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Supporting Information (SI)

The Catalyst-Free Chemoselective α-Sulfenylation/β-Thiolation for α,β-Unsaturated Carbonyl Compounds

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1. Experimental Section

General Remarks

All reagents were of analytical grade and obtained from commercial suppliers; unless stated otherwise, all reagents were used without further purification. The solvents DMF, DMSO, THF and toluene were commercial anhydrous reagents and 1,4-dioxane was further disposed under sodium reflux. Chalcones were synthesized by standard method and were confirmed by GC-MS. The crude products were all recrystallized from 98% ethanol. The column chromatography was performed on Biotage Isolera Prime. The ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker AM-400 spectrometer (400 MHz and 100 MHz, respectively) using TMS as internal standard. $CDCl_3$ was used as the NMR solvent for vatious products. Chemical shifts were recorded in parts per million (d) relative to $CDCl_3$ at 7.26 for ^{1}H NMR and 77.23 for ^{13}C NMR. Gas chromatography-mass spectrometry (GC-MS) was performed on Agilent 7890A/5975C and Gas chromatograms were recorded on Agilent 7890A. Liquid chromatograms were recorded on Agilent 1260 Infinity.

2. Experimental Procedure

General procedure

General procedure A for optimization of α-Sulfenylation reaction condition: A mixture of the chalcone (104.1 mg, 0.5 mmol), N-(phenylthio)phthalimide, K_2CO_3 (6.9 mg, 0.05 mmol) and solvent was placed in a 10-mL reaction tube with a magnetic stirring bar. After being sealed with a cap, the reaction tube was purged with nitrogen for 10 min. The tube was then placed into an oil bath and the reaction was conducted at 70 ºC for 2h. After the reaction was finished, dodecane (50.0 mg) was added into the mixture as an internal standard. The resulting suspension was diluted with water (2.0 mL) and extracted with ethyl acetate (6.5 mL). The upper clear mixture (0.5 mL) was collected for GC analysis.

General procedure B for α-Sulfenylation of α,β-unsaturated carbonyl compounds with N-(phenylthio)phthalimide: A mixture of the α,β-unsaturated ketone (0.5 mmol), N-(phenylthio)phthalimide (191.5 mg, 0.75 mmol), K_2CO_3 (6.9 mg, 0.05 mmol) and DMSO (1.5 mL) was placed in a 10-mL reaction tube with a magnetic stirring bar. After being sealed with a cap, the tube was heated at 70 ºC for 3-6 hours. The resulting suspension was diluted with water (2.0 mL) and extracted with ethyl acetate (6.5 mL × 3). The combined organic layers were washed with brine and dried over $MgSO_4$, and the solvents were removed under vacuum. The resultant crude residue was purified by column chromatography to give the product **3** (eluent: EA: PE = 1:100~1:20). The products were further characterized by GC/MS, HRMS, ^{1}H NMR and ^{13}C NMR.

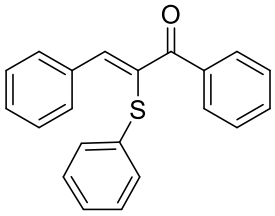
General procedure C for optimization of β-thiolation reaction condition: A mixture of the chalcone (104.1 mg, 0.5 mmol), diphenyldisulfide, bis(pinacolato)diboron (190.5 mg, 0.75 mmol), K_2CO_3 (6.9 mg, 0.05 mmol) and solvent was placed in a 10-mL reaction tube with a magnetic stirring bar. After being sealed with a cap, the reaction tube was purged with nitrogen for 10 min. The tube was then placed into an oil bath and the reaction was conducted at 70 ºC for 2h. After the reaction was finished, biphenyl (15.0 mg) was added into the mixture as an internal standard. The resulting suspension was diluted with water (2.0 mL) and extracted with ethyl acetate (6.5 mL). The upper clear mixture (0.5 mL) was collected for LC analysis.

General procedure D for β-thiolation of α,β-unsaturated carbonyl compounds with diphenyldisulfide and bis(pinacolato)diboron: A mixture of the α,β-unsaturated carbonyl compound (0.5 mmol), diphenyldisulfide (109.2 mg, 0.5 mmol), bis(pinacolato)diboron (190.5 mg, 0.75 mmol), K_2CO_3 (13.8 mg, 0.10 mmol) and n-BuOH (1.5 mL) was placed in a 10-mL reaction tube with a magnetic stirring bar. After being sealed with a cap, the reaction tube was purged with nitrogen for 10 min. The tube was then placed into an oil bath and the reaction was conducted at 80 ºC for 2h. The resulting suspension was diluted with water (2.0 mL) and extracted with ethyl acetate (6.5 mL × 3). The combined organic layers were washed with brine and dried over $MgSO_4$, and the solvents were removed under vacuum. The resultant crude residue was purified by column chromatography to give the product **6** (eluent: EA: PE = 1:100~1:20). The products were further characterized by HRMS, ^{1}H NMR and ^{13}C NMR.

General procedure E for β-thiolation of chalcone with 1,2-diaryldisulfides and bis(pinacolato)diboron: A mixture of the chalcone (104.1 mg, 0.5 mmol), 1,2-diaryldisulfide (0.5 mmol), bis(pinacolato)diboron (190.5 mg, 0.75 mmol), K_2CO_3 (13.8 mg, 0.10 mmol) and n-BuOH (1.5 mL) was placed in a 10-mL reaction tube with a magnetic stirring bar. After being sealed with a cap, the reaction tube was purged with nitrogen for 10 min. The tube was then placed into an oil bath and the reaction was conducted at 80 ºC for 2h. The resulting suspension was diluted with water (2.0 mL) and extracted with ethyl acetate (6.5 mL × 3). The combined organic layers were washed with brine and dried over $MgSO_4$, and the solvents were removed under vacuum. The resultant crude residue was purified by column chromatography to give the product **6** (eluent: EA: PE = 1:100~1:20). The products were further characterized by HRMS, ^{1}H NMR and ^{13}C NMR.

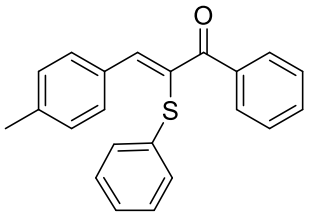
3. Characterization and NMR Spectra of the α-Sulfenylation Products:

3a 1,3-diphenyl-2-(phenylthio)prop-2-en-1-one.



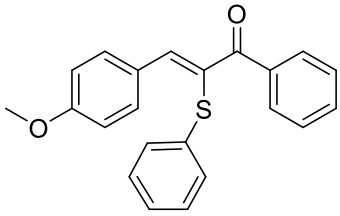
Z/E = 80:20, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, *J* = 7.3 Hz, 2H), 7.73 (d, *J* = 7.2 Hz, 2H), 7.51-7.31 (m, 6H), 7.25-7.18 (m, 2H), 7.17-7.07 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 194.40, 139.83, 137.40, 135.60, 134.66, 133.11, 132.49, 131.31(2C), 130.43(2C), 129.44, 129.39(2C), 128.96(2C), 128.49(2C), 128.12(2C), 127.39.
MS (GC-MS) *m/z*: 316 (M+), 211, 178, 170, 134, 105, 77.
HRMS (EI) *m/z* calcd for $C_{21}H_{16}OS$ [M]+ 316.0922, found 316.0921.

3b 1-phenyl-2-(phenylthio)-3-(p-tolyl)prop-2-en-1-one.



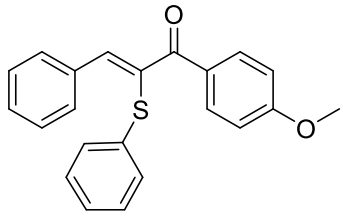
Z/E = 83:17, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 7.6 Hz, 4H), 7.48 (t, *J* = 7.3 Hz, 1H), 7.42-7.31 (m, 3H), 7.21 (dd, *J* = 16.3, 9.8 Hz, 4H), 7.16-7.07 (m, 3H), 2.39 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 194.56, 140.94, 140.00, 137.62, 134.28, 133.53, 132.35, 131.85, 130.96 (2C), 130.59 (2C), 129.38 (2C), 129.24 (2C), 128.95 (2C), 128.10 (2C), 127.20, 21.54.
MS (GC-MS) *m/z*: 330 (M+), 315, 225, 210, 181, 165, 147, 105, 77.
HRMS (EI) *m/z* calcd for $C_{22}H_{18}O_2S$ [M]+ 330.1078, found 330.1076.

3c 3-(4-methoxyphenyl)-1-phenyl-2-(phenylthio)prop-2-en-1-one.



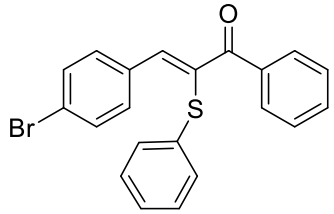
Z/E = 86:14, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.8 Hz, 2H), 7.71 (d, *J* = 7.8 Hz, 2H), 7.47 (dd, *J* = 14.4, 7.3 Hz, 2H), 7.42-7.31 (m, 2H), 7.26-7.07 (m, 5H), 6.94 (d, *J* = 8.7 Hz, 2H), 3.84 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 194.72, 160.84, 142.08, 137.86, 133.93, 132.59 (2C), 132.20, 132.17, 130.39 (2C), 129.34 (2C), 128.95 (2C), 128.07 (2C), 127.24, 126.95, 113.97 (2C), 55.40.
MS (GC-MS) *m/z*: 346 (M+), 315, 237, 210, 197, 165, 149, 105, 77.
HRMS (EI) *m/z* calcd for $C_{22}H_{18}O_2S$ [M]+ 346.1028, found 346.1027.

3d 1-(4-methoxyphenyl)-3-phenyl-2-(phenylthio)prop-2-en-1-one.



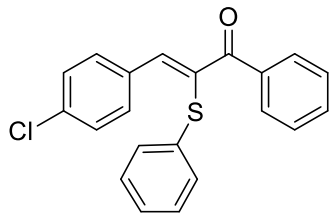
Z/E = 95:5, major isomer:^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 (dd, *J* = 8.0, 6.2 Hz, 4H), 7.47-7.32 (m, 3H), 7.28-7.22 (m, 3H), 7.15-7.09 (m, 3H), 6.87-6.82 (m, 2H), 3.83 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 192.91, 163.30, 138.16, 135.71, 134.83, 132.99, 131.93 (2C), 131.50 (2C), 130.27 (2C), 129.91, 129.16, 128.91 (2C), 128.46 (2C), 127.44, 113.45 (2C), 55.48.
MS (GC-MS) *m/z*: 346 (M+), 237, 211, 197, 135, 92, 77.
HRMS (EI) *m/z* calcd for $C_{22}H_{18}O_2S$ [M]+ 346.1028, found 346.1026.

3e -(4-bromophenyl)-1-phenyl-2-(phenylthio)prop-2-en-1-one.



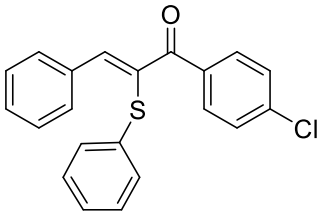
Z/E = 70:30, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (d, *J* = 7.5 Hz, 2H), 7.58 (d, *J* = 8.5 Hz, 2H), 7.46 (d, *J* = 8.5 Hz, 2H), 7.40 (dd, *J* = 12.7, 7.2 Hz, 1H), 7.27 (t, *J* = 7.7 Hz, 2H), 7.21-7.15 (m, 3H), 7.13-7.08 (m, 1H), 7.07-7.00 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 194.16, 137.78, 137.14, 136.53, 133.54, 132.62, 131.79 (2C), 131.68 (2C), 131.52 (2C), 130.01, 129.34 (2C), 129.02 (2C), 128.15 (2C), 127.63, 123.56.
MS (GC-MS) *m/z*: $C_{21}H_{15}{}^{79}BrOS$ 394 (M+), 315, 285, 245, 210, 165, 105, 77.
MS (GC-MS) *m/z*: $C_{21}H_{15}{}^{81}BrOS$ 352 (M+), 315, 287, 247, 210, 165, 105, 77.
HRMS (EI) *m/z* calcd for $C_{21}H_{15}{}^{79}BrOS$ [M]+ 394.0027, found 394.0025.
HRMS (EI) *m/z* calcd for $C_{21}H_{15}{}^{81}BrOS$ [M]+ 396.0007, found 396.0010.

3f 3-(4-chlorophenyl)-1-phenyl-2-(phenylthio)prop-2-en-1-one.



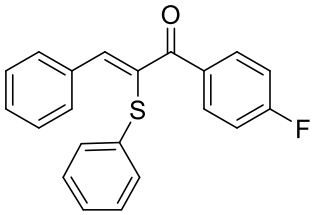
Z/E = 80:20, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (dd, *J* = 11.3, 8.2 Hz, 4H), 7.49 (dd, *J* = 13.2, 6.1 Hz, 1H), 7.44-7.31 (m, 4H), 7.28 (s, 1H), 7.19 (dd, *J* = 6.4, 3.0 Hz, 2H), 7.16-7.08 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 194.19, 137.88, 137.17, 136.34, 135.21, 133.10, 132.93, 132.61, 131.61 (2C), 131.47 (2C), 129.35 (2C), 129.02 (2C), 128.73 (2C), 128.15 (2C), 127.60.
MS (GC-MS) *m/z*: $C_{21}H_{15}{}^{35}ClOS$ 350 (M+), 315, 241, 210, 165, 105, 77.
MS (GC-MS) *m/z*: $C_{21}H_{15}{}^{37}ClOS$ 352 (M+), 317, 243, 210, 165, 105, 77.
HRMS (EI) *m/z* calcd for $C_{21}H_{15}{}^{35}ClOS$ [M]+ 350.0532, found 350.0529.
HRMS (EI) *m/z* calcd for $C_{21}H_{15}{}^{37}ClOS$ [M]+ 352.0503, found 352.0505.

3g 1-(4-chlorophenyl)-3-phenyl-2-(phenylthio)prop-2-en-1-one.



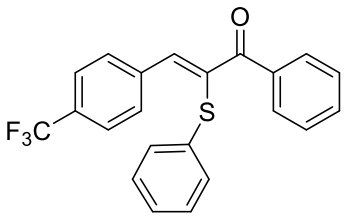
Z/E = 90:10, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, *J* = 7.1 Hz, 2H), 7.65 (d, *J* = 8.5 Hz, 2H), 7.47-7.37 (m, 3H), 7.35 (s, 1H), 7.34-7.29 (m, 2H), 7.15 (ddd, *J* = 9.2, 7.0, 3.3 Hz, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 193.30, 139.51, 138.81, 135.68, 134.50, 132.82, 132.58, 131.41 (2C), 130.69 (2C), 130.45 (2C), 129.57, 129.04 (2C), 128.53 (2C), 128.41 (2C), 127.56.
MS (GC-MS) *m/z*: $C_{21}H_{15}{}^{35}ClOS$ 350 (M+), 315, 241, 211, 178, 165, 139, 111.
MS (GC-MS) *m/z*: $C_{21}H_{15}{}^{37}ClOS$ 352 (M+), 317, 243, 211, 178, 165, 141, 111.
HRMS (EI) *m/z* calcd for $C_{21}H_{15}{}^{35}ClOS$ [M]+ 350.0532, found 350.0529.
HRMS (EI) *m/z* calcd for $C_{21}H_{15}{}^{37}ClOS$ [M]+ 352.0503, found 352.0502.

3h 1-(4-fluorophenyl)-3-phenyl-2-(phenylthio)prop-2-en-1-one.



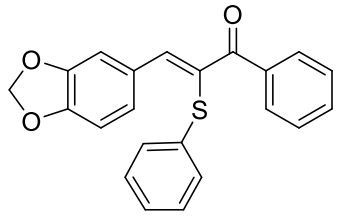
Z/E = 77:23, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, *J* = 7.5 Hz, 2H), 7.75 (dd, *J* = 8.6, 5.5 Hz, 2H), 7.47-7.36 (m, 3H), 7.34 (s, 1H), 7.16 (ddd, *J* = 17.1, 7.0, 3.3 Hz, 5H), 7.01 (q, *J* = 8.5 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 192.98, 165.31 (d, J_{CF} = 254.2 Hz, 1C), 139.01, 135.33, 134.58, 133.56 (d, J_{CF} = 3.0 Hz, 1C), 131.90 (d, J_{CF} = 9.3 Hz, 2C), 131.48 (2C), 130.38 (2C), 129.45, 128.99 (2C), 128.60, 128.51 (2C), 127.55, 115.23 (d, J_{CF} = 21.9 Hz, 2C).
MS (GC-MS) *m/z*: 334 (M+), 241, 225, 211, 178, 123, 95.
HRMS (EI) *m/z* calcd for $C_{21}H_{15}FOS$ [M]+ 334.0828, found 334.0827.

3i 1-phenyl-2-(phenylthio)-3-(4-(trifluoromethyl)phenyl)prop-2-en-1-one.



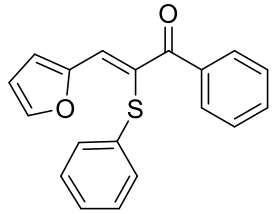
Z/E = 80:20, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.1 Hz, 2H), 7.70 (dd, *J* = 15.8, 7.9 Hz, 4H), 7.51 (dd, *J* = 13.2, 6.2 Hz, 1H), 7.36 (t, *J* = 7.7 Hz, 2H), 7.26 (d, *J* = 8.6 Hz, 2H), 7.23-7.05 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 193.88, 138.15 (d, J_{CF} = 1.0 Hz, 1C), 136.86, 135.78, 133.56, 132.83, 132.08 (2C), 131.88, 131.11 (dd, J_{CF} = 65.7 Hz, 1C), 130.29 (2C), 129.34 (2C), 129.04 (2C), 128.79, 128.19 (2C), 125.36 (dd, J_{CF} = 4.4 Hz, 2C), 123.91 (q, J_{CF} = 264.6 Hz, 1C).
MS (GC-MS) *m/z*: 384(M+), 291, 275, 211, 178, 145.
HRMS (EI) *m/z* calcd for $C_{22}H_{15}F_3OS$ [M]+ 384.0796, found 384.0797.

