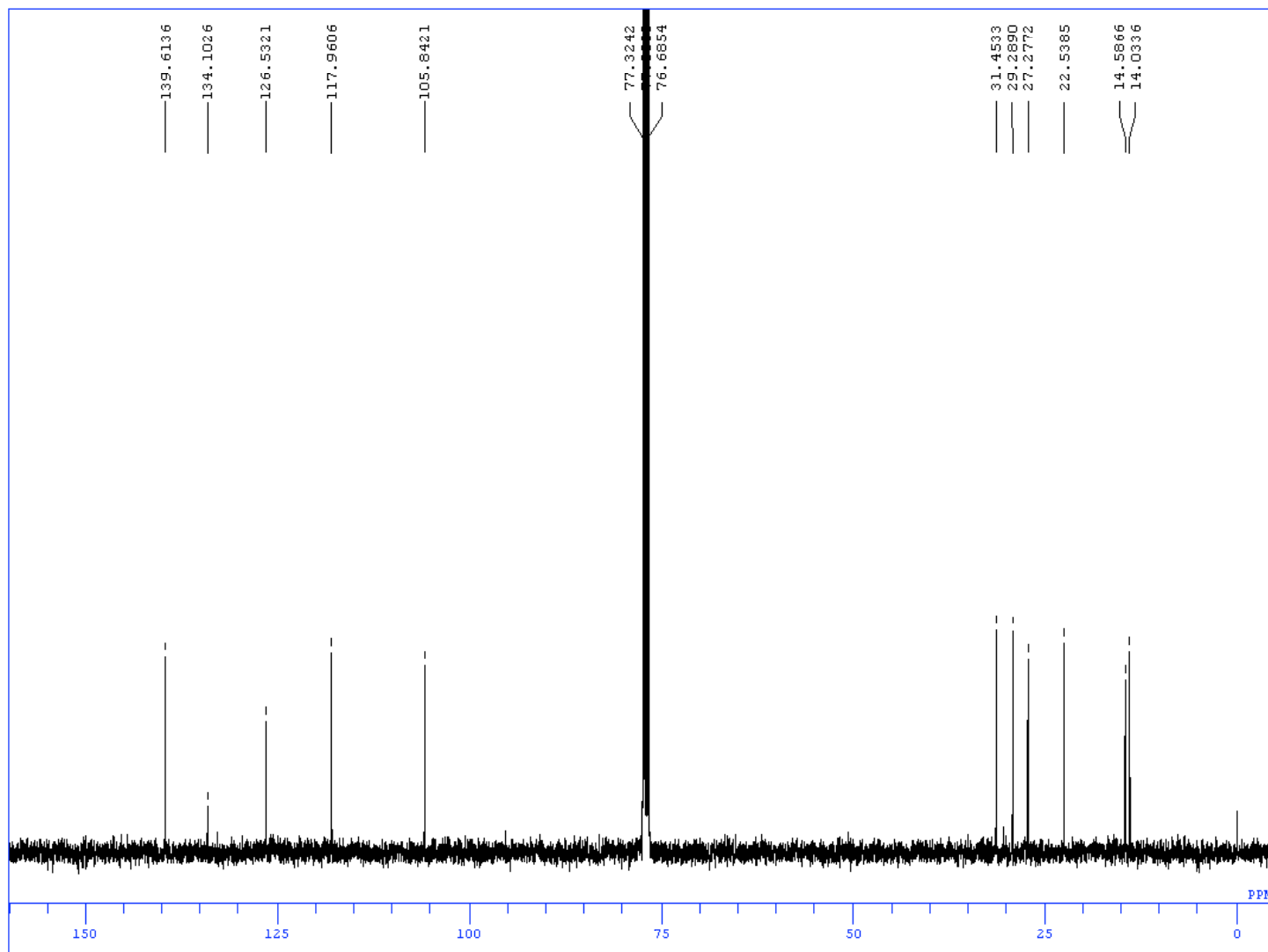


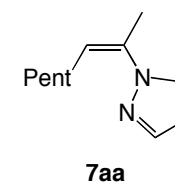
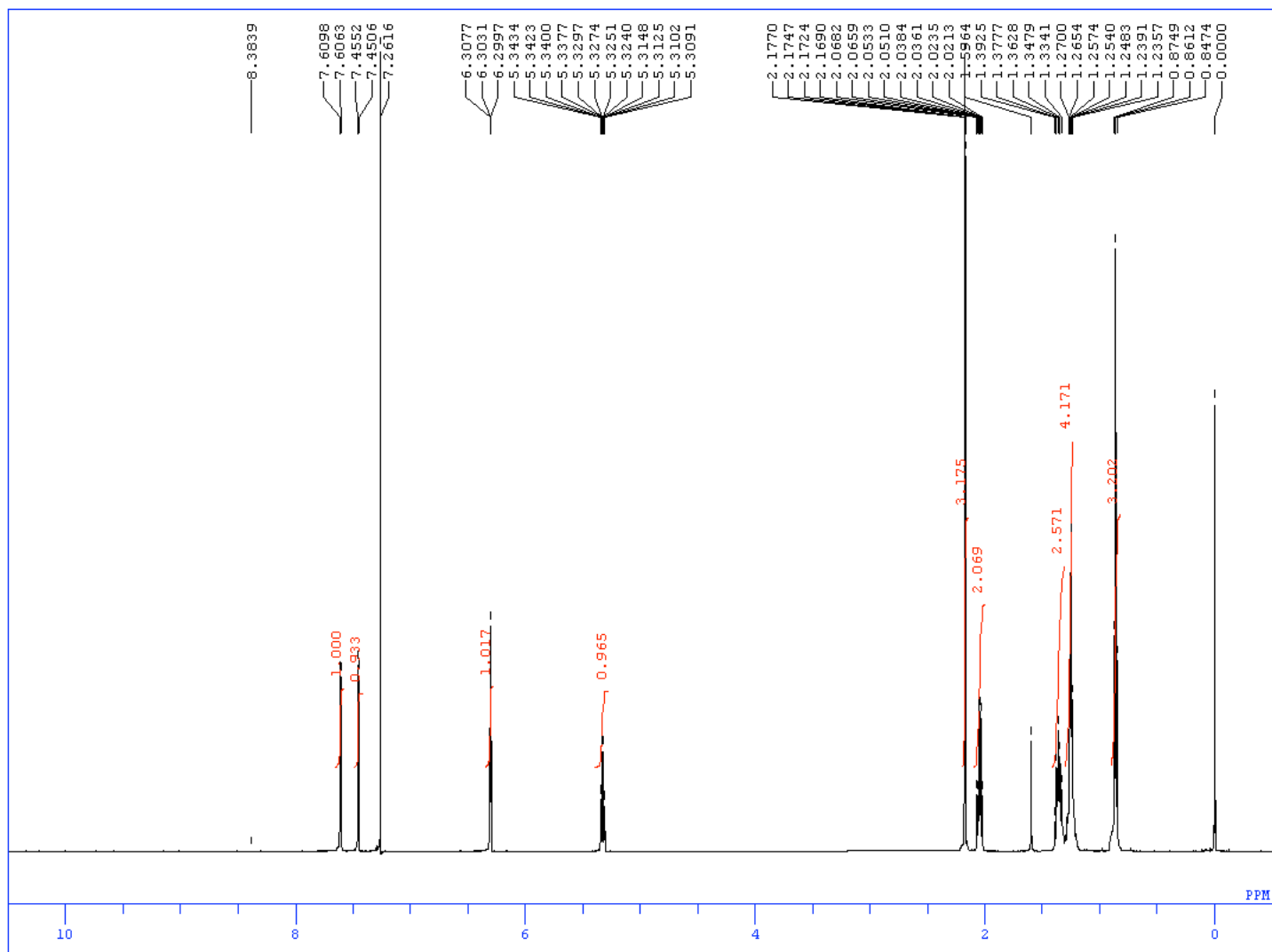
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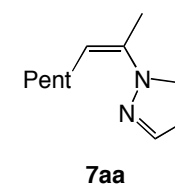
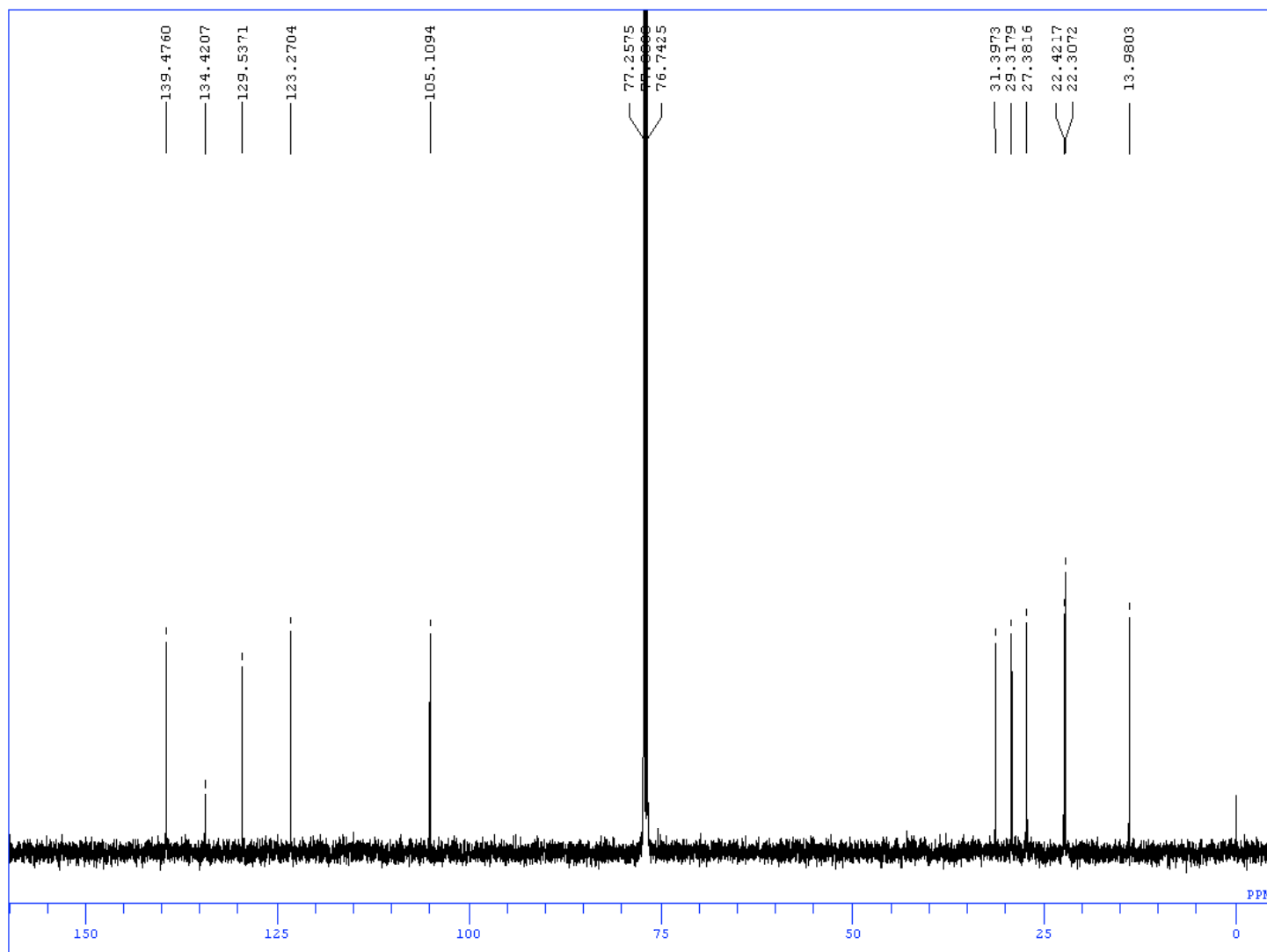