3j 3-(benzo[d][1,3]dioxol-5-yl)-1-phenyl-2-(phenylthio)prop-2-en-1-one.



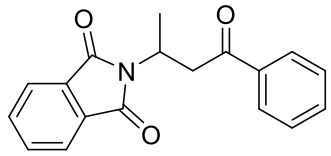
Z/E = 85:15, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75-7.66 (m, 2H), 7.60 (d, *J* = 1.7 Hz, 1H), 7.50-7.45 (m, 1H), 7.41-7.32 (m, 3H), 7.26-7.18 (m, 3H), 7.17-7.07 (m, 3H), 6.85 (d, *J* = 8.1 Hz, 1H), 6.00 (s, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 194.62, 148.93, 147.82, 141.49, 137.68, 133.60, 132.83, 132.27, 130.59 (2C), 129.33 (2C), 128.98 (2C), 128.75, 128.09 (2C), 127.10, 126.69, 109.90, 108.36, 101.58.
MS (GC-MS) *m/z*: 360(M+), 251, 225, 197, 105, 77.
HRMS (EI) *m/z* calcd for $C_{22}H_{16}O_3S$ [M]+ 360.0820, found 360.0821.

3k 3-(furan-2-yl)-1-phenyl-2-(phenylthio)prop-2-en-1-one.



Z/E = 85:15, major isomer: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75-7.65 (m, 2H), 7.55 (d, *J* = 1.5 Hz, 1H), 7.48 (dt, *J* = 11.4, 6.6 Hz, 1H), 7.38-7.30 (m, 3H), 7.27-7.21 (m, 3H), 7.16-7.10 (m, 3H), 6.55 (dd, *J* = 3.5, 1.7 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 193.69, 150.61, 144.58, 137.59, 132.52, 132.33, 131.87, 130.79 (2C), 129.27 (2C), 129.02 (2C), 128.23, 128.17 (2C), 122.30, 116.13, 112.78.
MS (GC-MS) *m/z*: 306(M+), 197, 173, 129, 105, 77.
HRMS (EI) *m/z* calcd for $C_{19}H_{14}O_2S$ [M]+ 306.0715, found 306.0712.

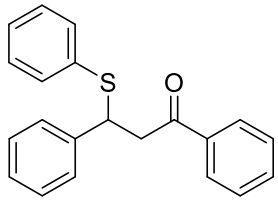
3m' 2-(4-oxo-4-phenylbutan-2-yl)isoindoline-1,3-dione.



^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00-7.90 (m, 2H), 7.87-7.75 (m, 2H), 7.74-7.63 (m, 2H), 7.58-7.50 (m, 1H), 7.49-7.37 (m, 2H), 5.15-4.97 (m, 1H), 3.90 (dd, *J* = 17.7, 7.9 Hz, 1H), 3.51 (dd, *J* = 17.7, 6.2 Hz, 1H), 1.55 (d, *J* = 6.9 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.35, 168.28 (2C), 136.61, 133.86 (2C), 133.29, 131.99 (2C), 128.63 (2C), 128.06 (2C), 123.16 (2C), 42.92, 41.88, 19.03.
MS (GC-MS) *m/z*: 293(M+), 278, 188, 174, 146, 130, 105, 77.
HRMS (EI) *m/z* calcd for 293.1052, found 293.1053.

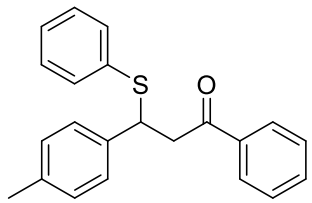
4. Characterization and NMR Spectra of the β-Thiolation Products:

6a 1,3-diphenyl-3-(phenylthio)propan-1-one.



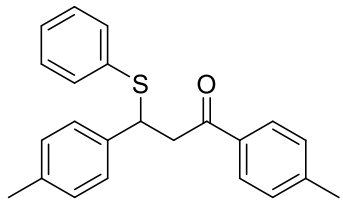
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91-7.81 (m, 2H), 7.55-7.48 (m, 1H), 7.43-7.37 (m, 2H), 7.37-7.28 (m, 4H), 7.27-7.14 (m, 6H), 4.96 (dd, *J* = 8.1, 6.0 Hz, 1H), 3.65 (dd, *J* = 17.2, 8.1 Hz, 1H), 3.57 (dd, *J* = 17.2, 6.0 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.01, 141.26, 136.79, 134.32, 133.28, 132.79 (2C), 128.89 (2C), 128.65 (2C), 128.49 (2C), 128.10 (2C), 127.85 (2C), 127.56, 127.41, 48.29, 44.76.
HRMS (EI) *m/z* calcd for $C_{21}H_{18}OS$ [M]+ 318.1078, found 318.1088.

6b 1-phenyl-3-(phenylthio)-3-(p-tolyl)propan-1-one.



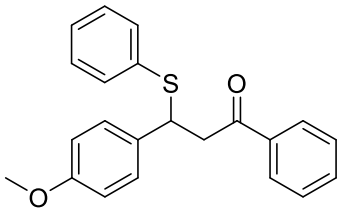
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91-7.79 (m, 2H), 7.51 (ddd, *J* = 6.8, 4.0, 1.2 Hz, 1H), 7.40 (dd, *J* = 10.5, 4.7 Hz, 2H), 7.37-7.29 (m, 2H), 7.27-7.18 (m, 5H), 7.05 (d, *J* = 8.0 Hz, 2H), 4.94 (dd, *J* = 8.0, 6.1 Hz, 1H), 3.64 (dd, *J* = 17.1, 8.3 Hz, 1H), 3.54 (dd, *J* = 17.2, 5.9 Hz, 1H), 2.27 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.15, 138.16, 137.05, 136.82, 134.60, 133.24, 132.58 (2C), 129.22 (2C), 128.90 (2C), 128.63 (2C), 128.11 (2C), 127.70 (2C), 127.44, 47.97, 44.86, 21.13.
HRMS (EI) *m/z* calcd for $C_{22}H_{20}OS$ [M]+ 332.1235, found 332.1236.

6c 3-(phenylthio)-1,3-di-p-tolylpropan-1-one.



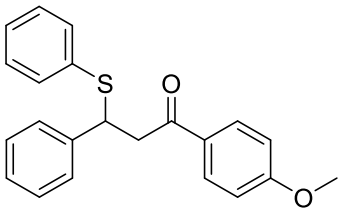
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (d, *J* = 8.2 Hz, 2H), 7.33 (dd, *J* = 7.5, 1.6 Hz, 2H), 7.25-7.16 (m, 7H), 7.04 (d, *J* = 7.9 Hz, 2H), 4.94 (dd, *J* = 8.1, 6.0 Hz, 1H), 3.61 (dd, *J* = 17.0, 8.3 Hz, 1H), 3.51 (dd, *J* = 17.0, 5.9 Hz, 1H), 2.36 (s, 3H), 2.26 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.74, 144.06, 138.28, 136.98, 134.71, 134.42, 132.55 (2C), 129.32 (2C), 129.21 (2C), 128.88 (2C), 128.26 (2C), 127.72 (2C), 127.39, 48.05, 44.72, 21.66, 21.14.
HRMS (EI) *m/z* calcd for $C_{23}H_{22}OS$ [M]+ 346.1391, found 346.1394.

6d 3-(4-methoxyphenyl)-1-phenyl-3-(phenylthio)propan-1-one.



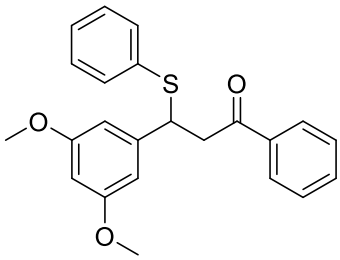
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (dd, *J* = 5.2, 3.3 Hz, 2H), 7.56-7.49 (m, 1H), 7.41 (dd, *J* = 10.5, 4.7 Hz, 2H), 7.36-7.29 (m, 2H), 7.28-7.19 (m, 5H), 6.84-6.72 (m, 2H), 4.93 (dd, *J* = 8.5, 5.7 Hz, 1H), 3.74 (s, 3H), 3.63 (dd, *J* = 17.1, 8.5 Hz, 1H), 3.53 (dd, *J* = 17.1, 5.7 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.19, 158.79, 136.81, 134.49, 133.23, 133.16, 132.70 (2C), 128.90 (2C), 128.87 (2C), 128.62 (2C), 128.08 (2C), 127.46, 113.87 (2C), 55.22, 47.71, 44.89.
HRMS (EI) *m/z* calcd for $C_{22}H_{20}O_2S$ [M]+ 348.1184, found 348.1188.

6e 1-(4-methoxyphenyl)-3-phenyl-3-(phenylthio)propan-1-one.



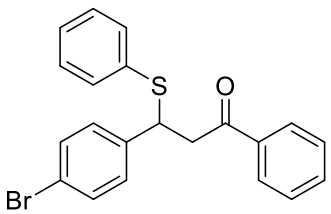
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (dd, *J* = 8.9, 2.7 Hz, 2H), 7.37-7.28 (m, 4H), 7.27-7.14 (m, 6H), 6.88 (dd, *J* = 8.9, 2.7 Hz, 2H), 4.95 (dd, *J* = 9.5, 4.6 Hz, 1H), 3.81 (s, 3H), 3.60 (ddd, *J* = 16.9, 8.1, 2.9 Hz, 1H), 3.52 (ddd, *J* = 16.9, 6.0, 3.0 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 195.48, 163.64, 141.37, 134.41, 132.69 (2C), 130.40 (2C), 129.92, 128.83 (2C), 128.44 (2C), 127.83 (2C), 127.46, 127.32, 113.78 (2C), 55.48, 48.42, 44.32.
HRMS (EI) *m/z* calcd for $C_{22}H_{20}O_2S$ [M]+ 348.1184, found 348.1186.

6f 3-(3,5-dimethoxyphenyl)-1-phenyl-3-(phenylthio)propan-1-one.



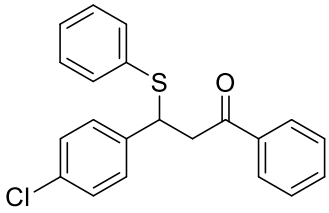
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99-7.81 (m, 2H), 7.56-7.49 (m, 1H), 7.41 (t, *J* = 7.6 Hz, 2H), 7.38-7.30 (m, 2H), 7.26-7.17 (m, 3H), 6.49 (d, *J* = 2.2 Hz, 2H), 6.29 (t, *J* = 2.2 Hz, 1H), 4.89 (dd, *J* = 7.7, 6.3 Hz, 1H), 3.71 (s, 6H), 3.62 (dd, *J* = 17.2, 7.8 Hz, 1H), 3.53 (dd, *J* = 17.2, 6.2 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.96, 160.72 (2C), 143.65, 136.79, 134.38, 133.28, 132.72 (2C), 128.89 (2C), 128.64 (2C), 128.10 (2C), 127.55, 105.89 (2C), 99.51, 55.31 (2C), 48.47, 44.67.
HRMS (EI) *m/z* calcd for $C_{23}H_{22}O_3S$ [M]+ 378.1290, found 378.1291.

6g 3-(4-bromophenyl)-1-phenyl-3-(phenylthio)propan-1-one.



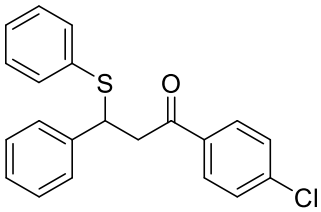
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93-7.80 (m, 2H), 7.55-7.50 (m, 1H), 7.41 (dd, *J* = 10.6, 4.8 Hz, 2H), 7.37-7.33 (m, 2H), 7.33-7.27 (m, 2H), 7.27-7.15 (m, 5H), 4.89 (dd, *J* = 7.8, 6.3 Hz, 1H), 3.65-3.51 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.62, 140.47, 136.61, 133.76, 133.41, 133.00 (2C), 131.55 (2C), 129.55 (2C), 128.98 (2C), 128.69 (2C), 128.06 (2C), 127.84, 121.15, 47.77, 44.51.
HRMS (EI) *m/z* calcd for $C_{21}H_{17}{}^{79}BrOS$ [M]+ 396.0183, found 396.0187.
HRMS (EI) *m/z* calcd for $C_{21}H_{17}{}^{81}BrOS$ [M]+ 398.0163, found 398.0163.

6h 3-(4-chlorophenyl)-1-phenyl-3-(phenylthio)propan-1-one.



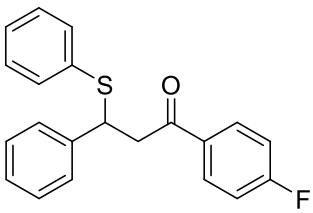
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90-7.80 (m, 2H), 7.53-7.48 (m, 1H), 7.38 (dd, *J* = 10.6, 4.7 Hz, 2H), 7.33-7.28 (m, 2H), 7.27-7.13 (m, 7H), 4.91 (dd, *J* = 7.9, 6.3 Hz, 1H), 3.64-3.51 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.67, 139.97, 136.63, 133.82, 133.43, 133.02 (3C), 129.24 (2C), 129.01 (2C), 128.71 (2C), 128.62 (2C), 128.08 (2C), 127.85, 47.73, 44.57.
HRMS (EI) *m/z* calcd for $C_{21}H_{17}{}^{35}ClOS$ [M]+ 352.0689, found 352.0687.
HRMS (EI) *m/z* calcd for $C_{21}H_{17}{}^{35}ClOS$ [M]+ 354.0659, found 354.0663.

6i 1-(4-chlorophenyl)-3-phenyl-3-(phenylthio)propan-1-one.



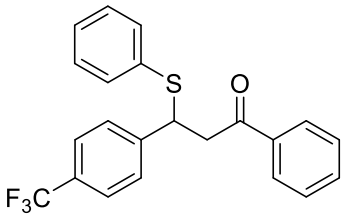
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83-7.75 (m, 2H), 7.40-7.35 (m, 2H), 7.31 (d, *J* = 7.3 Hz, 4H), 7.27-7.14 (m, 6H), 4.92 (t, *J* = 7.0 Hz, 1H), 3.56 (qd, *J* = 17.1, 7.0 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 195.85, 141.06, 139.75, 135.09, 134.15, 132.83 (2C), 129.50 (2C), 128.95 (2C), 128.90 (2C), 128.52 (2C), 127.79 (2C), 127.64, 127.48, 48.33, 44.72.
HRMS (EI) *m/z* calcd for $C_{21}H_{17}{}^{35}ClOS$ [M]+ 352.0689, found 352.0686.
HRMS (EI) *m/z* calcd for $C_{21}H_{17}{}^{35}ClOS$ [M]+ 354.0659, found 354.0660.

6j 1-(4-fluorophenyl)-3-phenyl-3-(phenylthio)propan-1-one



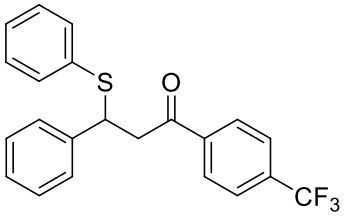
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96-7.82 (m, 2H), 7.37-7.28 (m, 4H), 7.28-7.15 (m, 6H), 7.13-7.03 (m, 2H), 4.93 (dd, *J* = 8.0, 6.2 Hz, 1H), 3.57 (qd, *J* = 17.1, 7.1 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 195.46, 165.83 (d, J_{CF}= 255.1 Hz, 1C), 141.15, 134.22, 133.23 (d, J_{CF} = 3.0 Hz, 1C), 132.80 (2C), 130.76 (d, J_{CF} = 9.4 Hz, 2C), 128.91 (2C), 128.52 (2C), 127.82 (2C), 127.62, 127.47, 115.75 (d, J_{CF} = 21.9 Hz, 2C), 48.34, 44.67.
HRMS (EI) *m/z* calcd for $C_{21}H_{17}FOS$ [M]+ 336.0984, found 336.0982.

6k 1-phenyl-3-(phenylthio)-3-(4-(trifluoromethyl)phenyl)propan-1-one.



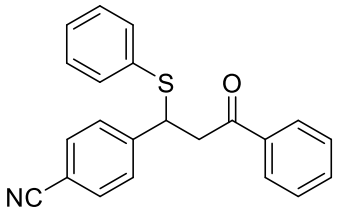
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (dd, *J* = 5.2, 3.4 Hz, 2H), 7.57-7.52 (m, 1H), 7.49 (d, *J* = 8.3 Hz, 2H), 7.46-7.37 (m, 4H), 7.35-7.27 (m, 2H), 7.26-7.19 (m, 3H), 5.04-4.88 (m, 1H), 3.66 (dd, *J* = 15.2, 5.6 Hz, 1H), 3.61 (dd, *J* = 15.2, 4.1 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.46, 145.62 (d, J_{CF} = 0.5 Hz, 1C), 136.53, 133.50 (2C), 133.15 (2C), 129.46 (dd, J_{CF} = 64.8, 32.4 Hz, 1C), 129.05 (2C), 128.74 (2C), 128.24 (2C), 128.07 (2C), 128.03, 125.42 (dd, J_{CF} = 7.4, 3.6 Hz, 2C), 124.12 (q, J_{CF} = 272.0 Hz, 1C), 47.97, 44.39.
HRMS (EI) *m/z* calcd for $C_{22}H_{17}F_3OS$ [M]+ 386.0952, found 386.0951.

6l 3-phenyl-3-(phenylthio)-1-(4-(trifluoromethyl)phenyl)propan-1-one.



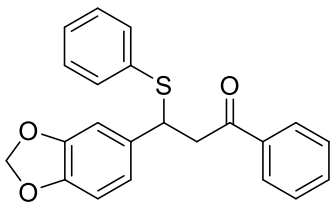
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.1 Hz, 2H), 7.67 (d, *J* = 8.2 Hz, 2H), 7.38-7.28 (m, 4H), 7.28-7.14 (m, 6H), 4.92 (dd, *J* = 7.9, 6.3 Hz, 1H), 3.62 (qd, *J* = 17.2, 7.1 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.18, 140.92, 139.41, 134.52 (dd, J_{CF} = 65.5, 32.8 Hz, 1C), 134.03, 132.91 (2C), 128.94 (2C), 128.57 (2C), 128.41 (2C), 127.78 (2C), 127.74, 127.56, 125.71 (q, J_{CF} = 3.7 Hz, 2C), 123.56 (dd, J_{CF} = 545.4, 272.6 Hz, 1C), 48.30, 45.10.
HRMS (EI) *m/z* calcd for $C_{22}H_{17}F_3OS$ [M]+ 386.0952, found 386.0953.

6m 4-(3-oxo-3-phenyl-1-(phenylthio)propyl)benzonitrile.



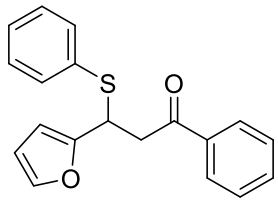
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93-7.83 (m, 2H), 7.58-7.53 (m, 1H), 7.53-7.48 (m, 2H), 7.43 (dd, *J* = 10.6, 4.8 Hz, 2H), 7.41-7.35 (m, 2H), 7.31-7.26 (m, 2H), 7.26-7.19 (m, 3H), 4.92 (t, *J* = 7.1 Hz, 1H), 3.64 (d, *J* = 7.1 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.21, 147.06, 136.35, 133.64, 133.42 (2C), 132.96, 132.21 (2C), 129.10 (2C), 128.79 (2C), 128.66 (2C), 128.27, 128.06 (2C), 118.73, 111.02, 48.16, 44.04.
HRMS (EI) *m/z* calcd for $C_{22}H_{17}NOS$ [M]+ 343.1034 found 343,1033.

6n 3-(benzo[d][1,3]dioxol-5-yl)-1-phenyl-3-(phenylthio)propan-1-one.



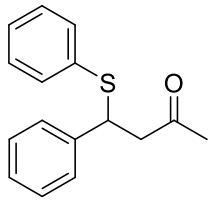
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (dd, *J* = 5.2, 3.3 Hz, 2H), 7.53-7.47 (m, 1H), 7.41-7.36 (m, 2H), 7.36-7.30 (m, 2H), 7.26-7.17 (m, 3H), 6.89 (d, *J* = 1.8 Hz, 1H), 6.75 (dd, *J* = 8.0, 1.8 Hz, 1H), 6.63 (d, *J* = 8.0 Hz, 1H), 5.84 (dd, *J* = 3.0, 1.4 Hz, 2H), 4.90 (dd, *J* = 8.4, 5.8 Hz, 1H), 3.59 (dd, *J* = 17.1, 8.4 Hz, 1H), 3.50 (dd, *J* = 17.1, 5.8 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.00, 147.76, 146.82, 136.75, 135.05, 134.39 133.31, 132.66 (2C), 128.94 (2C), 128.66 (2C), 128.10 (2C), 127.56, 121.32, 108.14, 108.04, 101.07, 48.21, 44.96.
HRMS (EI) *m/z* calcd for $C_{22}H_{18}O_3S$ [M]+ 362.0977, found 362.0974.

6o 3-(furan-2-yl)-1-phenyl-3-(phenylthio)propan-1-one.



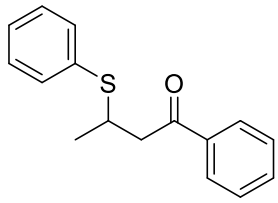
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (dt, *J* = 8.5, 1.6 Hz, 2H), 7.58-7.52 (m, 1H), 7.47-7.41 (m, 2H), 7.38-7.30 (m, 3H), 7.28-7.22 (m, 3H), 6.21 (dd, *J* = 3.2, 1.9 Hz, 1H), 6.01 (d, *J* = 3.2 Hz, 1H), 4.98 (dd, *J* = 7.8, 6.3 Hz, 1H), 3.69 (dd, *J* = 17.3, 7.9 Hz, 1H), 3.53 (dd, *J* = 17.3, 6.3 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.54, 153.34, 141.94, 136.62, 133.80 (2C), 133.38, 133.31, 128.87 (2C), 128.69 (2C), 128.15 (2C), 128.06, 110.34, 107.40, 42.09 (2C), 41.67 (2C).
HRMS (EI) *m/z* calcd for $C_{116}H_{16}O_2S$ [M]+ 308.0871, found 308.0872.

6p 4-phenyl-4-(phenylthio)butan-2-one.



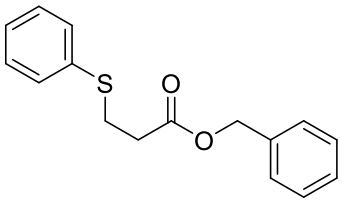
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32-7.14 (m, 10H), 4.70 (dd, *J* = 7.7, 6.8 Hz, 1H), 3.10-2.97 (m, 2H), 2.03 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 205.52, 141.08, 134.09, 132.91 (2C), 128.87 (2C), 128.52 (2C), 127.74 (2C), 127.64, 127.46, 49.53, 48.08, 30.70.
HRMS (EI) *m/z* calcd for $C_{116}H_{16}OS$ [M]+ 256.0922, found 256.0926.

6q 1-phenyl-3-(phenylthio)butan-1-one.



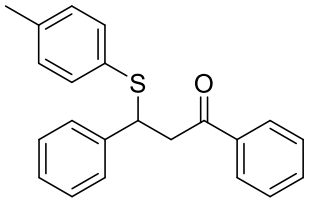
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (dt, *J* = 8.5, 1.6 Hz, 2H), 7.58-7.52 (m, 1H), 7.48-7.39 (m, 4H), 7.34-7.21 (m, 3H), 3.90 (dqd, *J* = 9.0, 6.7, 4.6 Hz, 1H), 3.30 (dd, *J* = 16.9, 4.6 Hz, 1H), 3.10 (dd, *J* = 16.9, 9.0 Hz, 1H), 1.37 (d, *J* = 6.7 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.07, 136.87, 134.43, 133.27, 132.36 (2C), 129.00 (2C), 128.66 (2C), 128.09 (2C), 127.25, 45.50, 38.80, 21.04.
HRMS (EI) *m/z* calcd for $C_{116}H_{16}OS$ [M]+ 256.0922, found 256.0923.

6r benzyl 3-(phenylthio)propanoate.



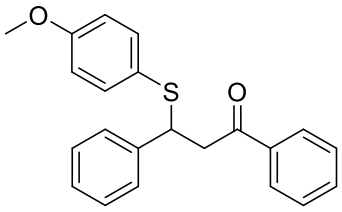
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.30 (m, 7H), 7.30-7.25 (m, 2H), 7.24-7.16 (m, 1H), 5.12 (s, 2H), 3.18 (t, *J* = 7.4 Hz, 2H), 2.67 (t, *J* = 7.4 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.58, 135.72, 135.15, 130.25 (2C), 129.04 (2C), 128.59 (2C), 128.33, 128.28 (2C), 126.64, 66.58, 34.48, 29.12.
HRMS (EI) *m/z* calcd for $C_{16}H_{16}O_2S$ [M]+ 272.0871, found 272.0873.

6u 1,3-diphenyl-3-(p-tolylthio)propan-1-one.



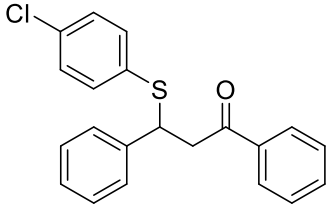
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92-7.81 (m, 2H), 7.54-7.48 (m, 1H), 7.39 (dd, *J* = 10.6, 4.7 Hz, 2H), 7.35-7.28 (m, 2H), 7.26-7.19 (m, 4H), 7.19-7.13 (m, 1H), 7.02 (d, *J* = 7.9 Hz, 2H), 4.88 (dd, *J* = 8.1, 6.1 Hz, 1H), 3.63 (dd, *J* = 17.1, 8.1 Hz, 1H), 3.55 (dd, *J* = 17.1, 6.1 Hz, 1H), 2.27 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.11, 141.45, 137.86, 136.88, 133.52 (2C), 133.24, 130.54, 129.71 (2C), 128.64 (2C), 128.47 (2C), 128.12 (2C), 127.90 (2C), 127.35, 48.76, 44.70, 21.18.
HRMS (EI) *m/z* calcd for $C_{22}H_{20}OS$ [M]+ 332.1235, found 332.1236.

6v 3-((4-methoxyphenyl)thio)-1,3-diphenylpropan-1-one.



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92-7.82 (m, 2H), 7.55-7.48 (m, 1H), 7.40 (t, *J* = 7.7 Hz, 2H), 7.28-7.20 (m, 6H), 7.20-7.12 (m, 1H), 6.78-6.69 (m, 2H), 4.99-4.59 (m, 1H), 3.73 (s, 3H), 3.65-3.52 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.14, 159.89, 141.45, 136.84, 136.28 (2C), 133.25, 128.65 (2C), 128.41 (2C), 128.10 (2C), 127.89 (2C), 127.29, 124.26, 114.42 (2C), 55.30, 49.44, 44.31.
HRMS (EI) *m/z* calcd for $C_{22}H_{20}O_2S$ [M]+ 348.1184, found 348.1185.

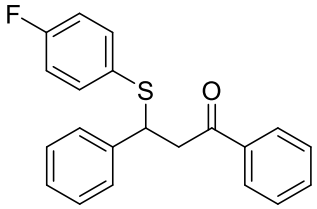
6w 3-((4-chlorophenyl)thio)-1,3-diphenylpropan-1-one.



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93-7.81 (m, 2H), 7.56-7.49 (m, 1H), 7.41 (dd, *J* = 10.6, 4.7 Hz, 2H), 7.31 (dd, *J* = 5.3, 3.4 Hz, 2H), 7.27-7.12 (m, 7H), 4.91 (t, *J* = 7.0 Hz, 1H), 3.66-3.51 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.73, 141.07, 136.72, 134.26 (2C), 133.83, 133.36, 132.71, 129.00 (2C), 128.68 (2C), 128.55 (2C), 128.09 (2C), 127.82 (2C), 127.53, 48.57, 44.58.

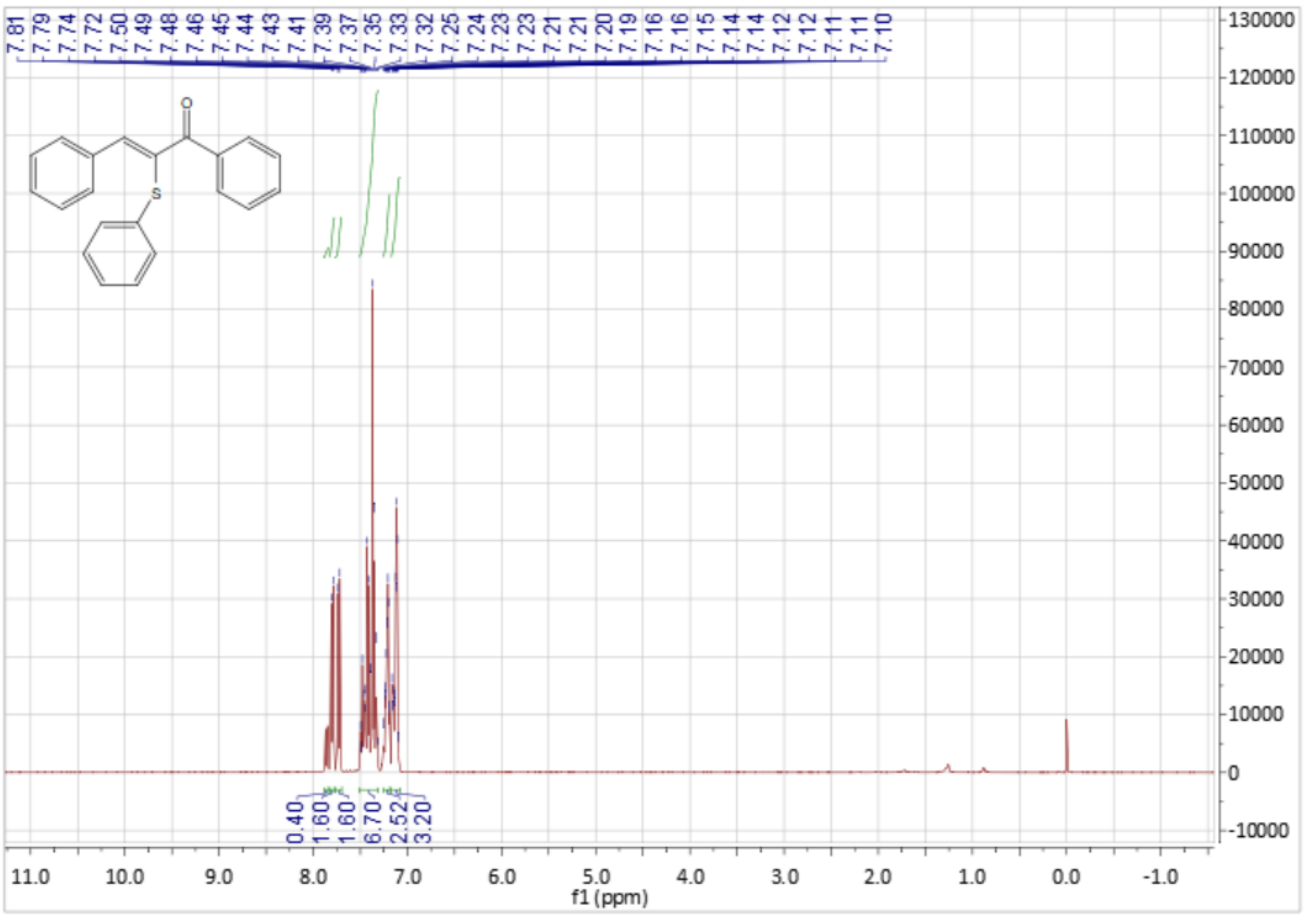
HRMS (EI) *m/z* calcd for $C_{21}H_{17}{}^{35}ClOS$ [M]+ 352.0689, found 352.0688.
HRMS (EI) *m/z* calcd for $C_{21}H_{17}{}^{35}ClOS$ [M]+ 354.0659, found 354.0663.

6x 3-((4-fluorophenyl)thio)-1,3-diphenylpropan-1-one.

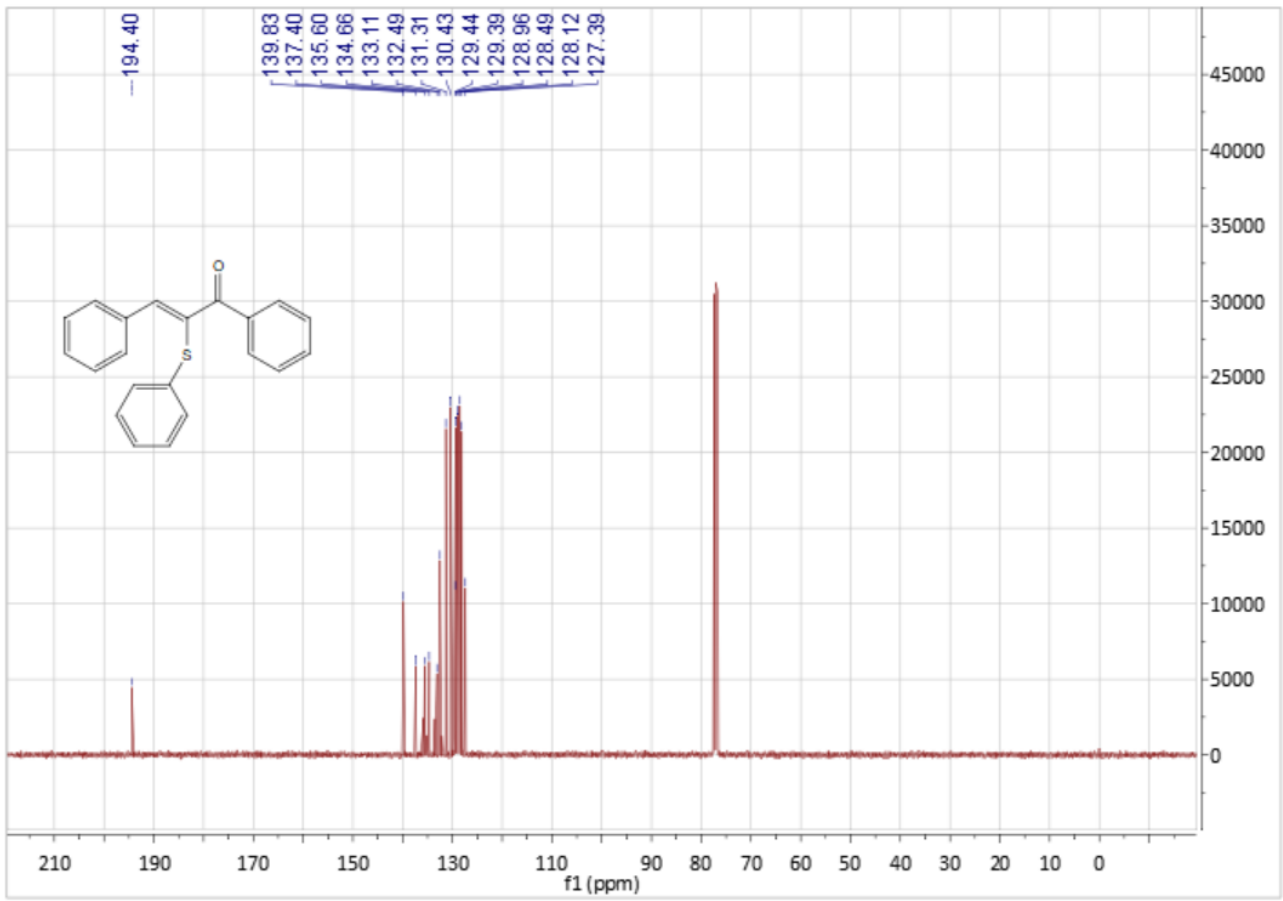


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97-7.82 (m, 2H), 7.52 (dd, *J* = 10.5, 4.2 Hz, 1H), 7.42 (t, *J* = 7.7 Hz, 2H), 7.25 (tt, *J* = 12.2, 5.1 Hz, 6H), 7.20-7.12 (m, 1H), 7.00-6.77 (m, 2H), 4.84 (t, *J* = 7.1 Hz, 1H), 3.66-3.52 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.83, 162.74 (d, J_{CF} = 248.2 Hz, 1C), 141.18, 136.74, 135.98 (d, J_{CF} = 8.3 Hz, 2C), 133.35, 129.00 (d, J_{CF} = 3.4 Hz, 1C), 128.68 (2C), 128.48 (2C), 128.09 (2C), 127.83 (2C), 127.44, 115.93 (d, J_{CF} = 21.8 Hz, 2C), 49.16, 44.36.
HRMS (EI) *m/z* calcd for $C_{21}H_{17}FOS$ [M]+ 336.0984, found 336.0988.