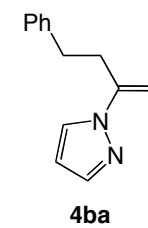
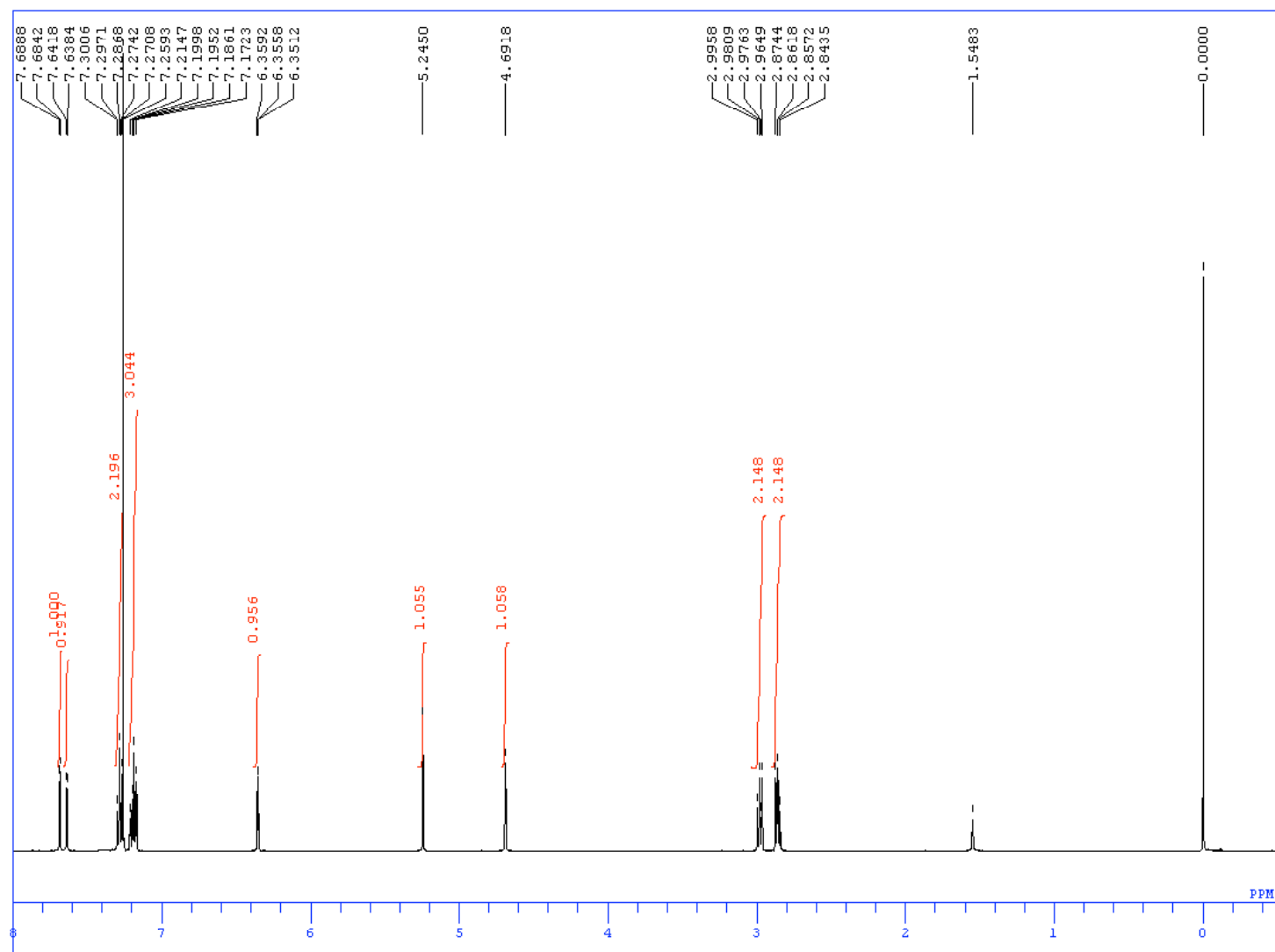
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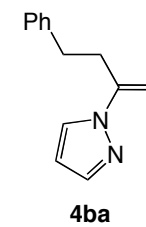
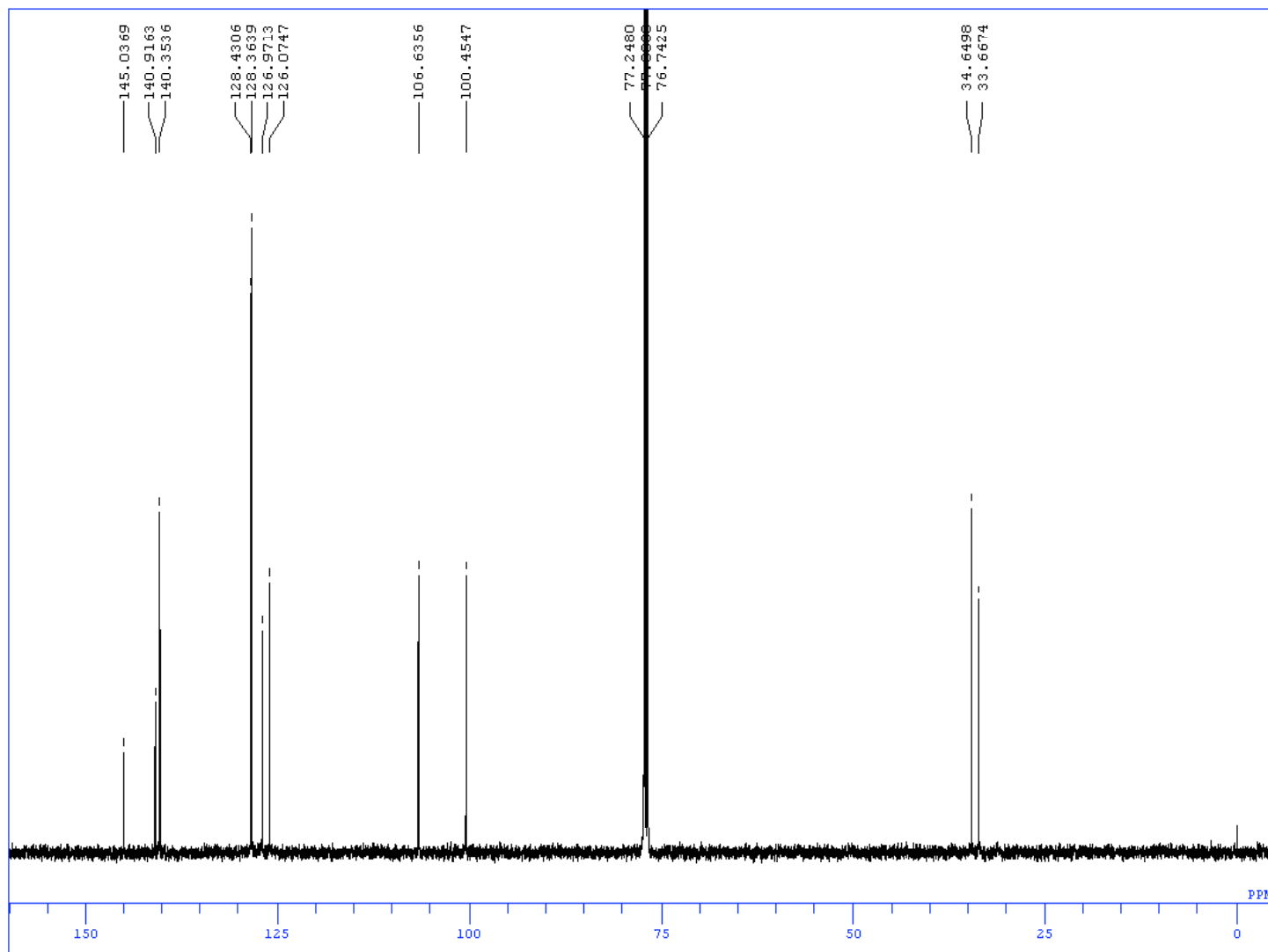