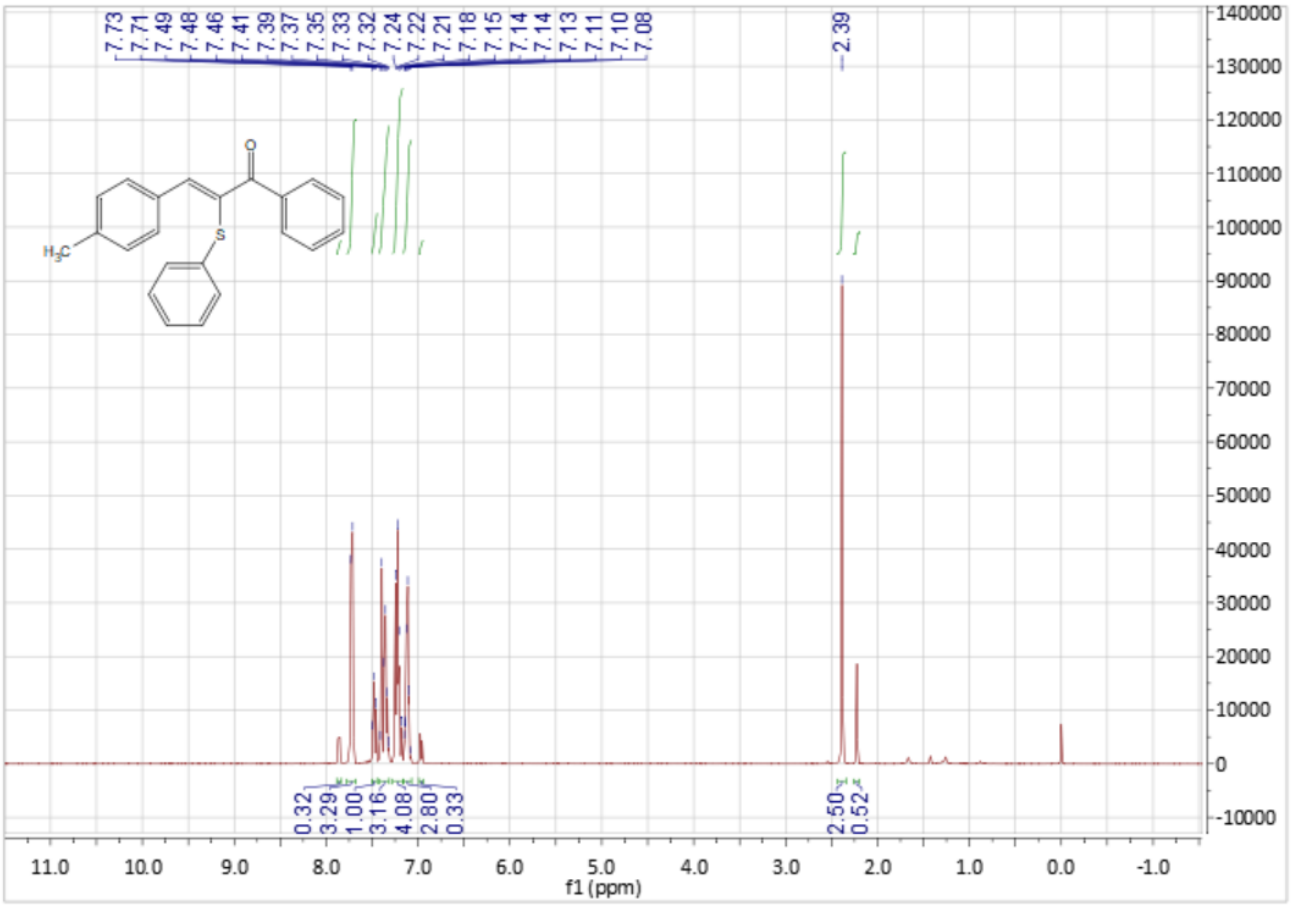
^{1}H NMR spectra of **3a**



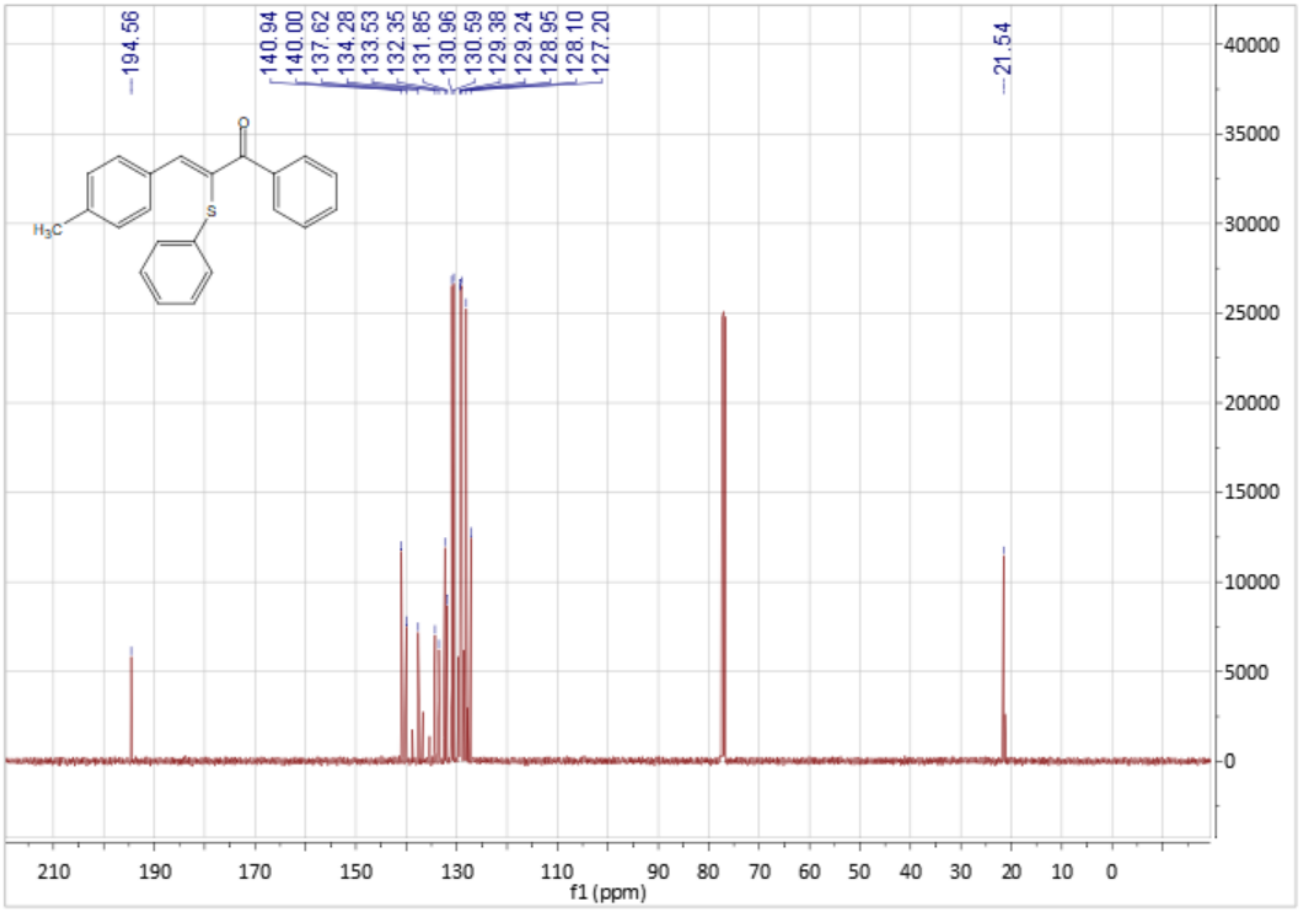
^{13}C NMR spectra of **3a**



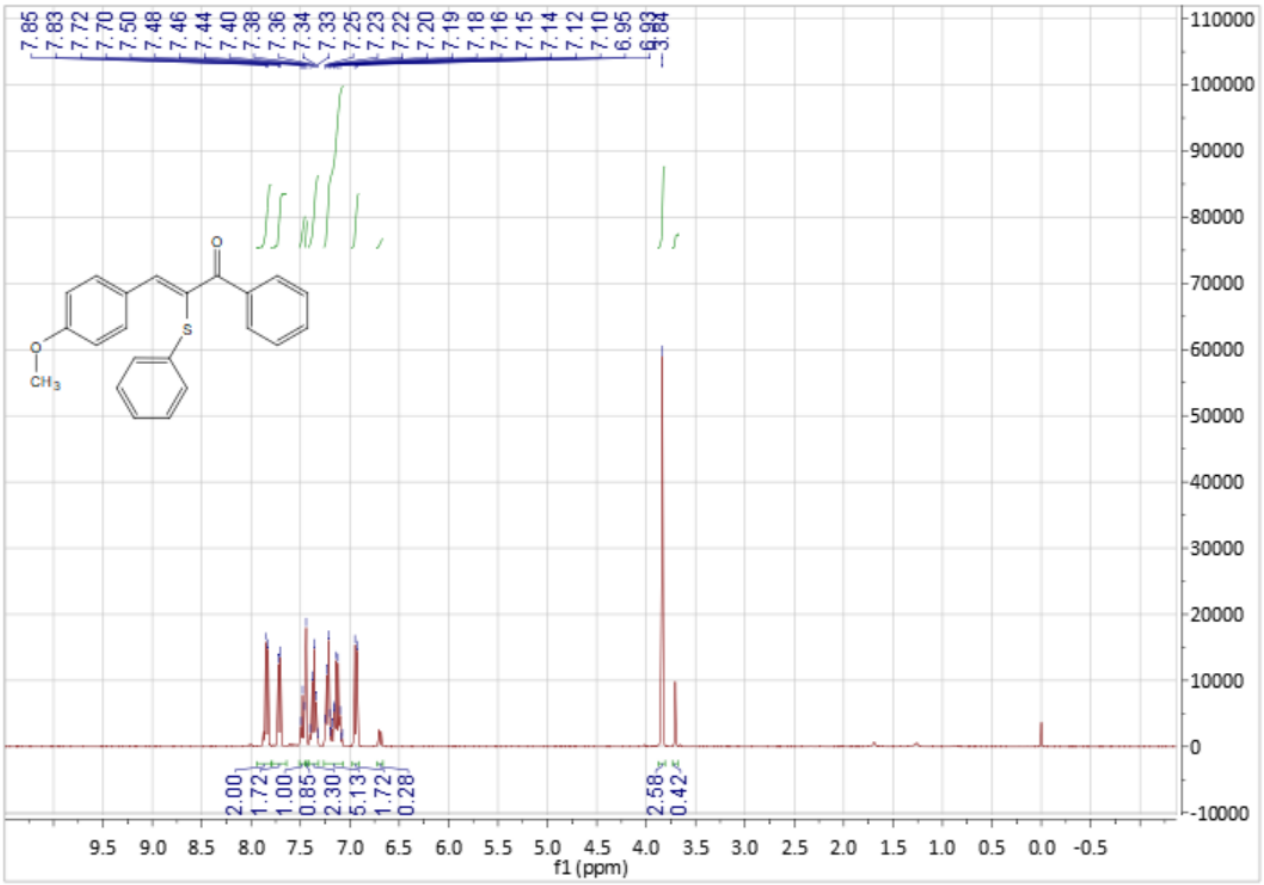
^{1}H NMR spectra of **3b**



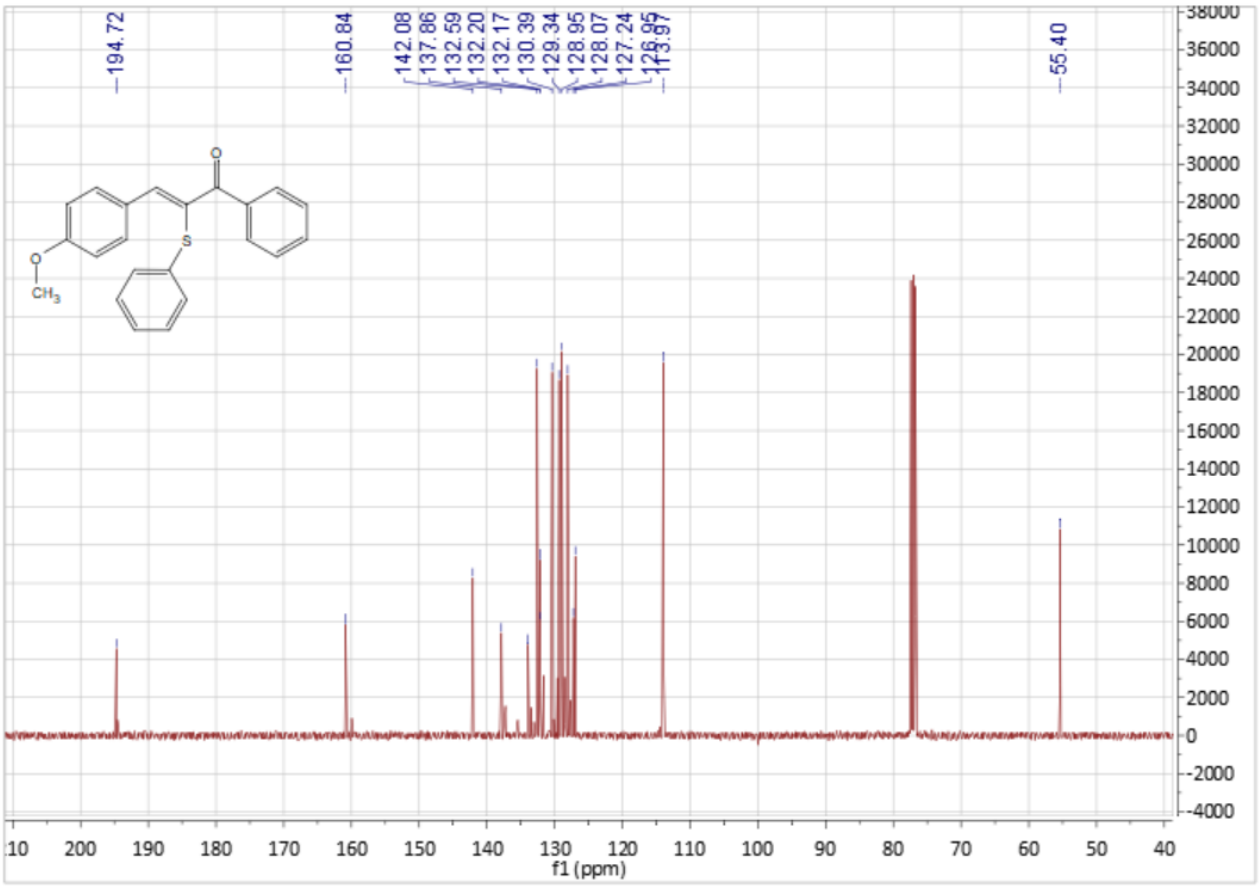
^{13}C NMR spectra of **3b**



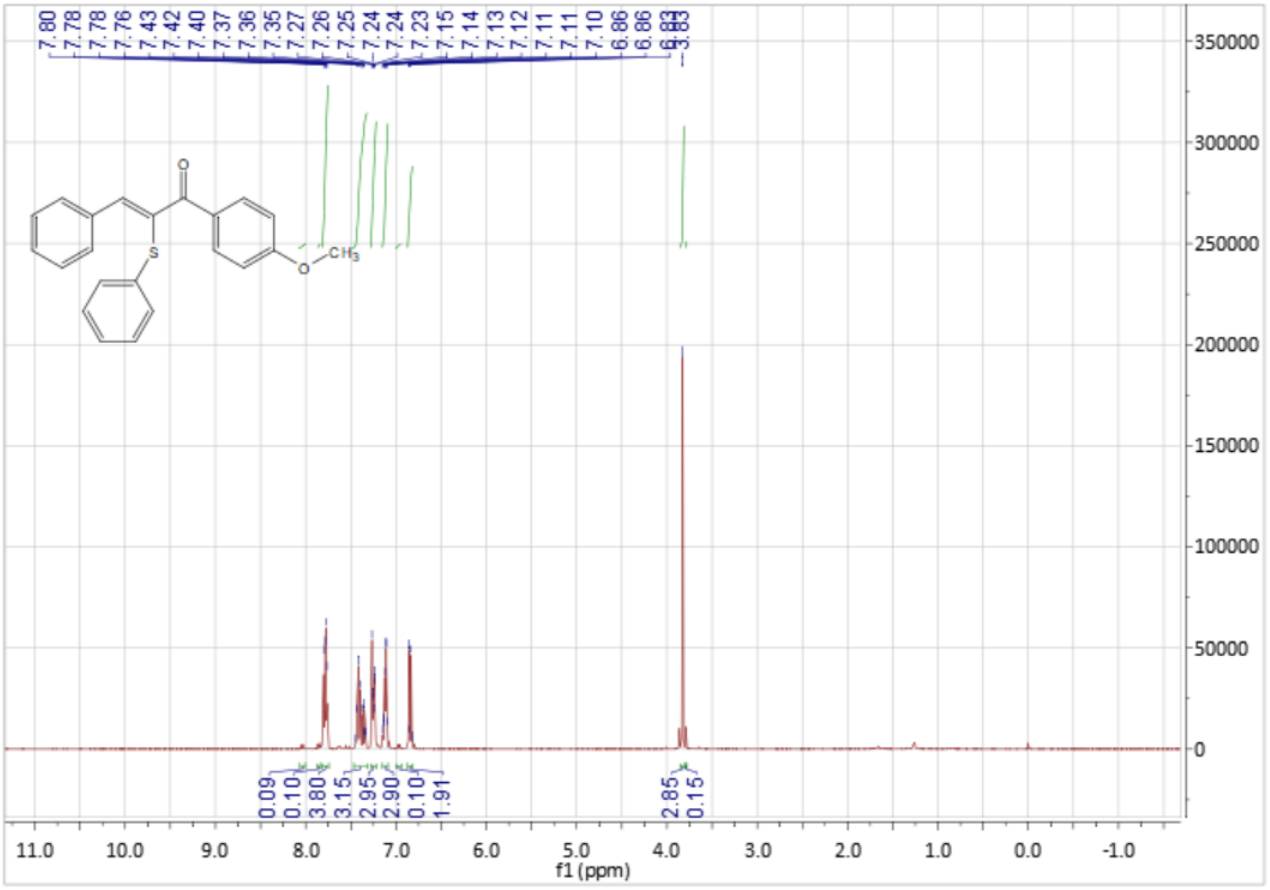
^{1}H NMR spectra of **3c**



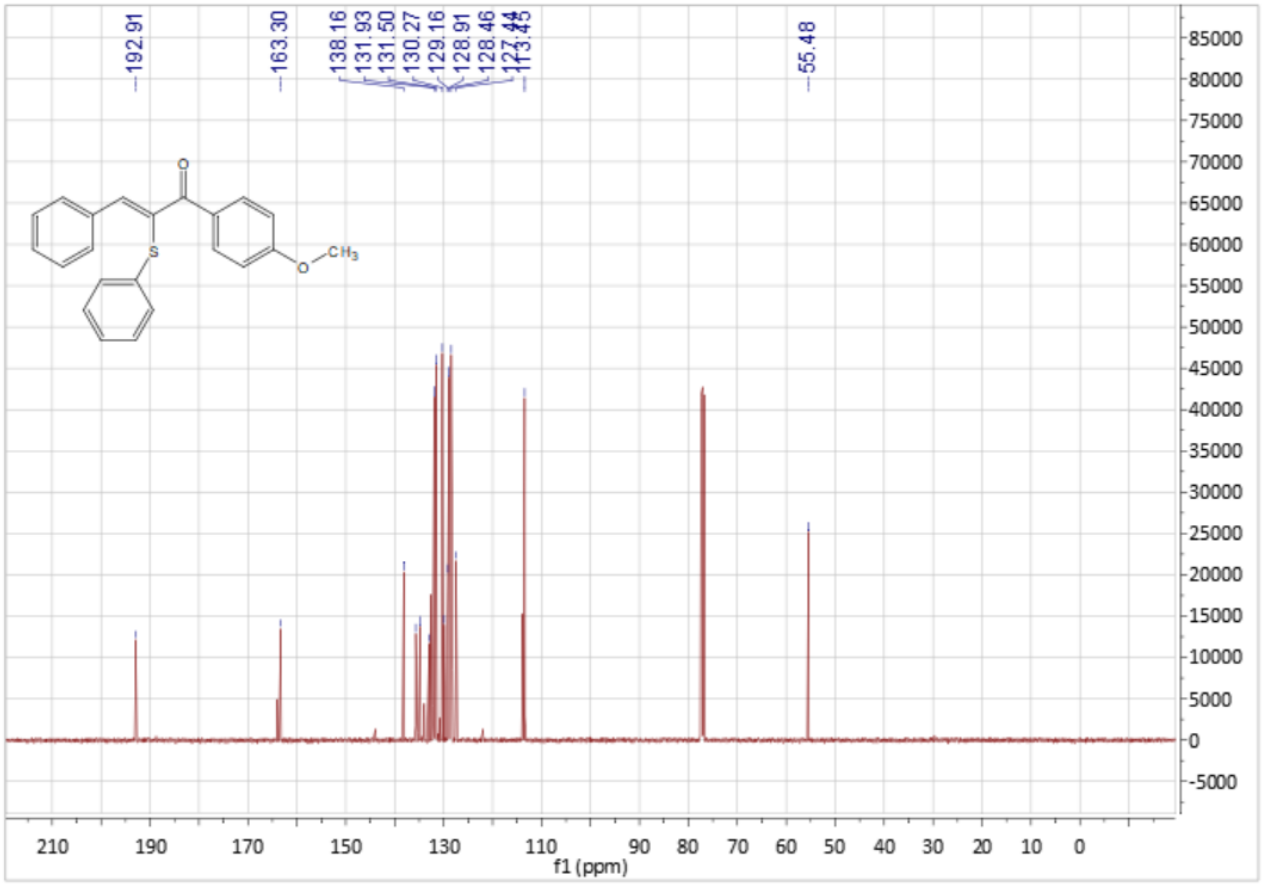
^{13}C NMR spectra of **3c**



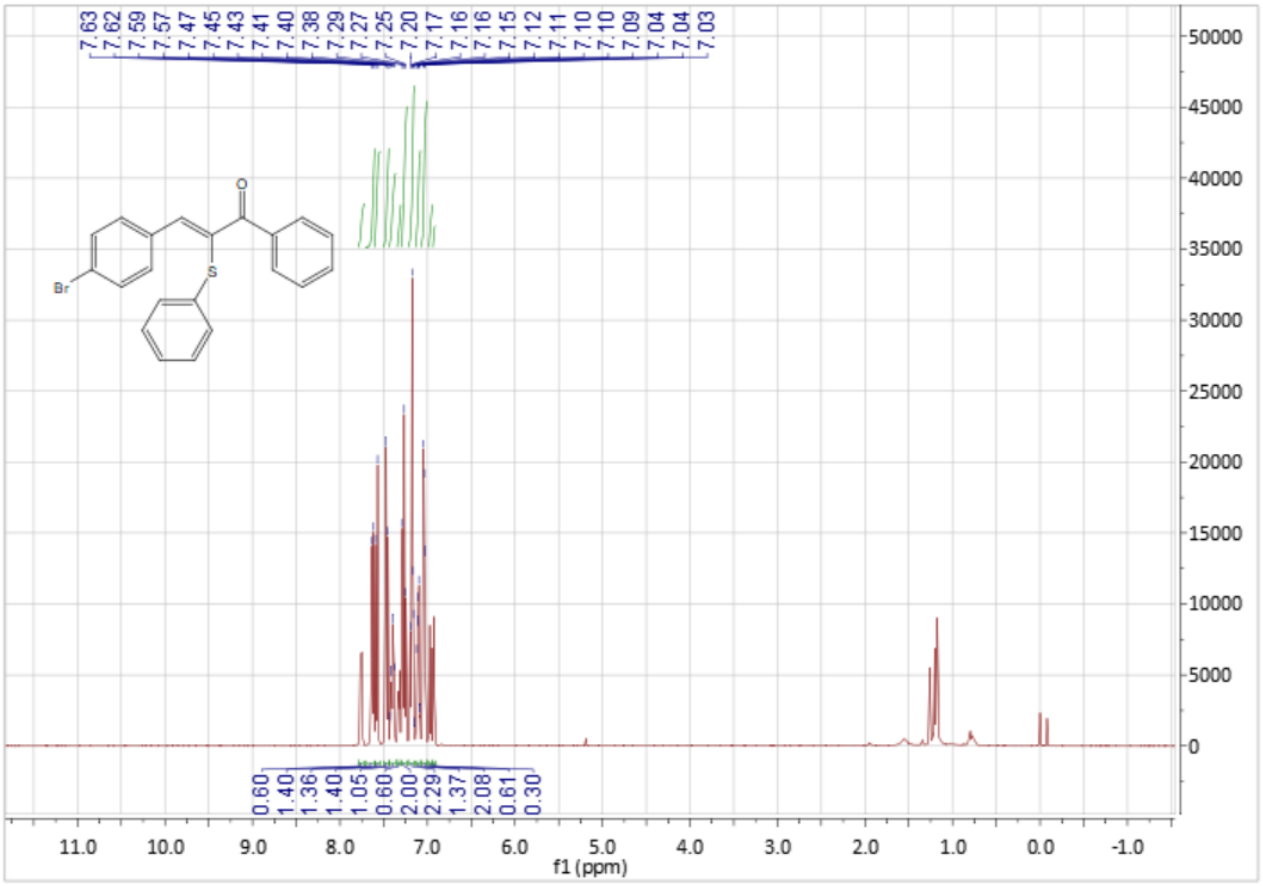
^{1}H NMR spectra of **3d**



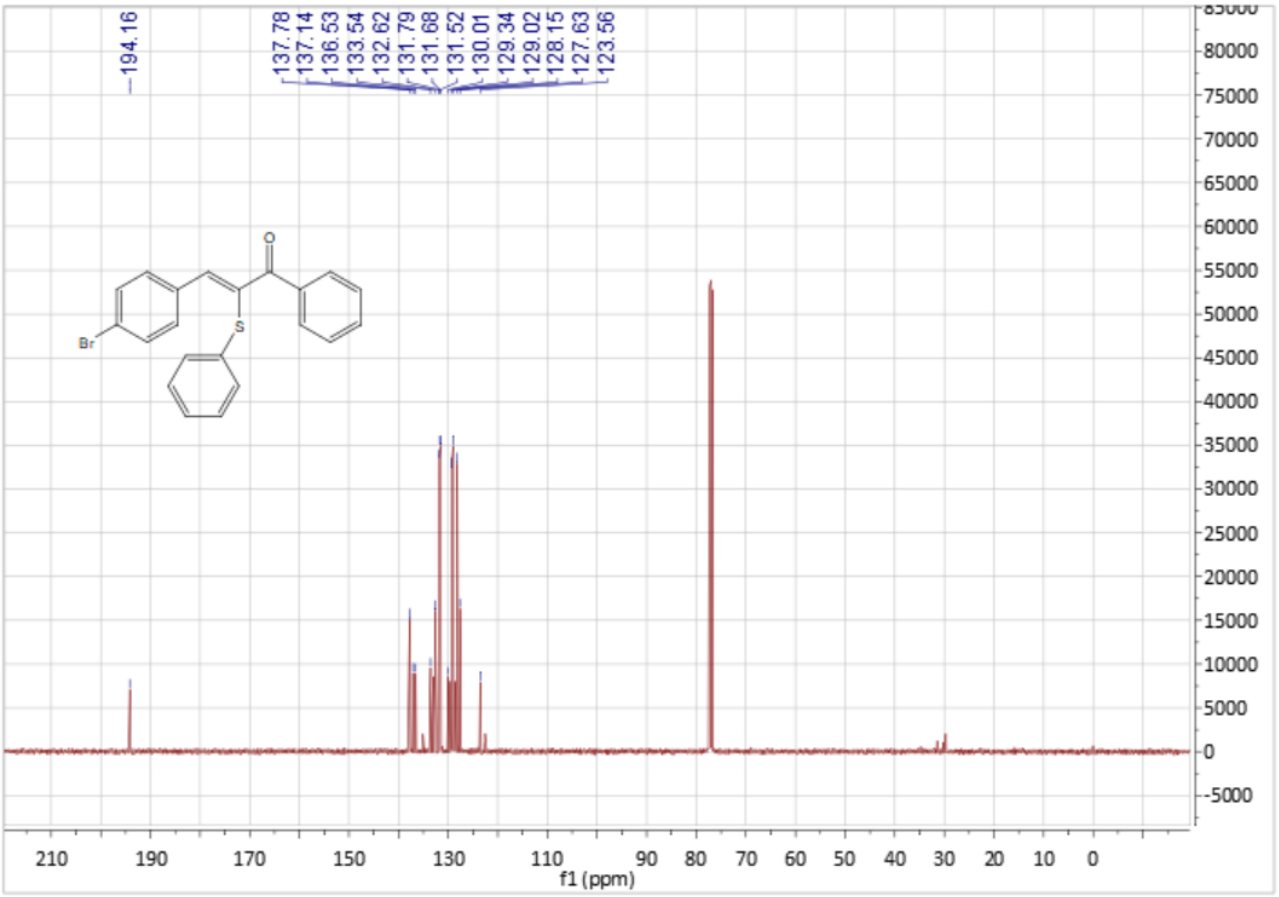
^{13}C NMR spectra of **3d**



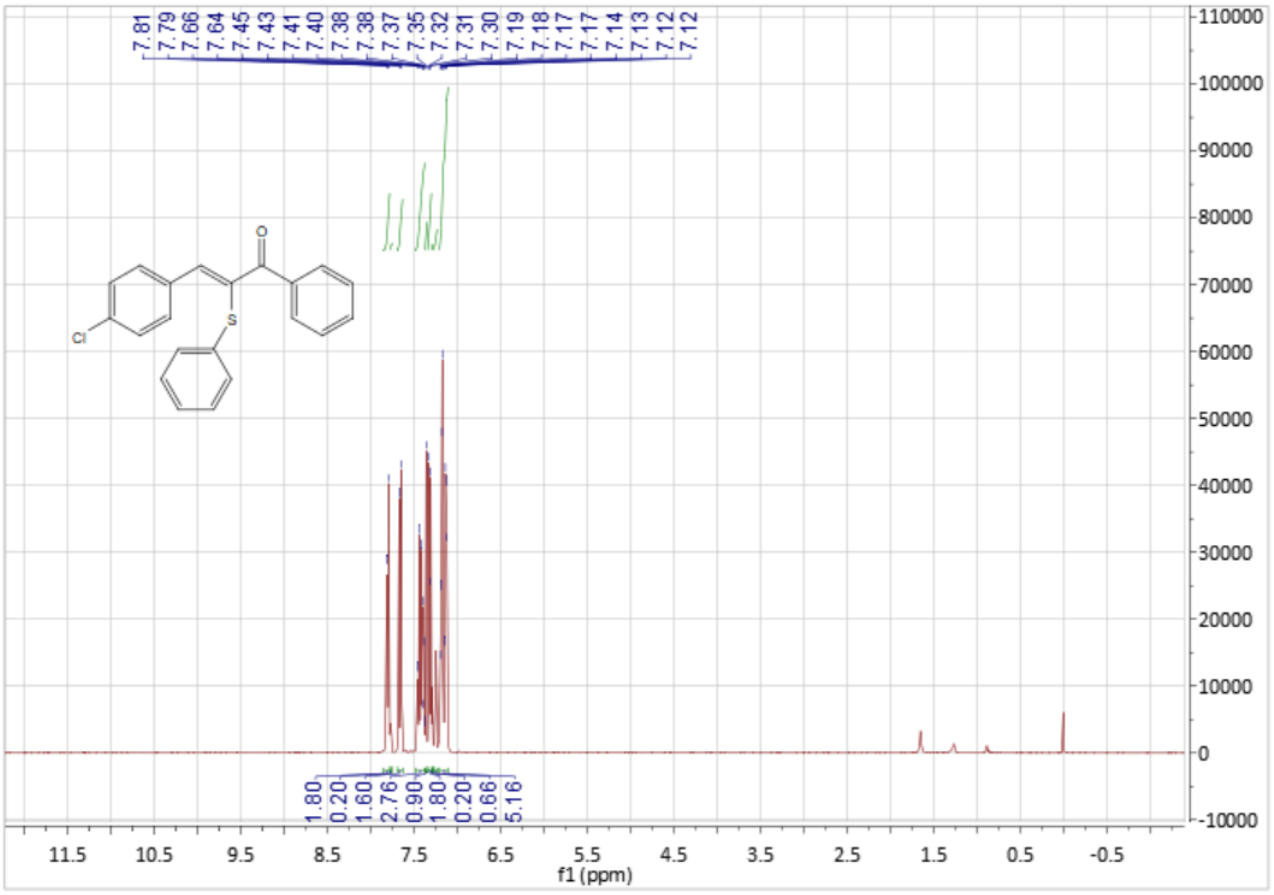
^{1}H NMR spectra of **3e**



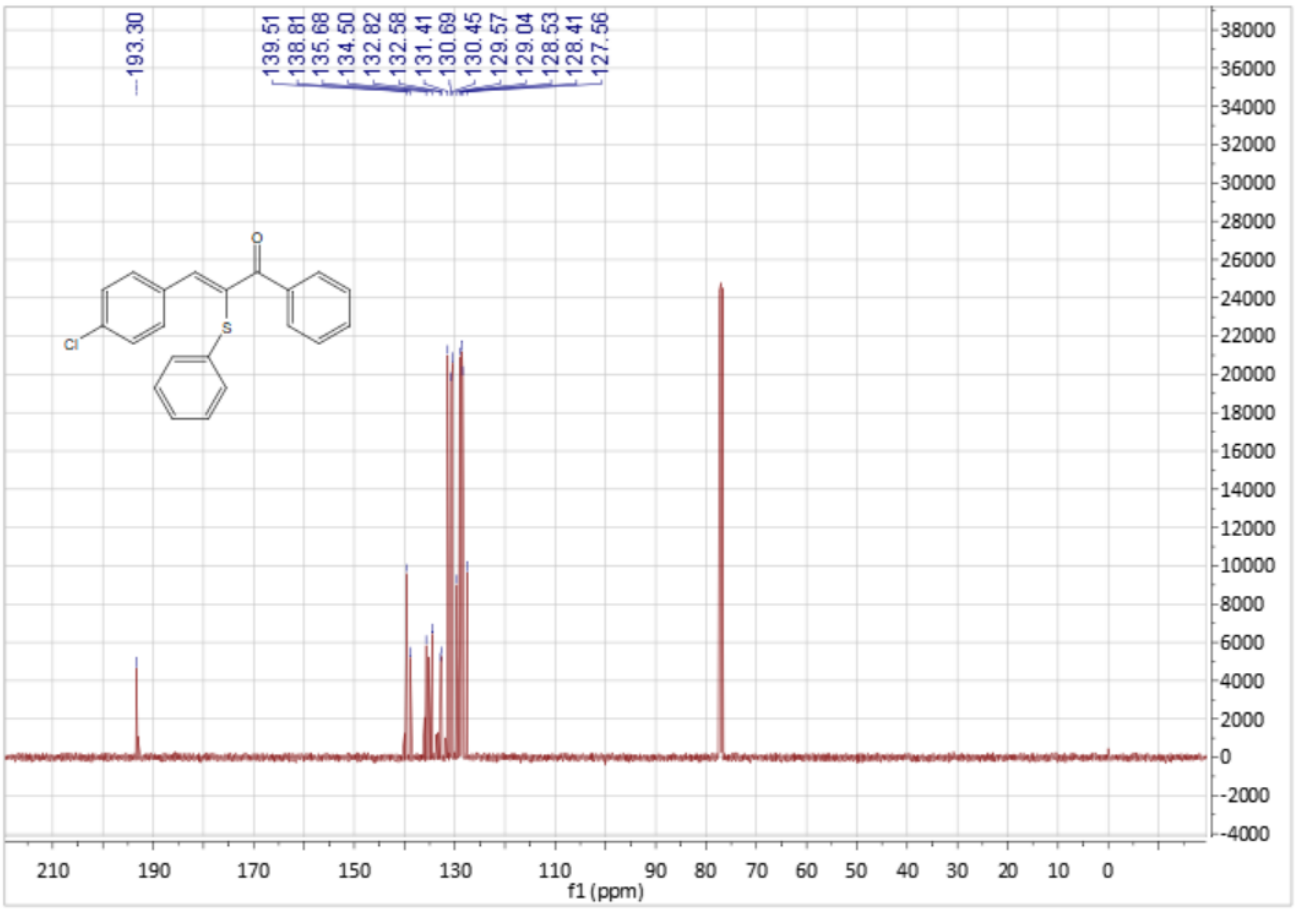