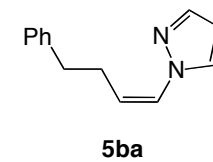
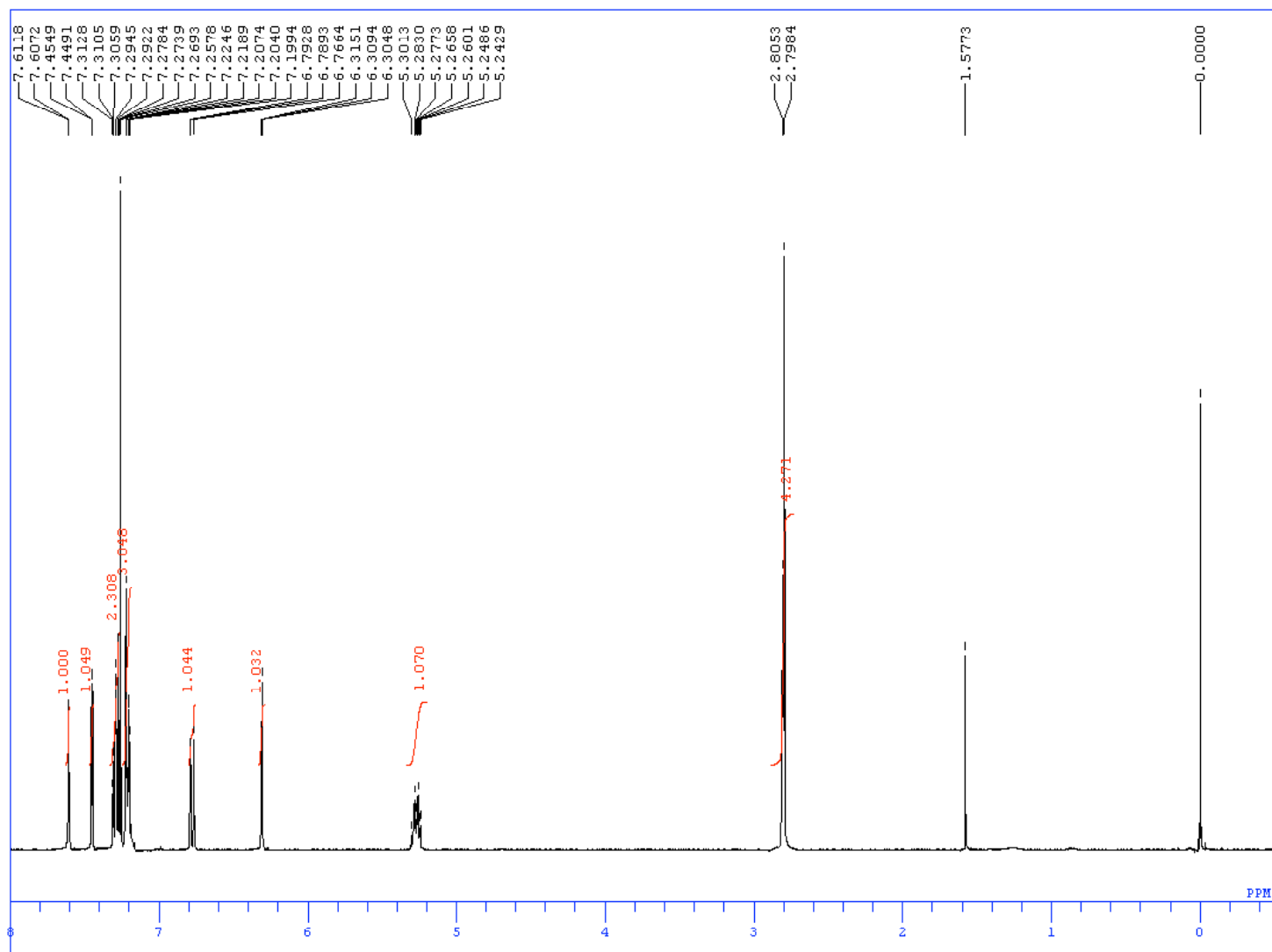


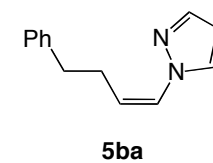
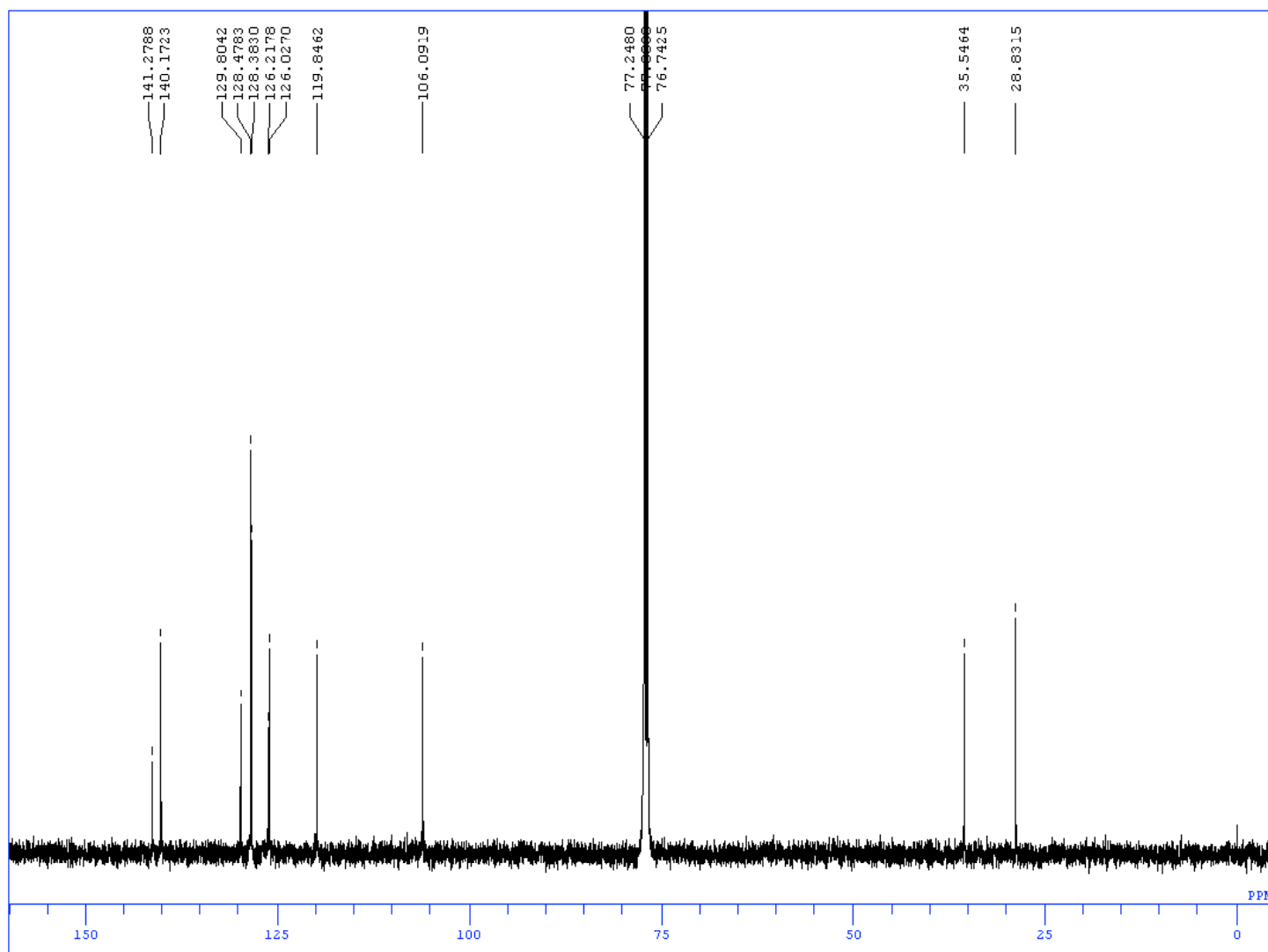


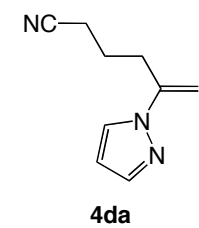
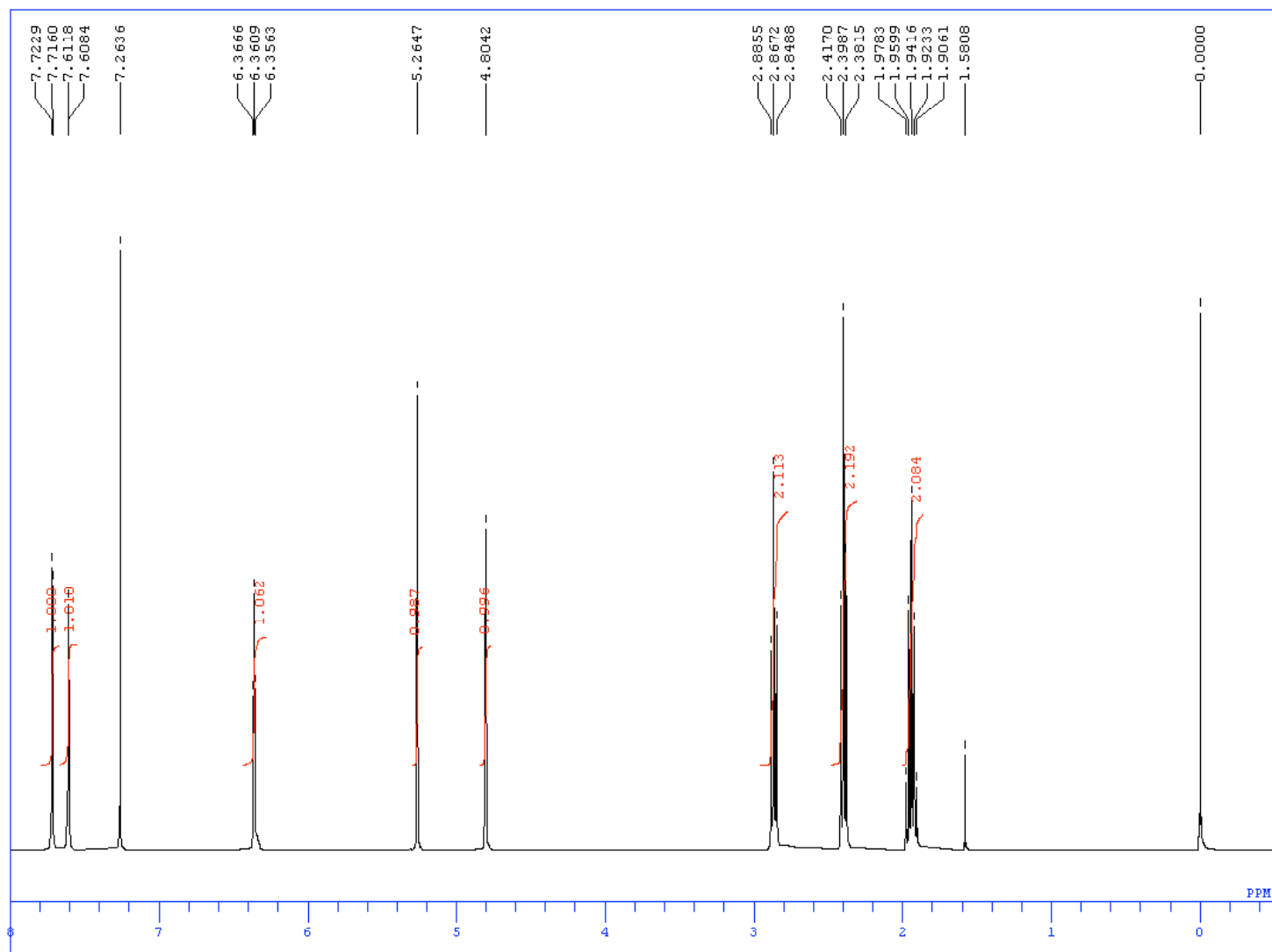


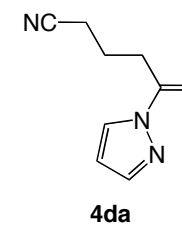
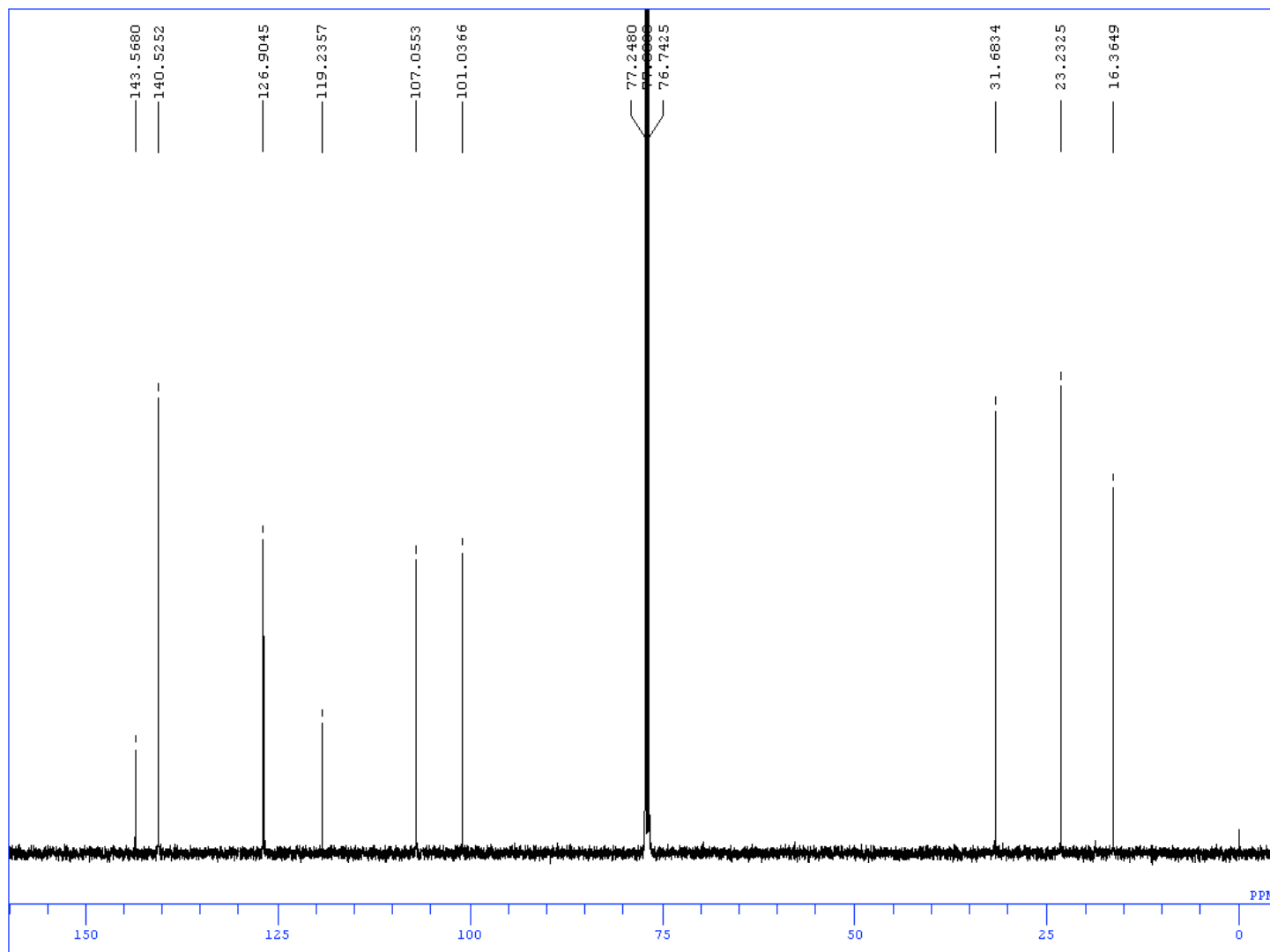