^{13}C NMR spectra of **3e**



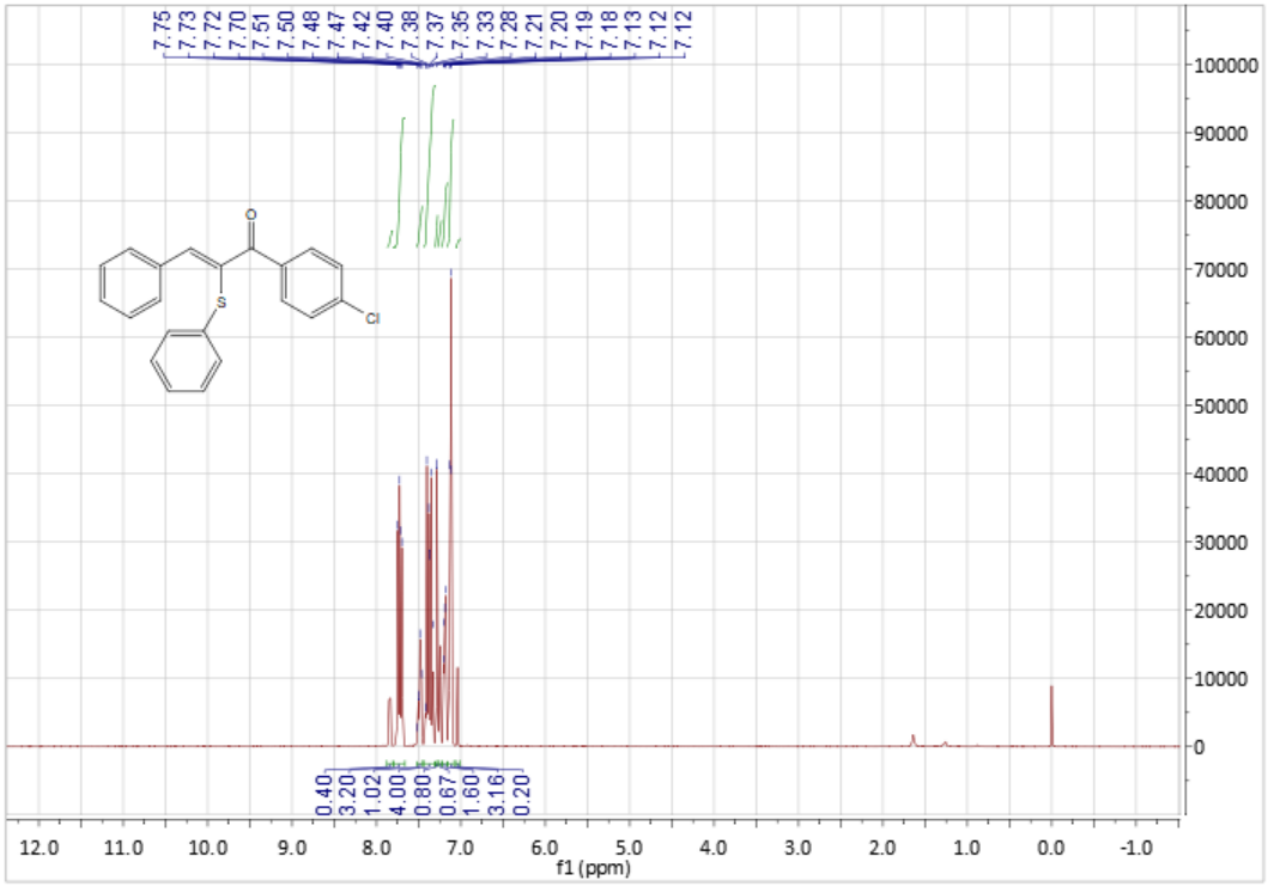
^{1}H NMR spectra of **3f**



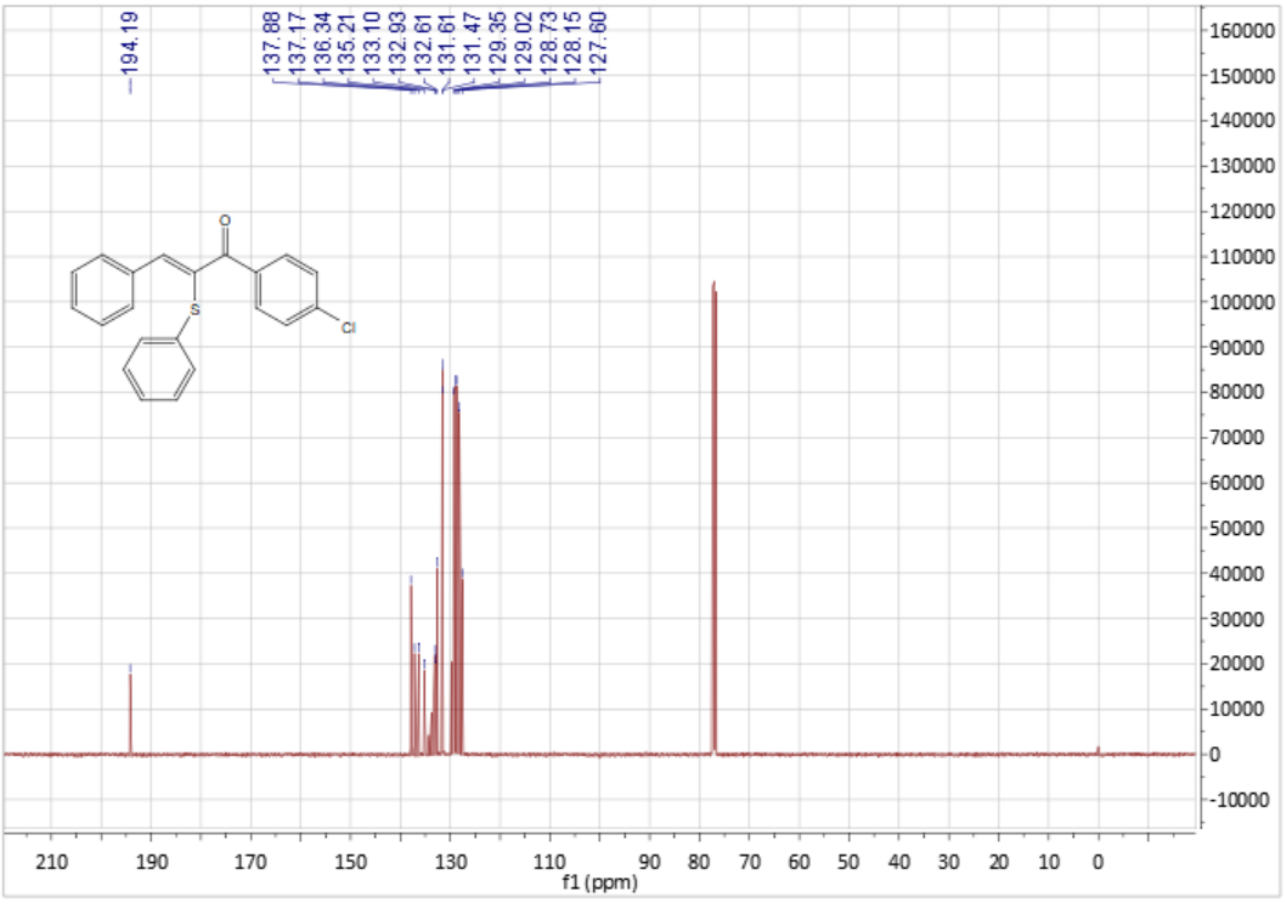
^{13}C NMR spectra of **3f**



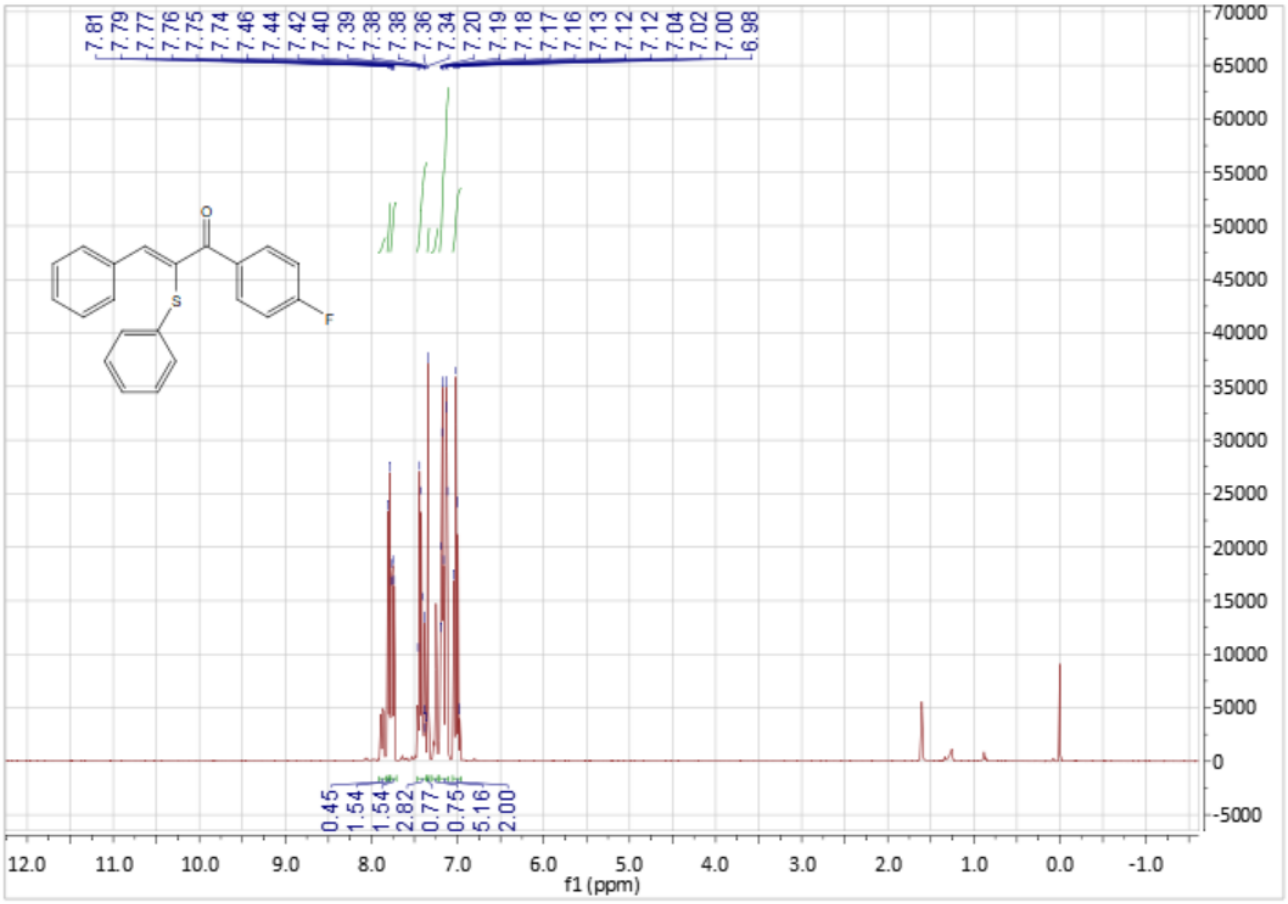
^{1}H NMR spectra of **3g**



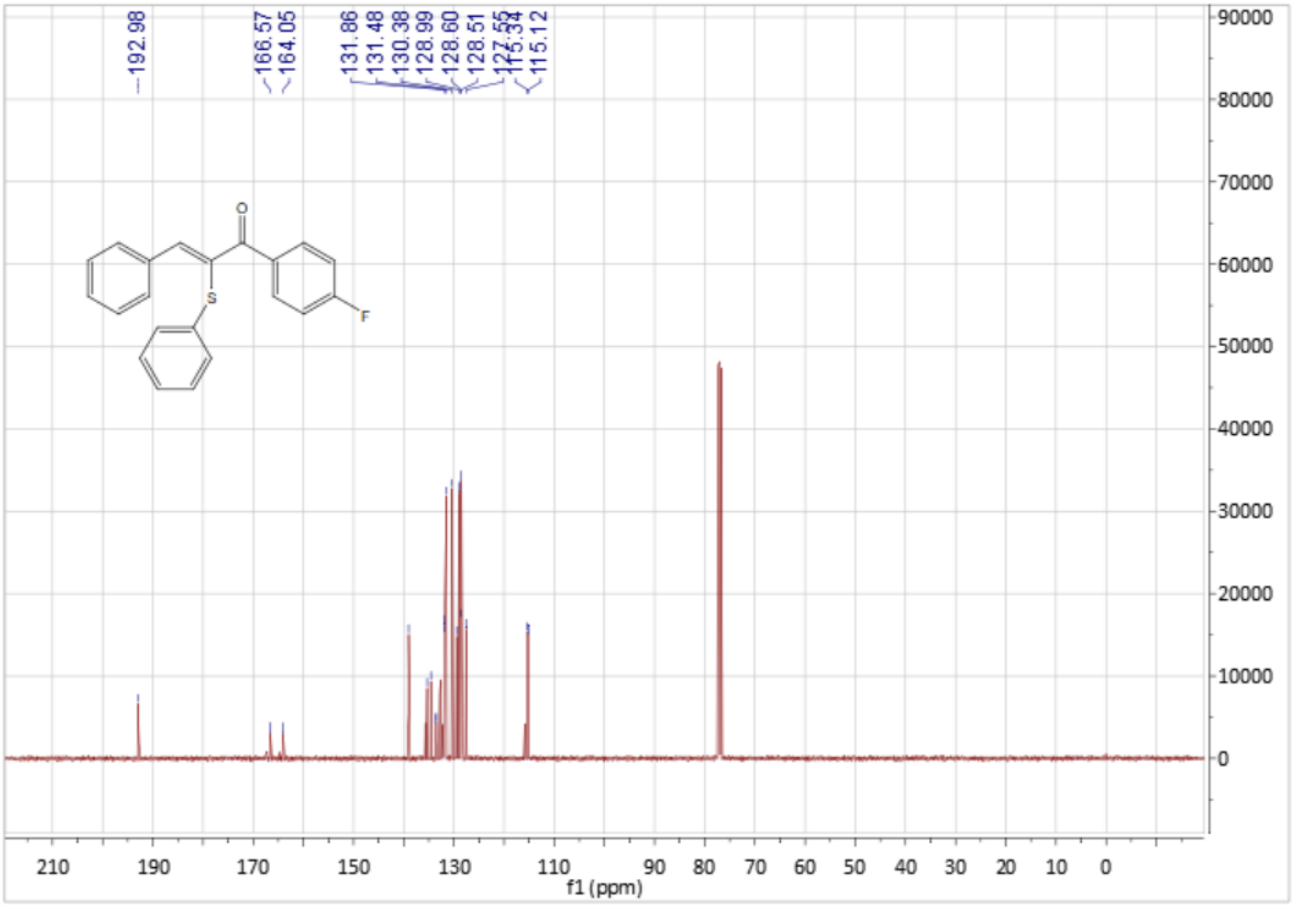
^{13}C NMR spectra of **3g**



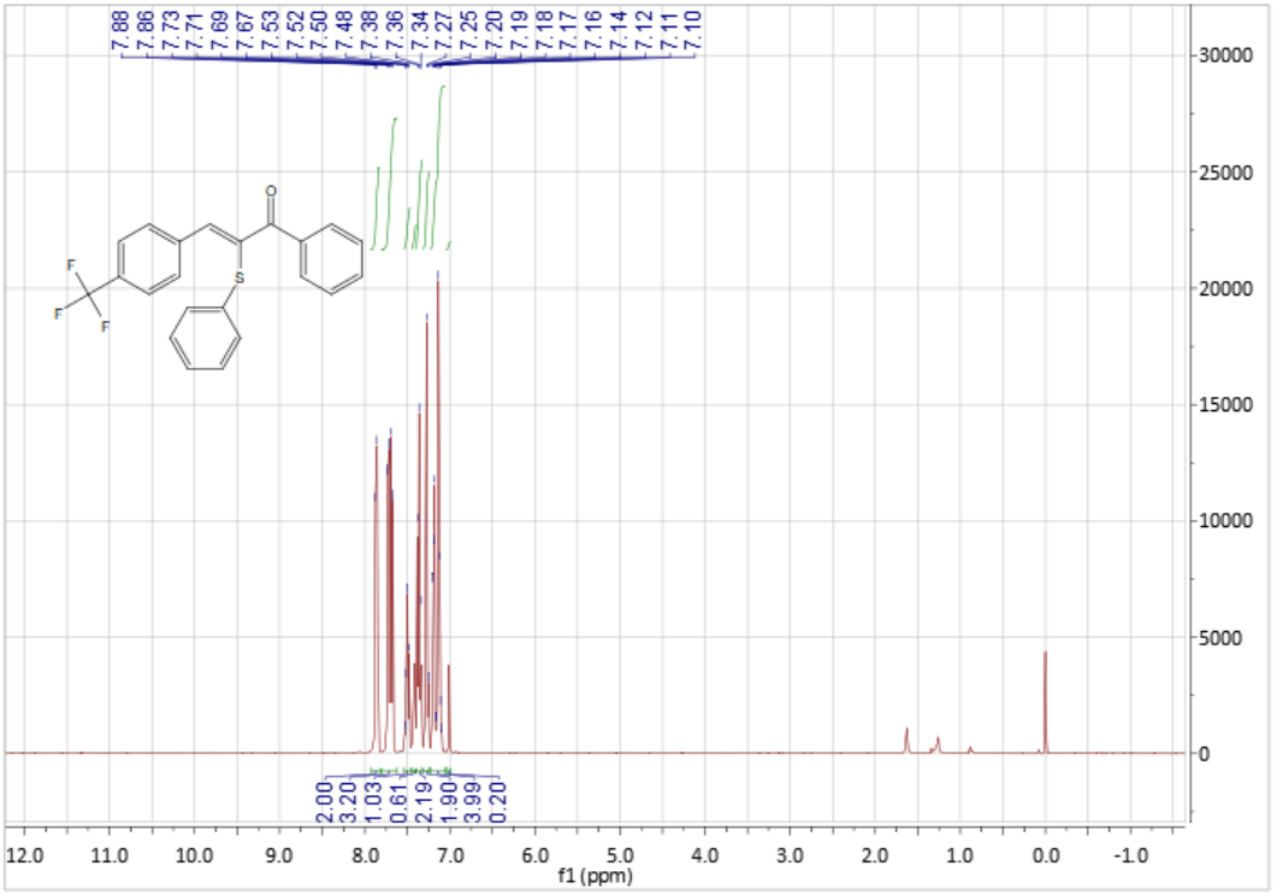