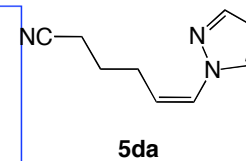
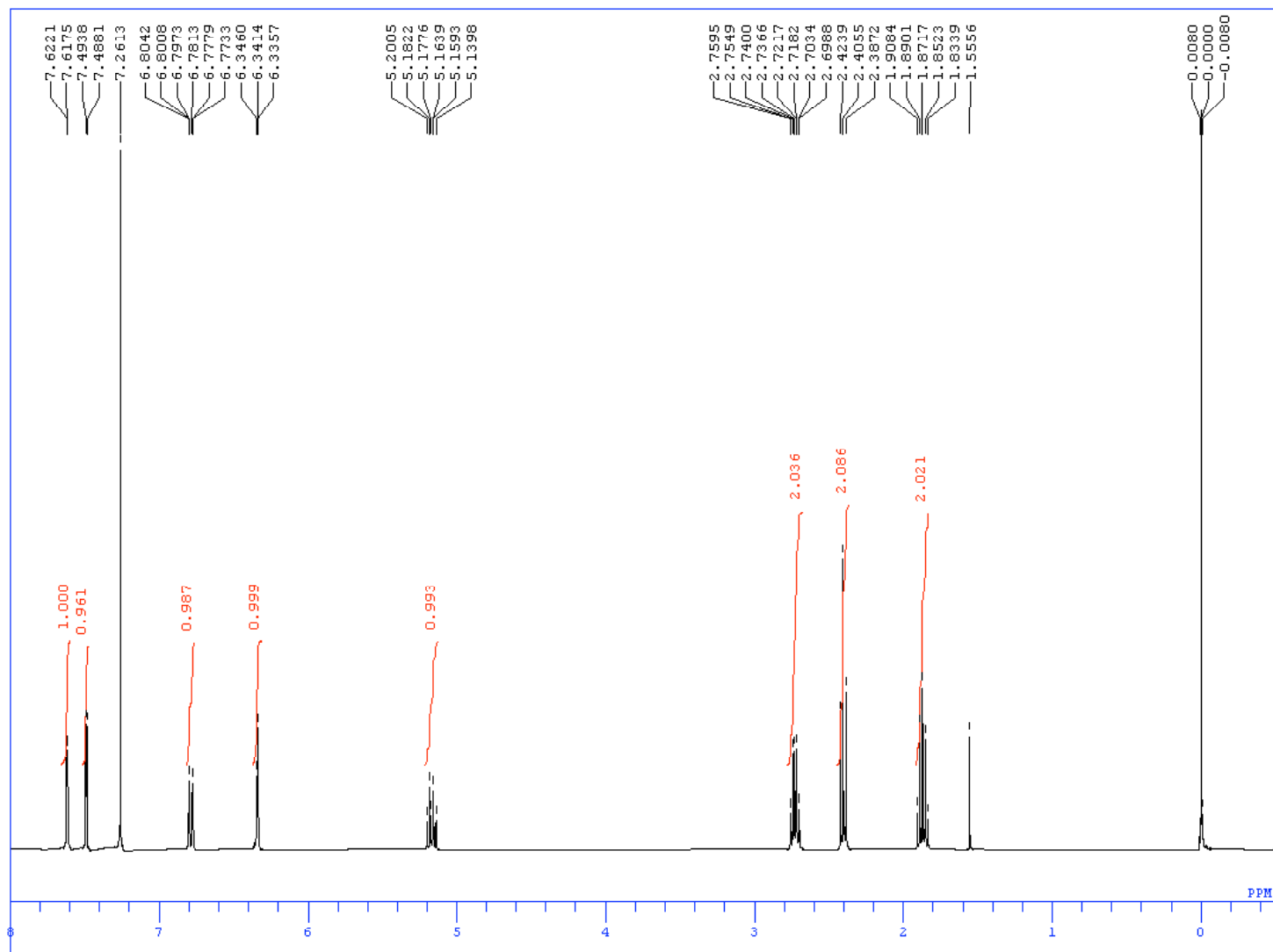


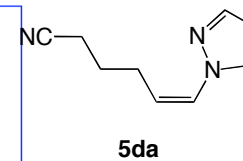
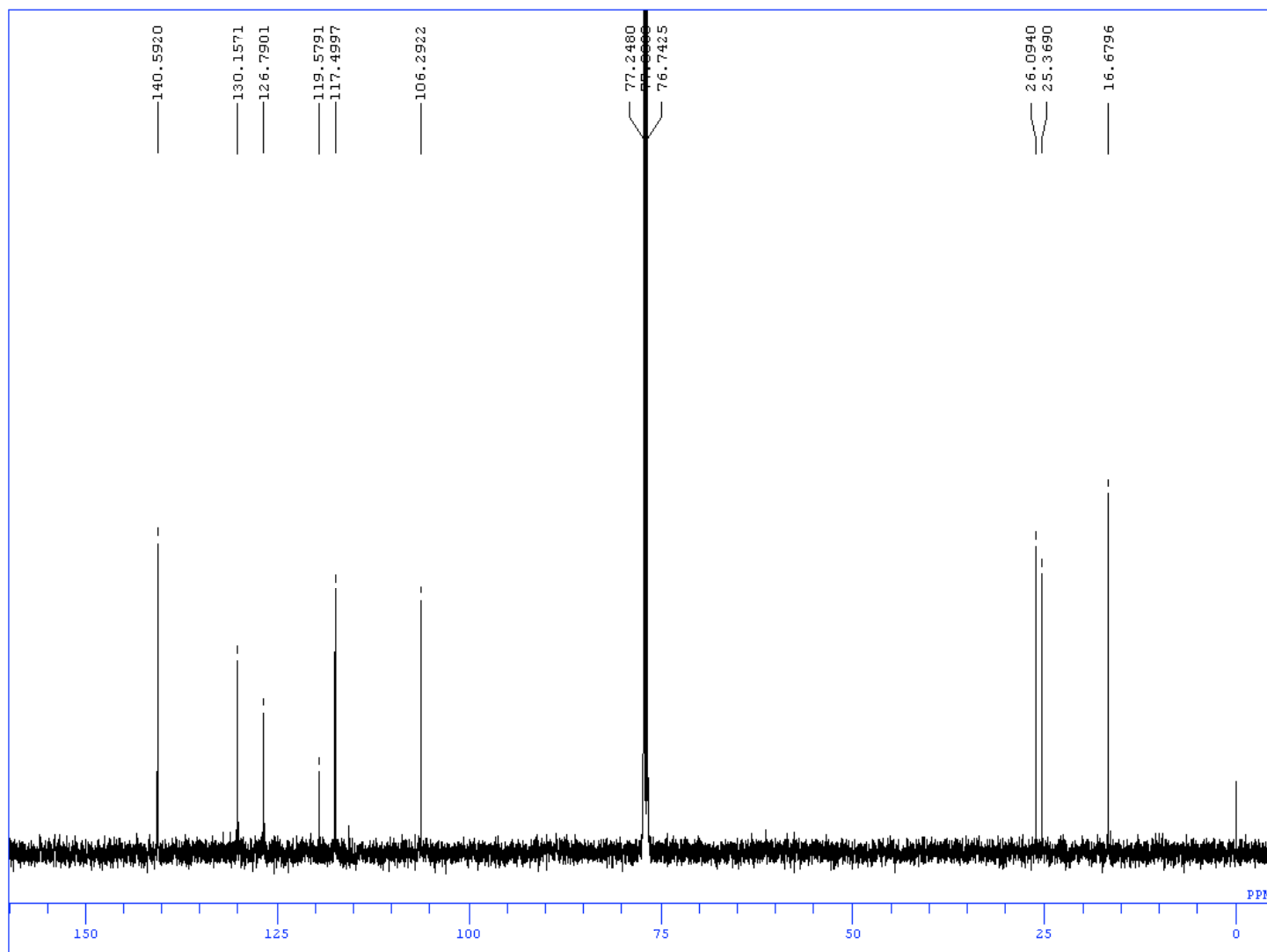


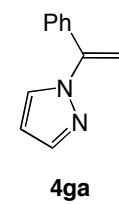
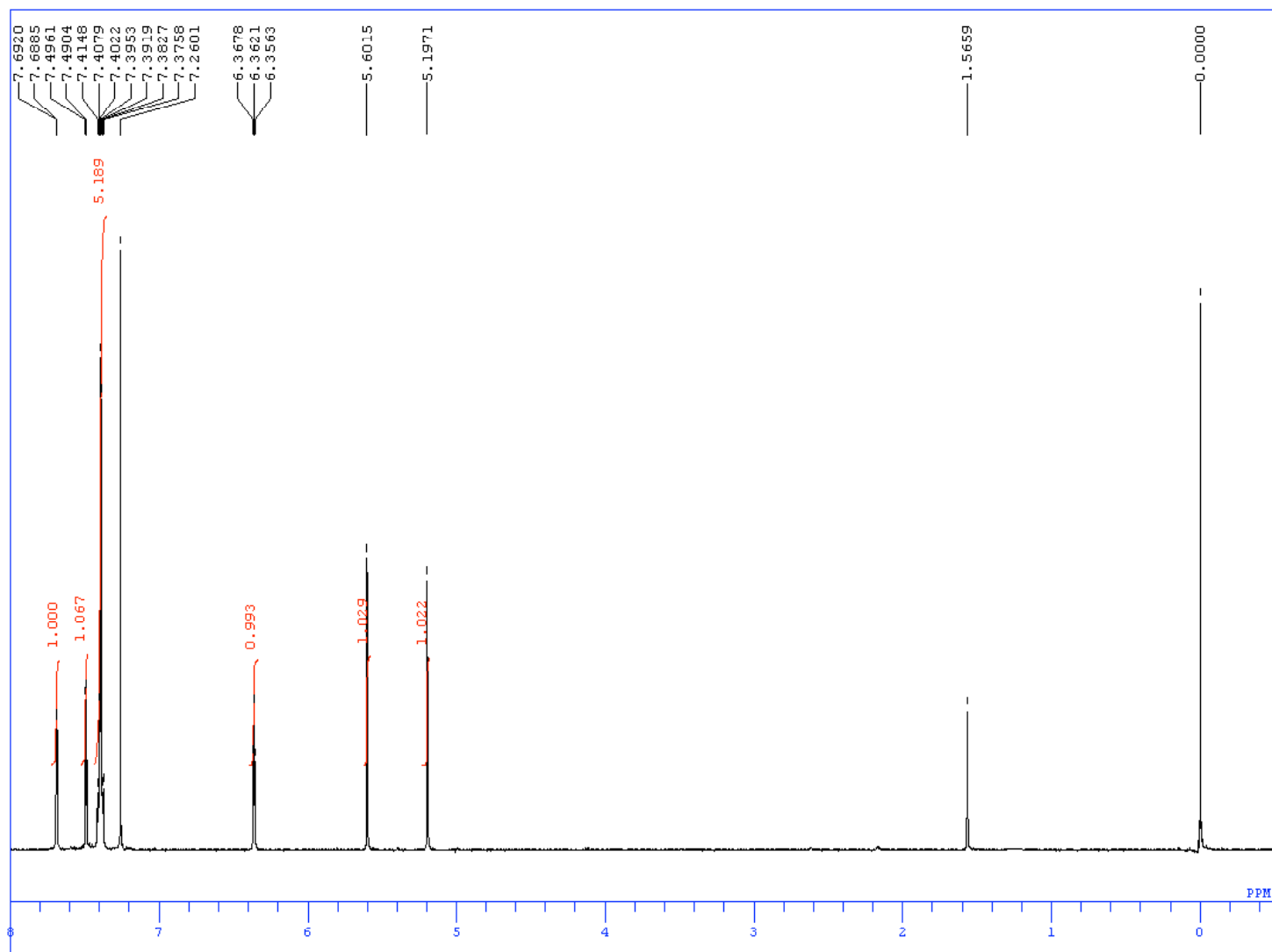


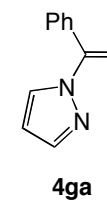
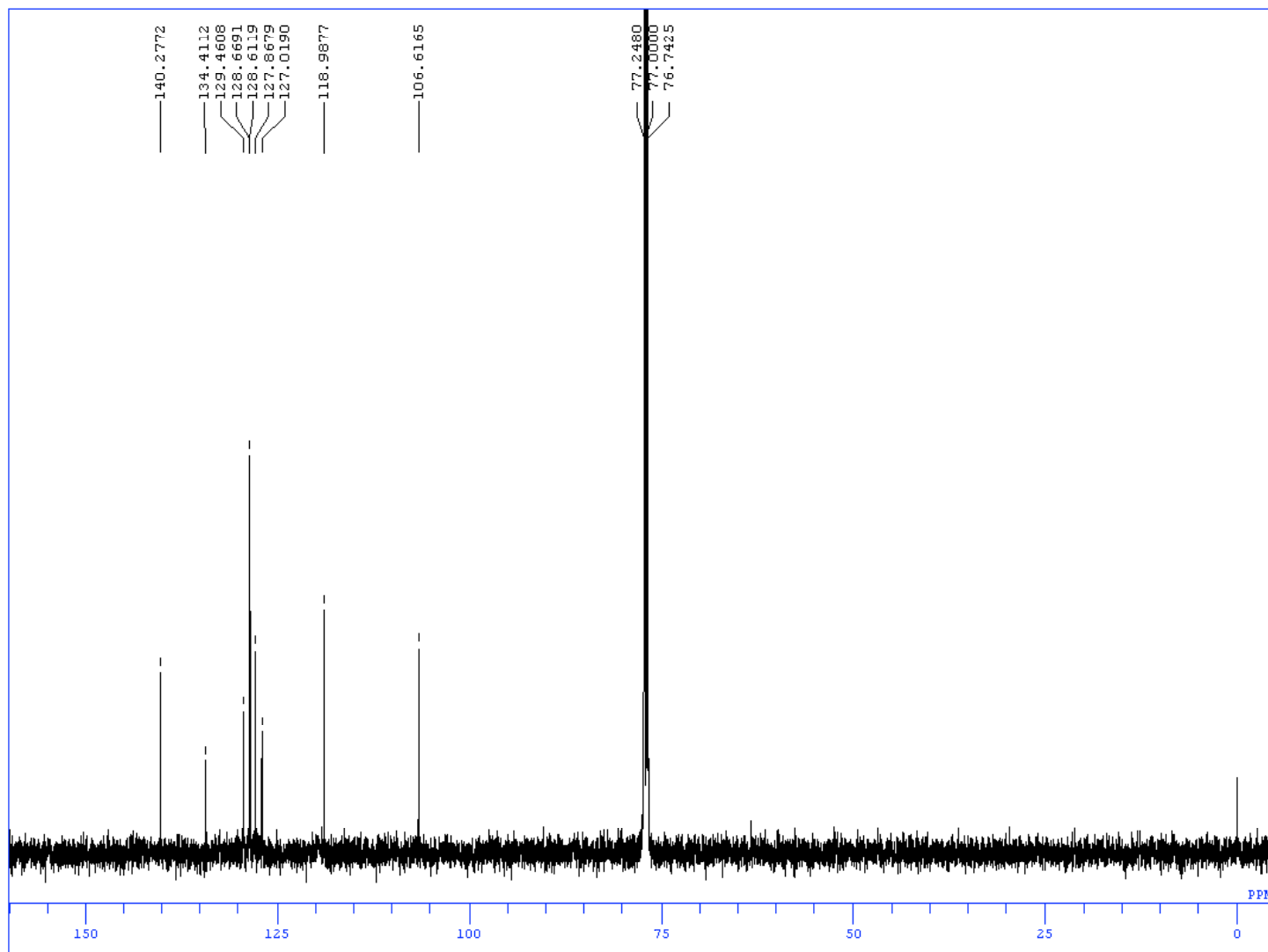


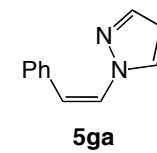
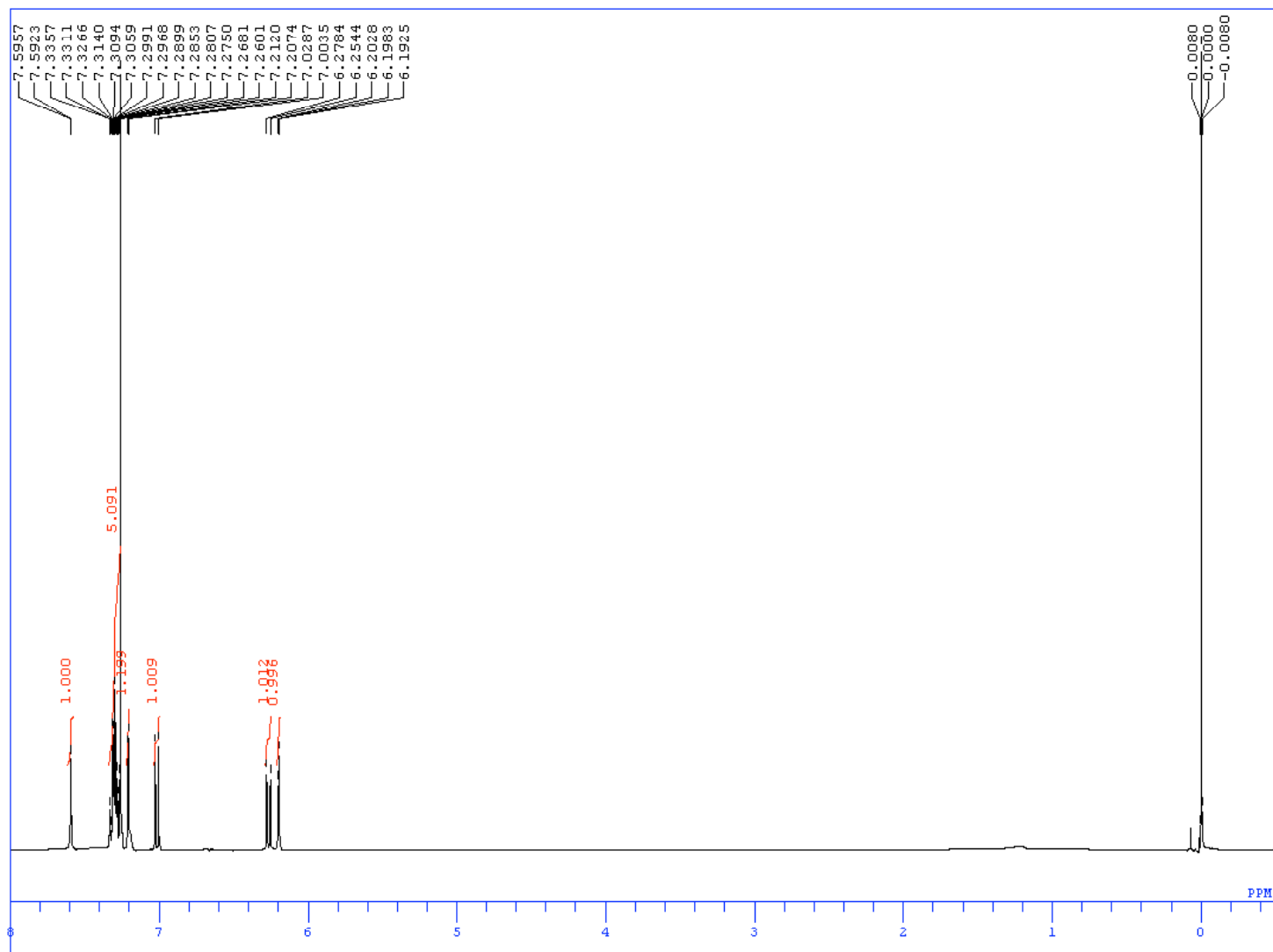