^{1}H NMR spectra of **3h**



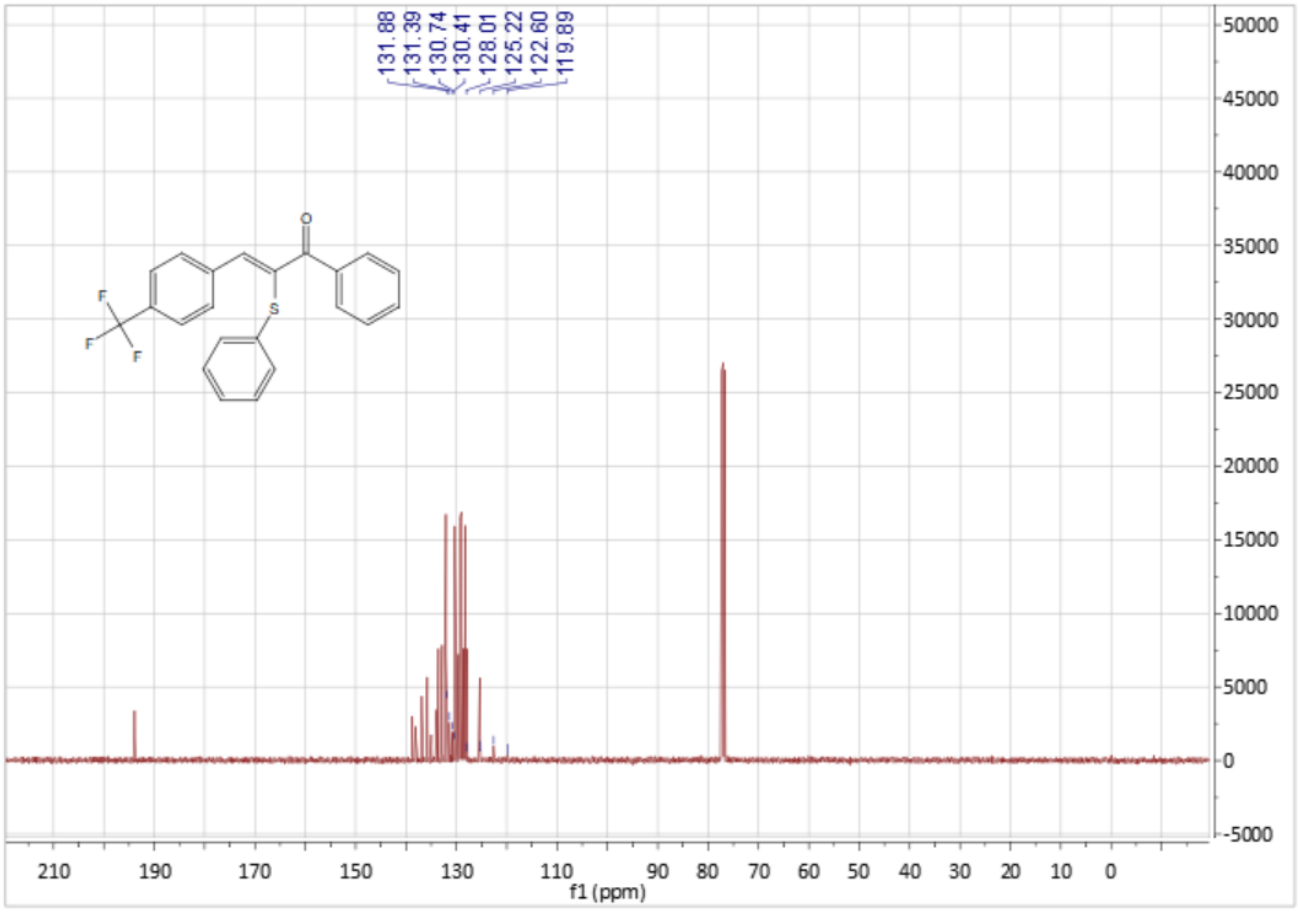
^{13}C NMR spectra of **3h**



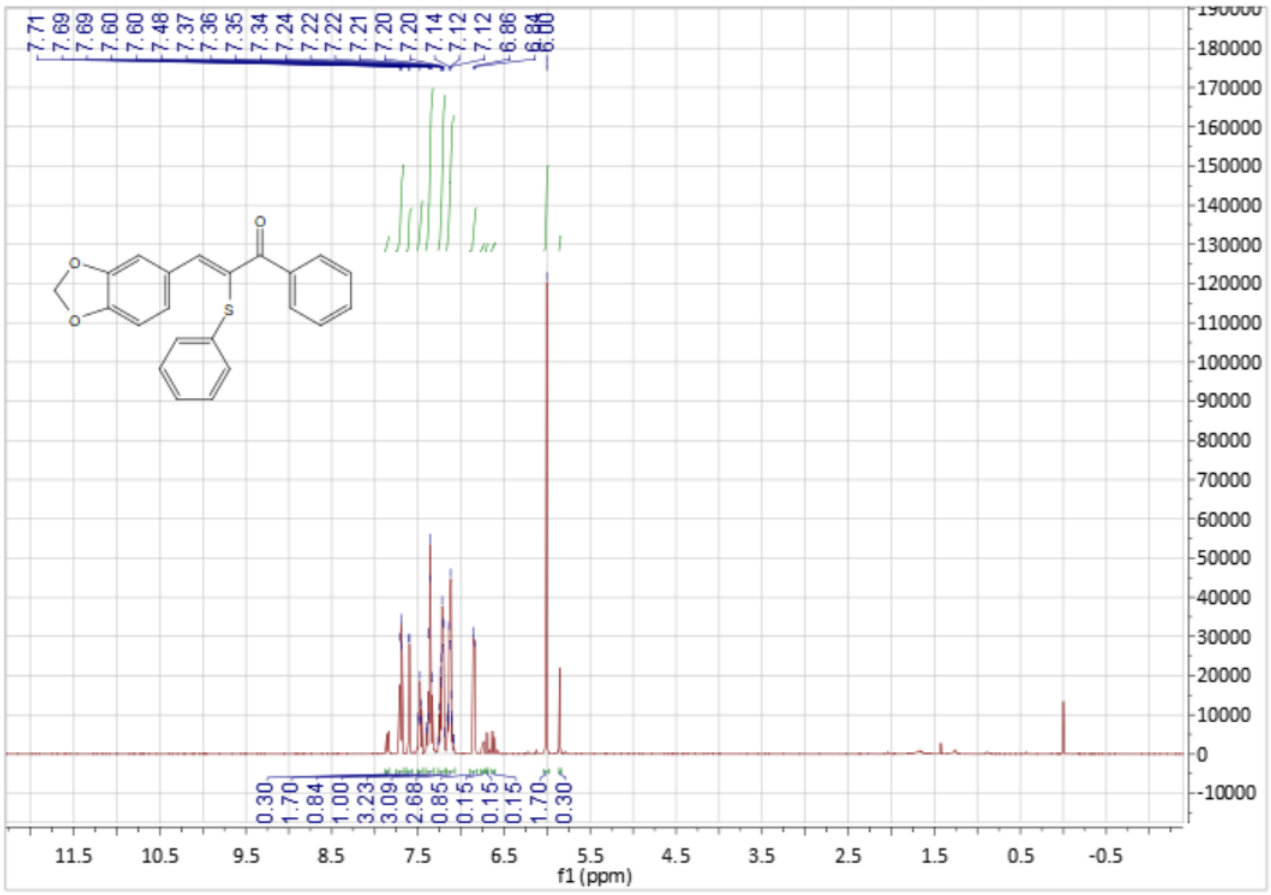
^{1}H NMR spectra of **3i**



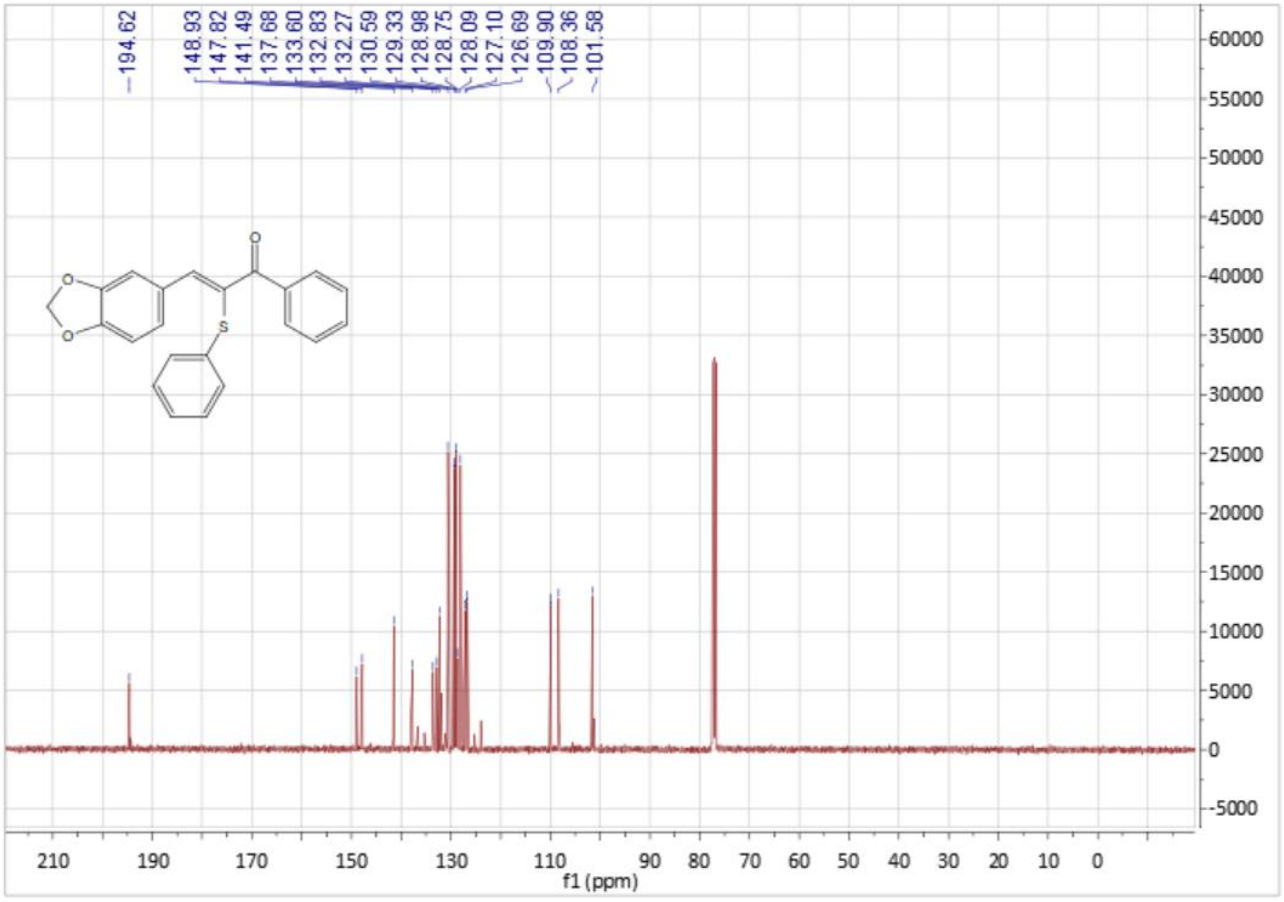
^{13}C NMR spectra of **3i**



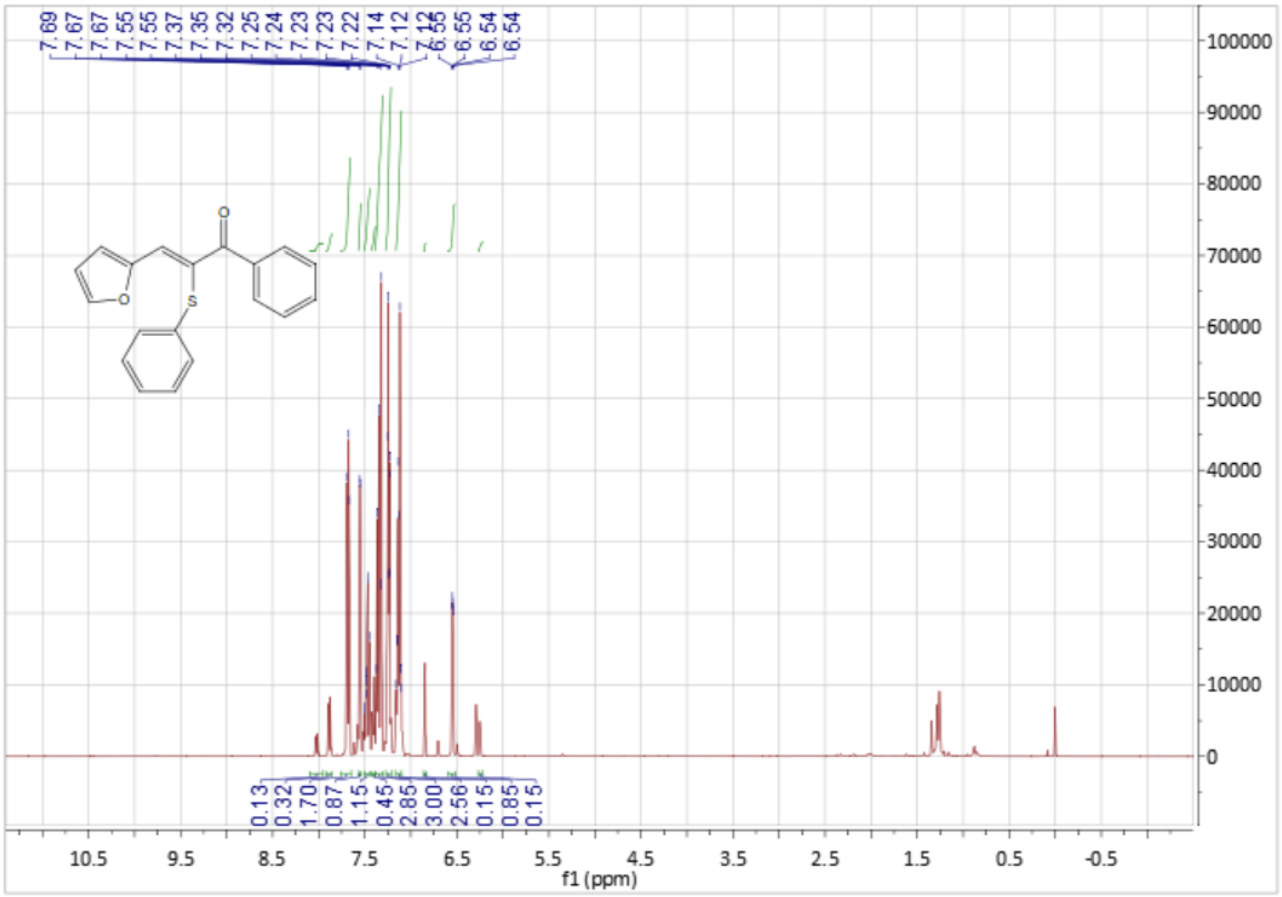
^{1}H NMR spectra of **3j**