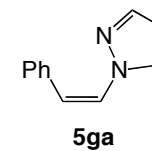
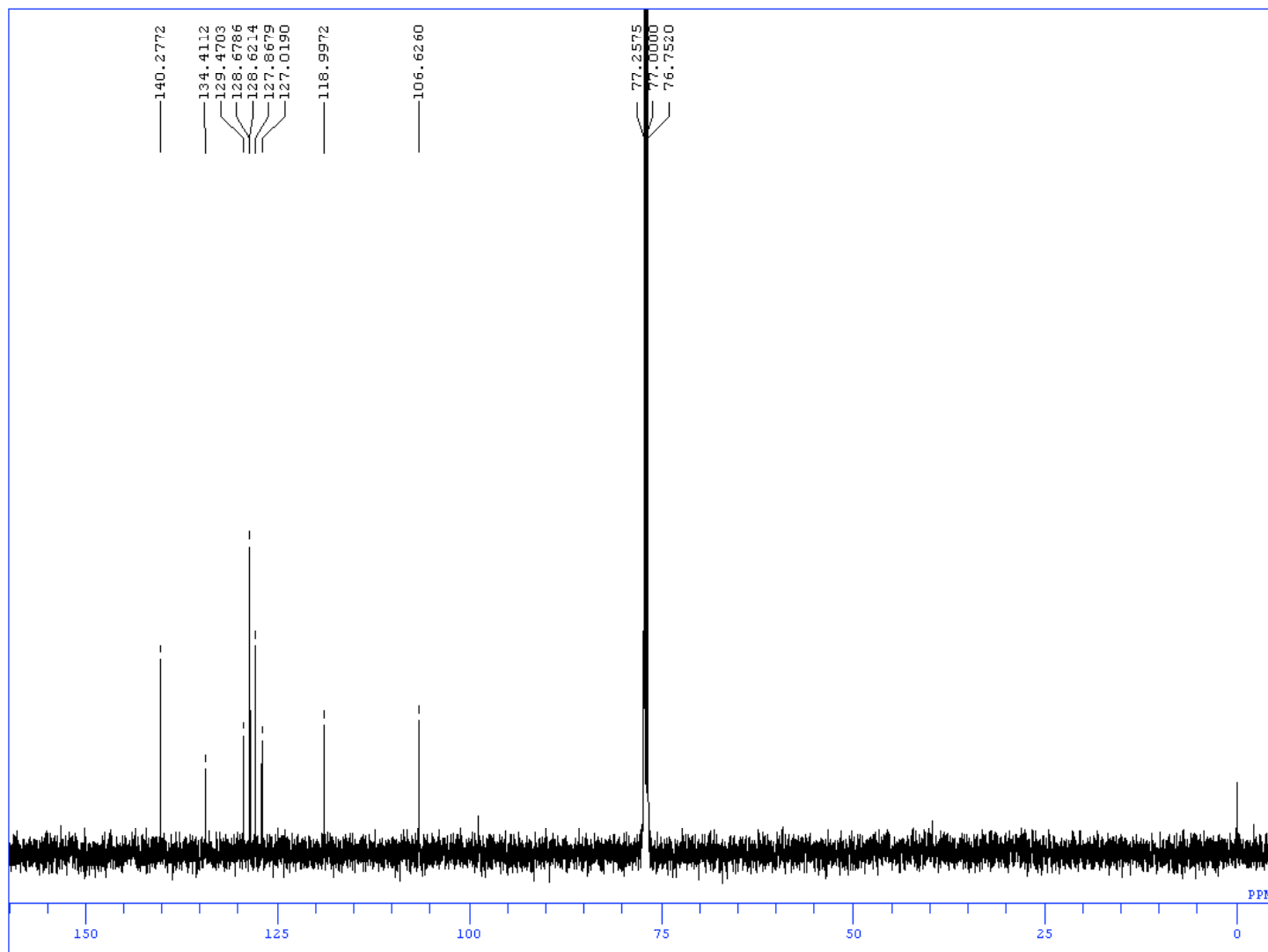


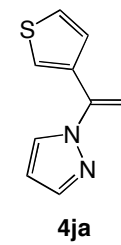
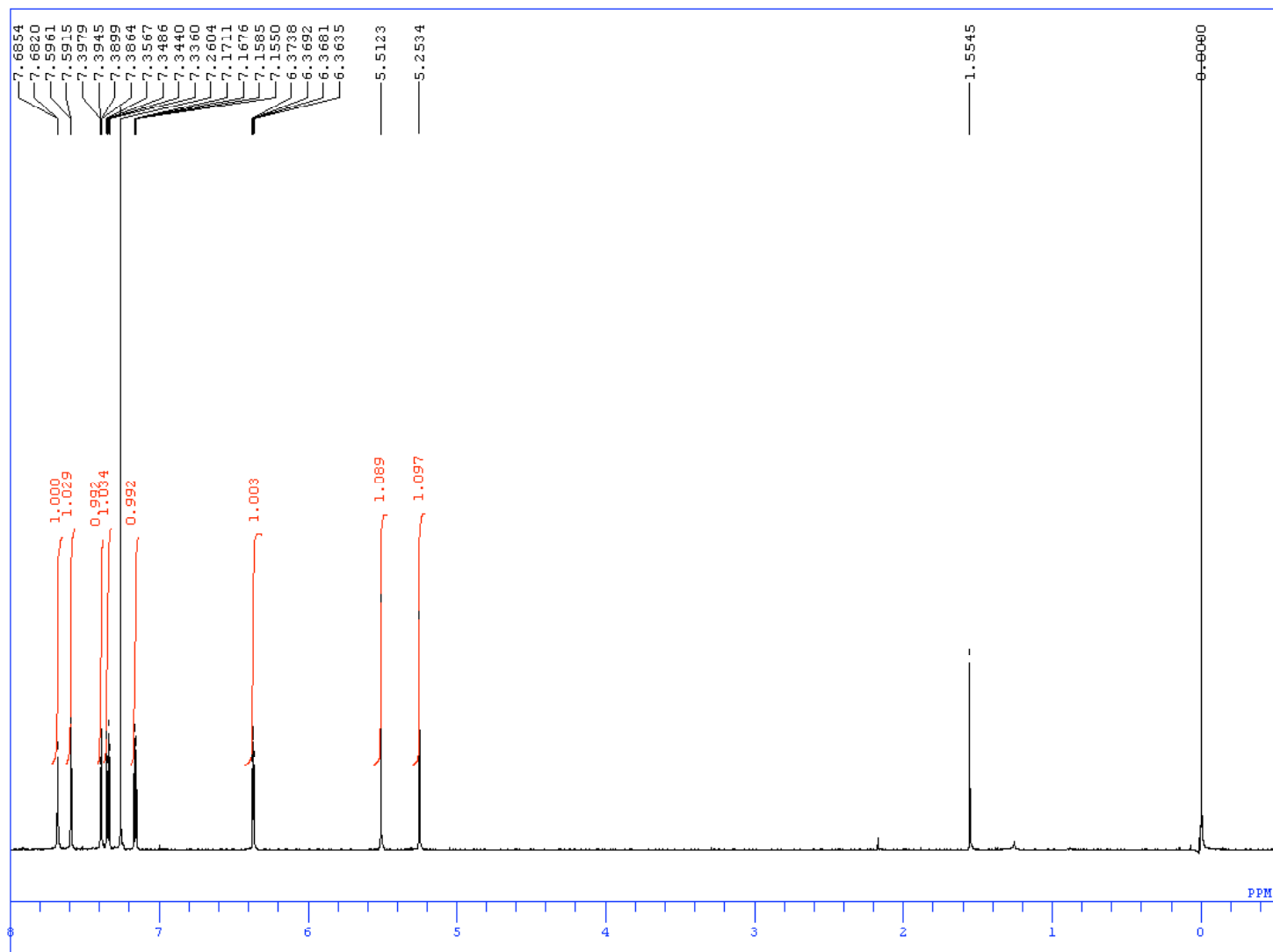


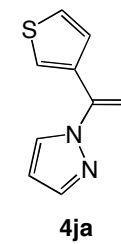
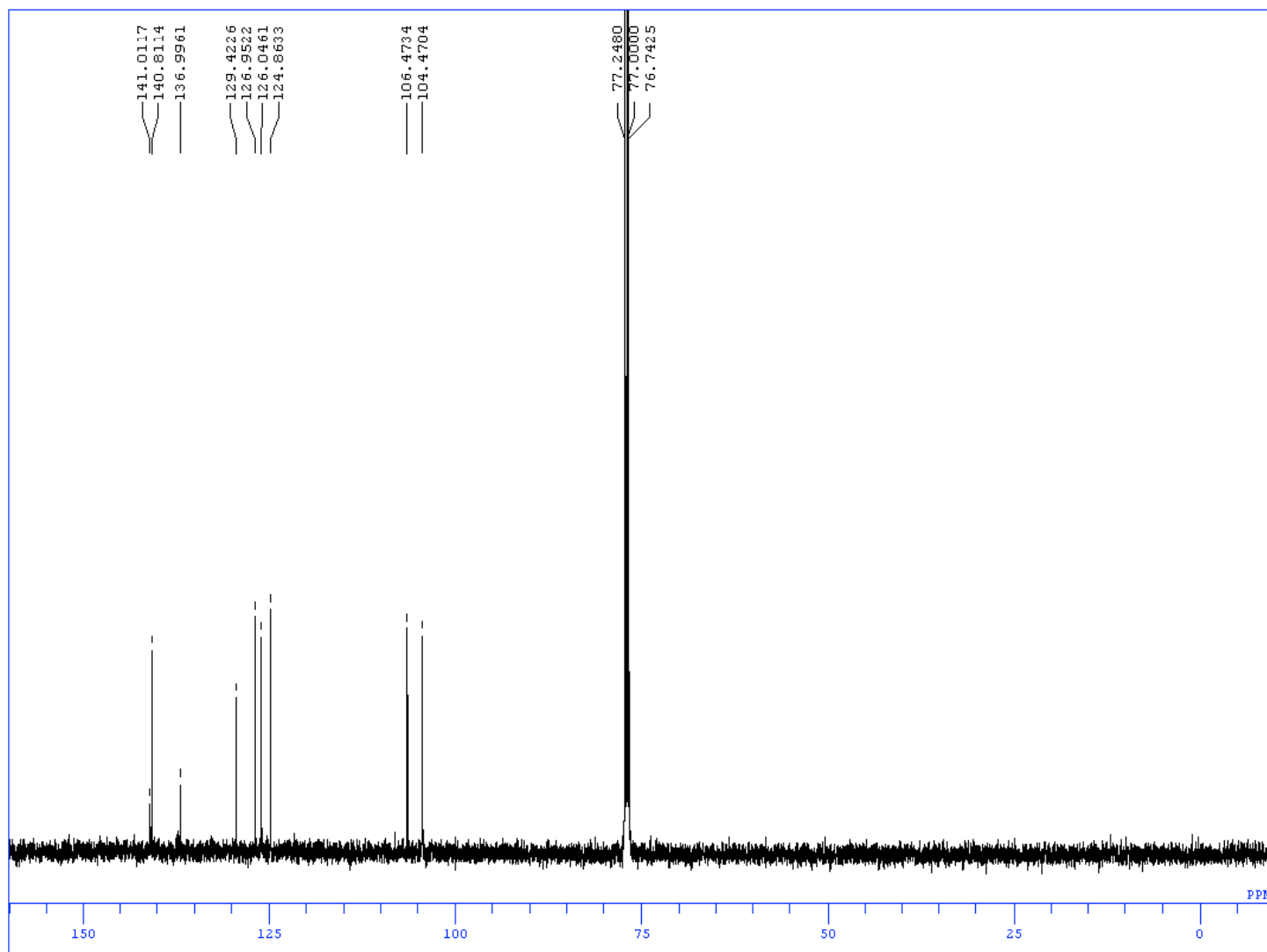


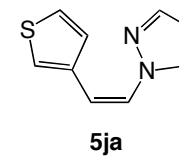
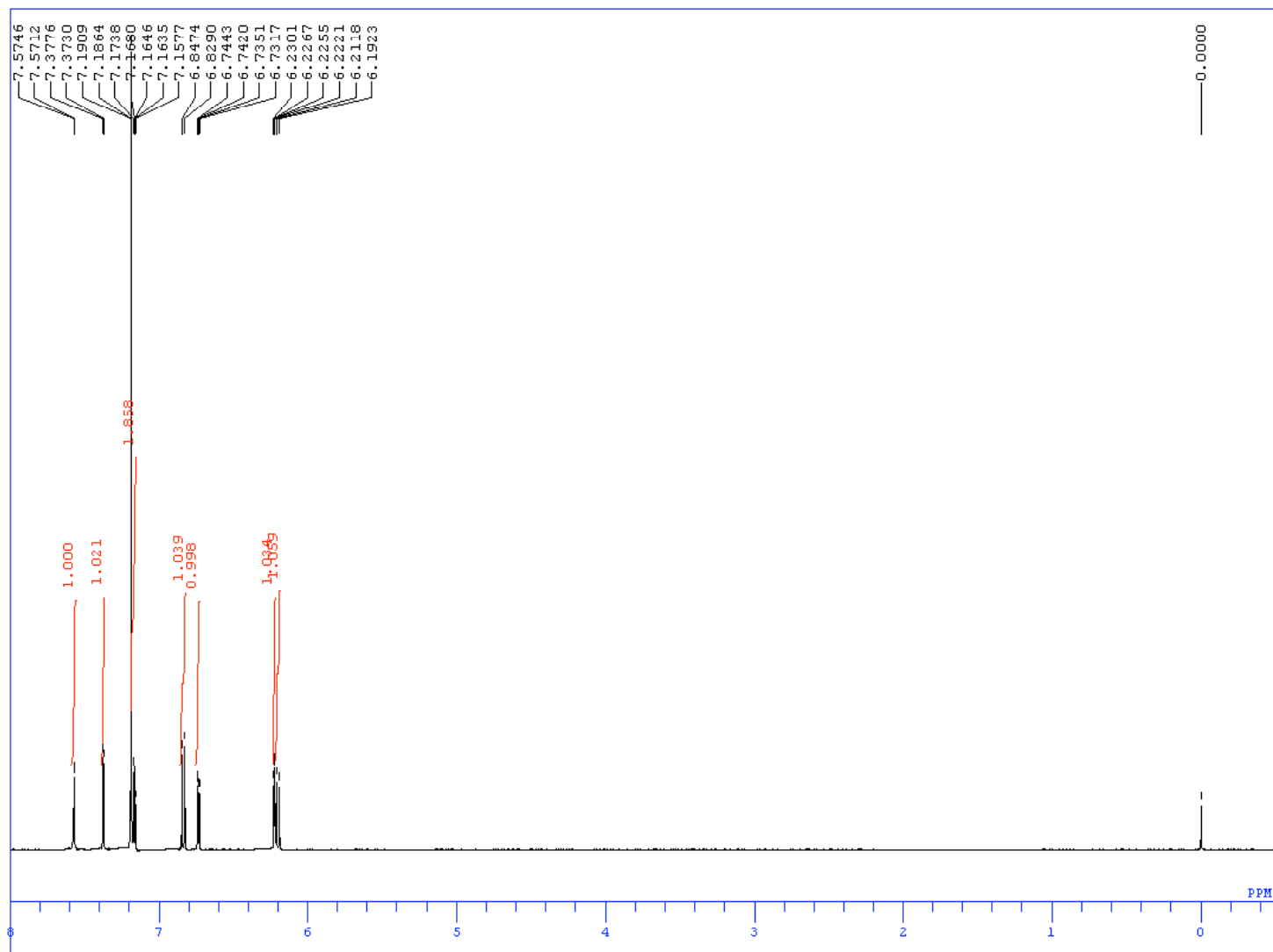


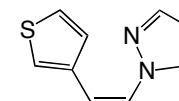
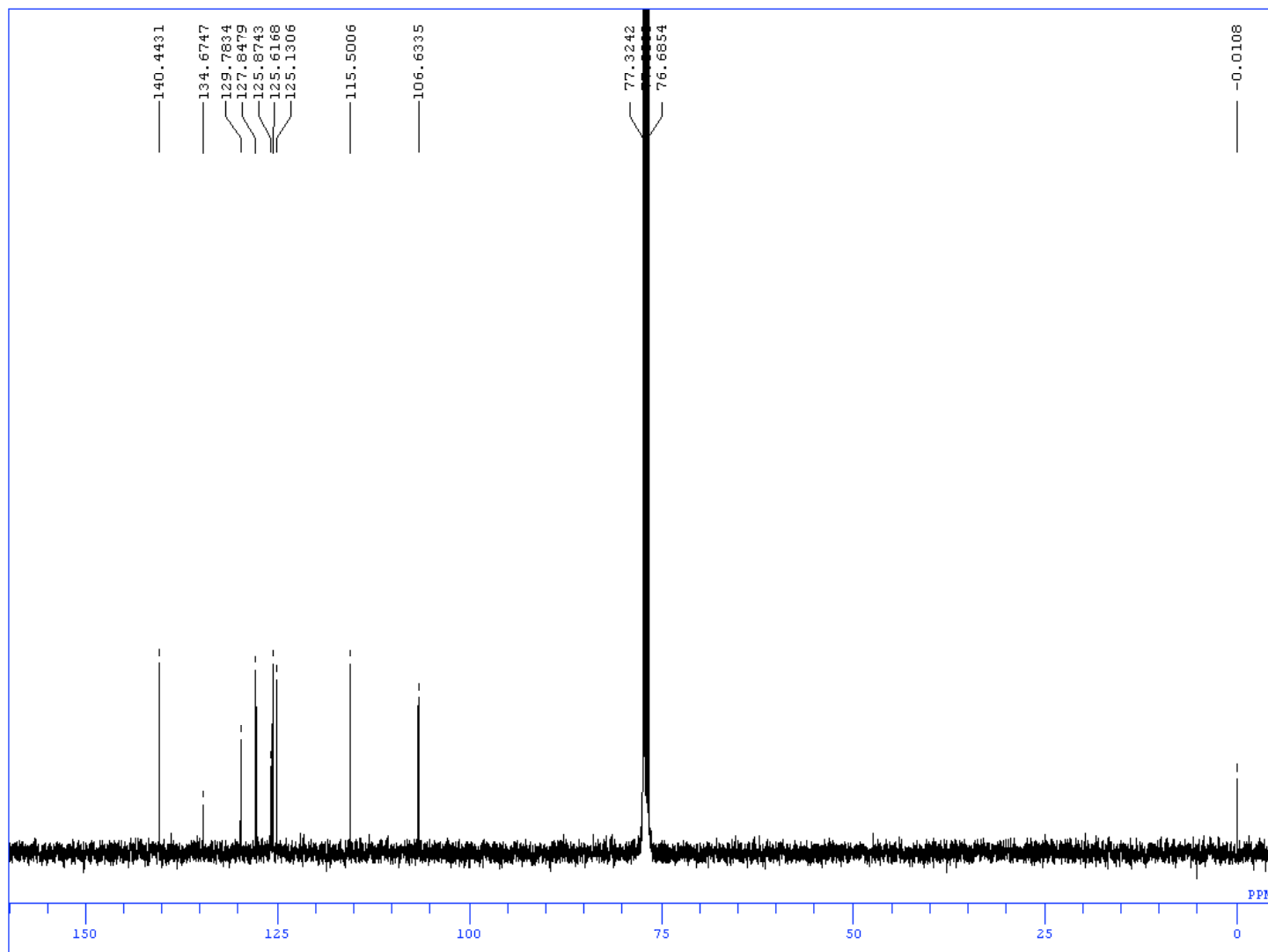












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