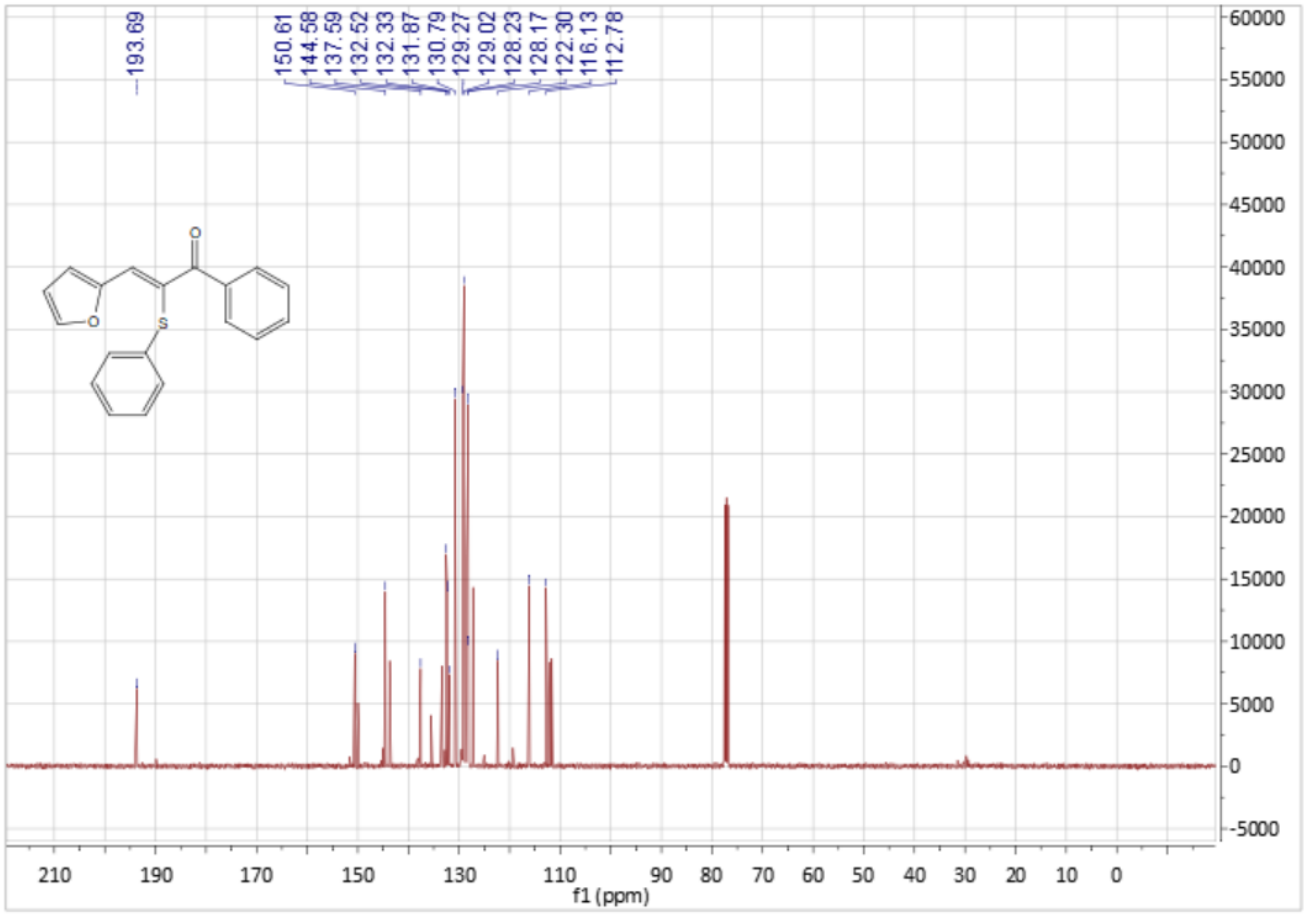
^{13}C NMR spectra of **3j**



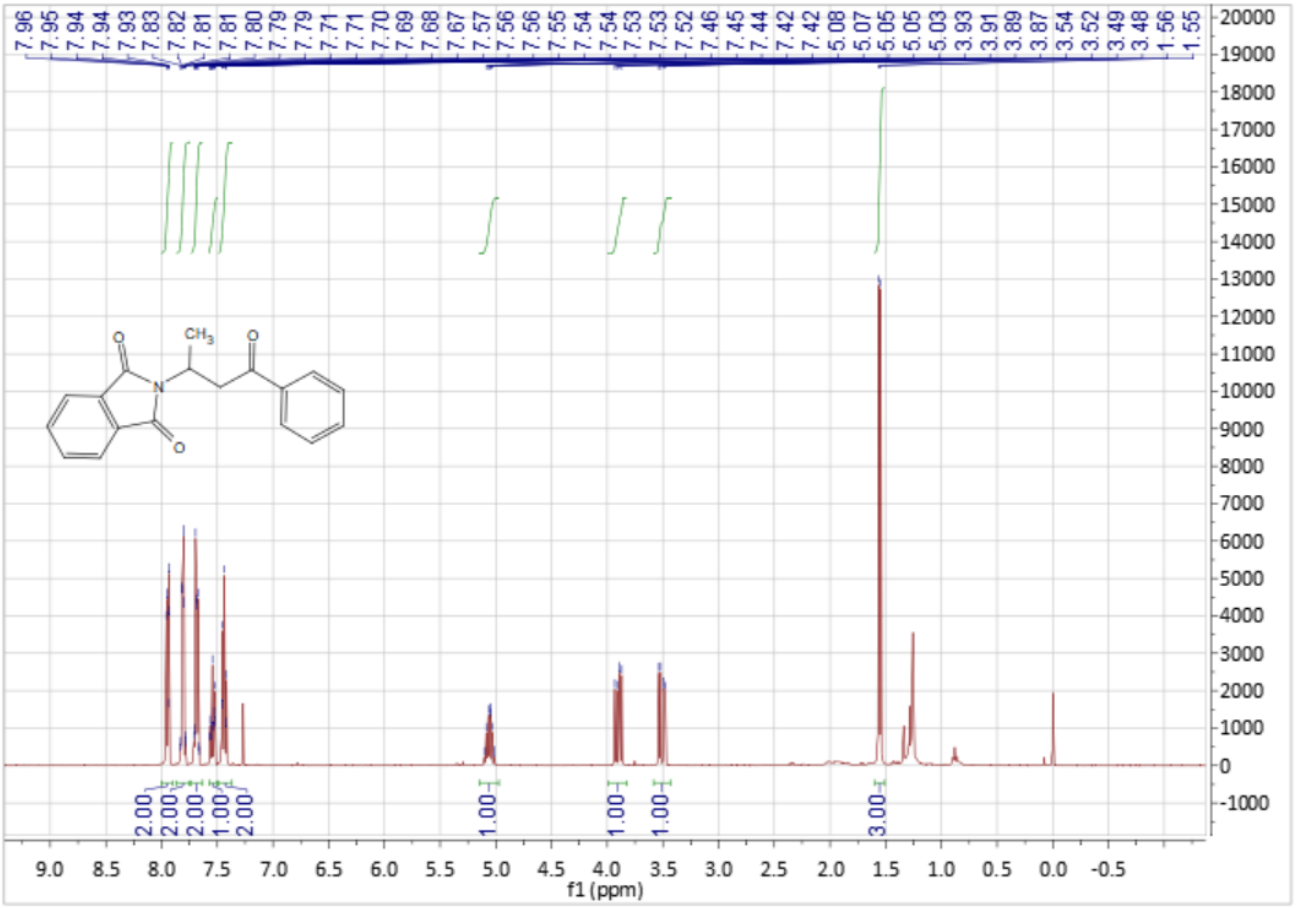
^{1}H NMR spectra of **3k**



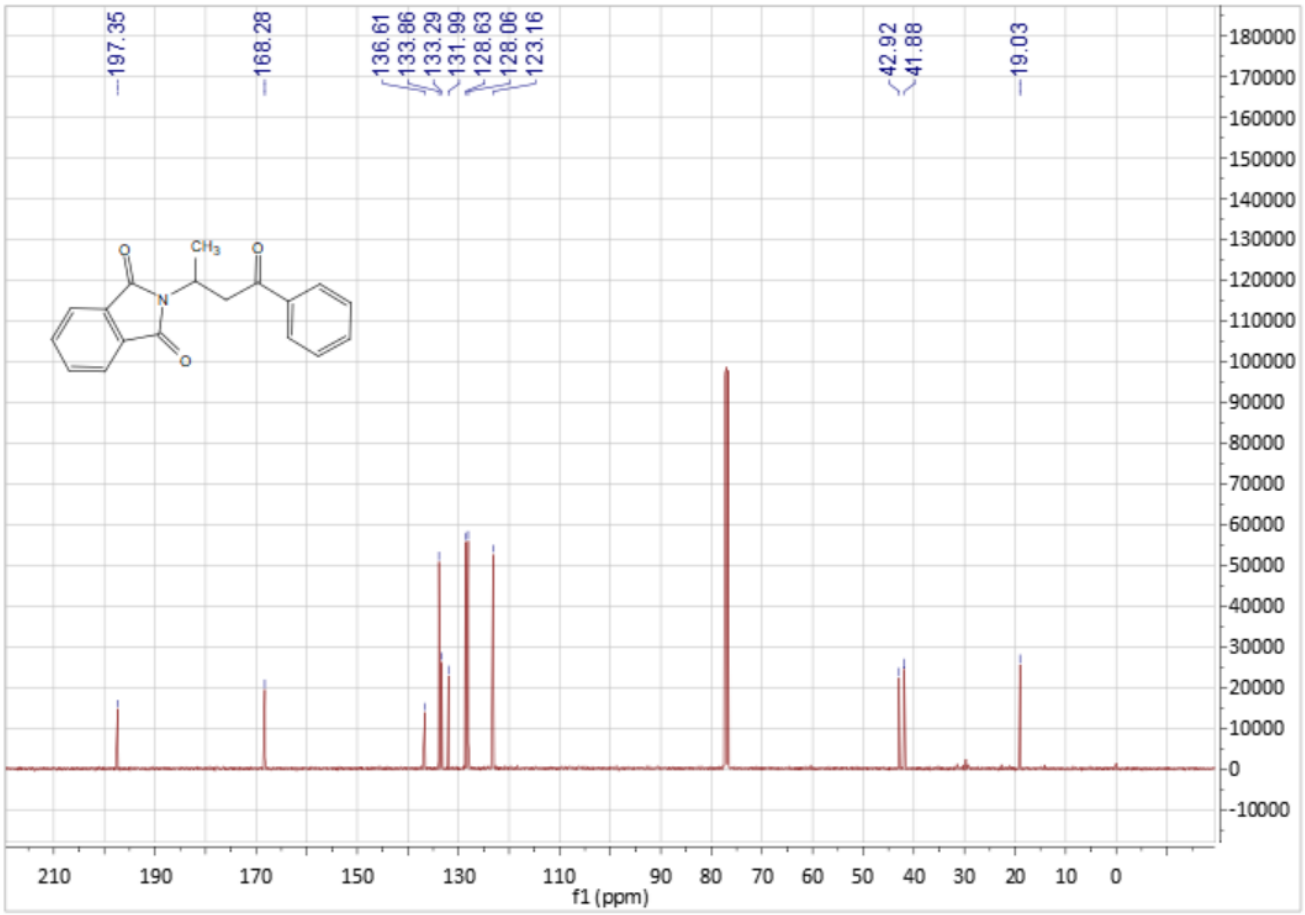
^{13}C NMR spectra of **3k**



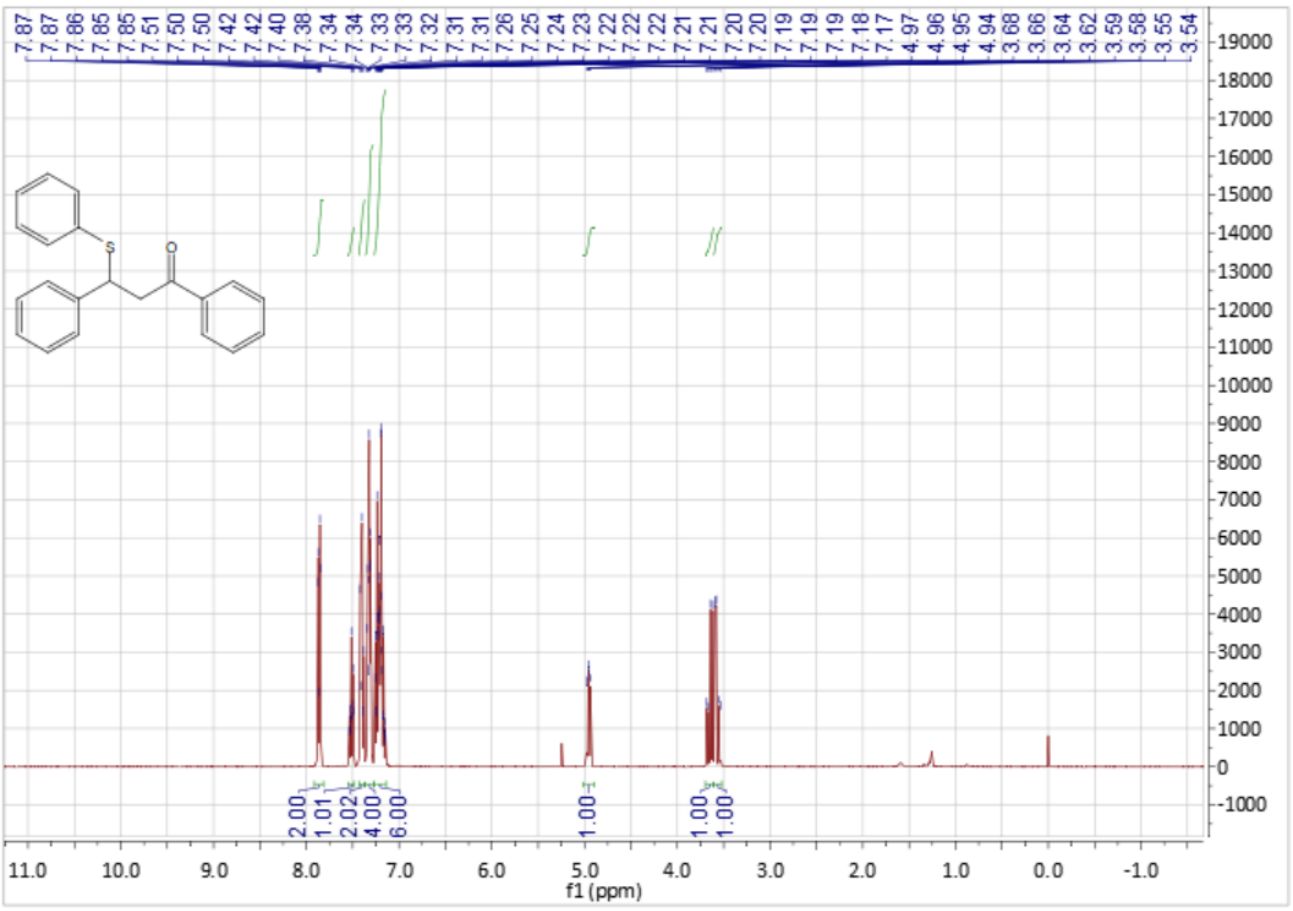
^{1}H NMR spectra of **3m'**



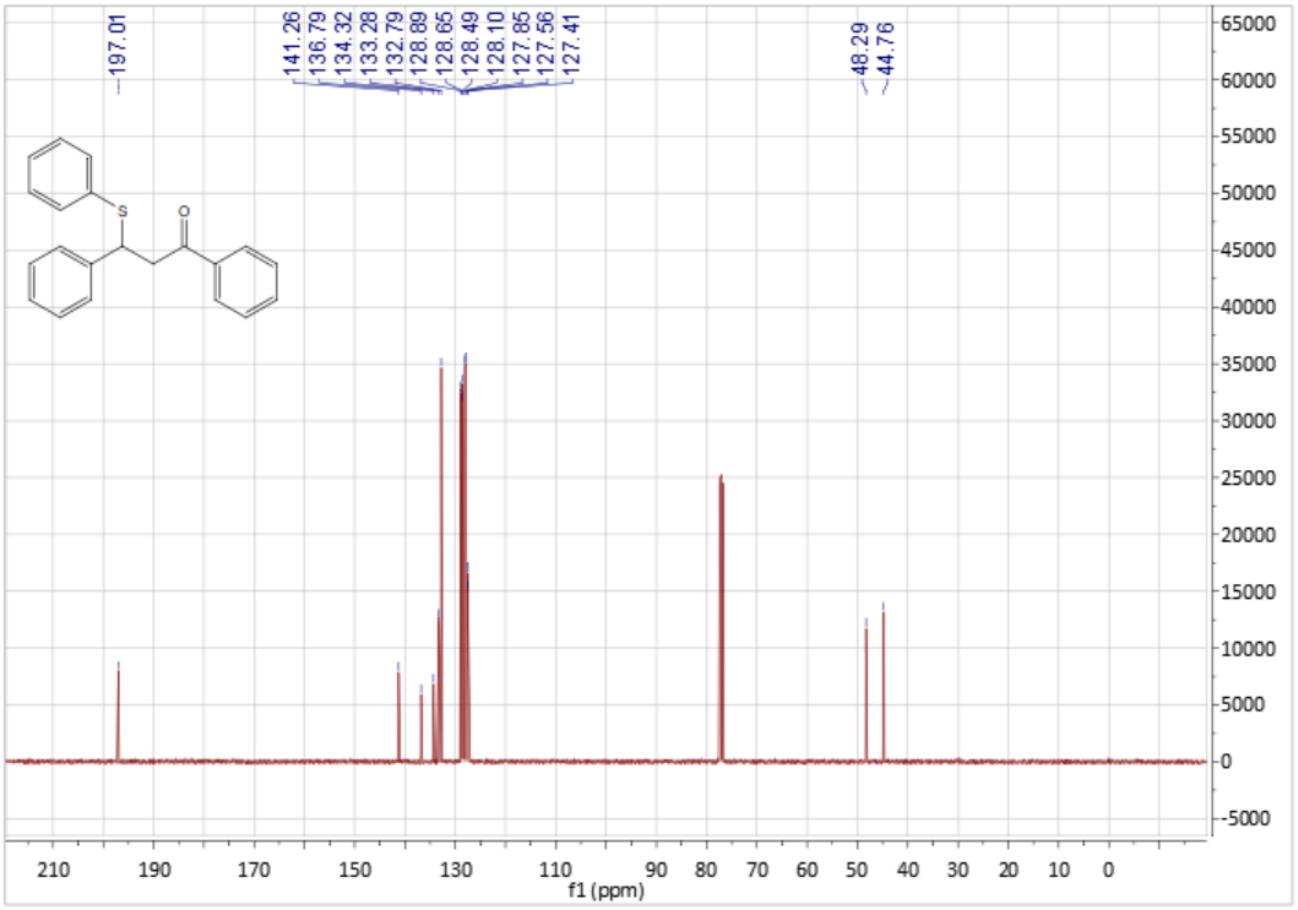
^{13}C NMR spectra of **3m'**



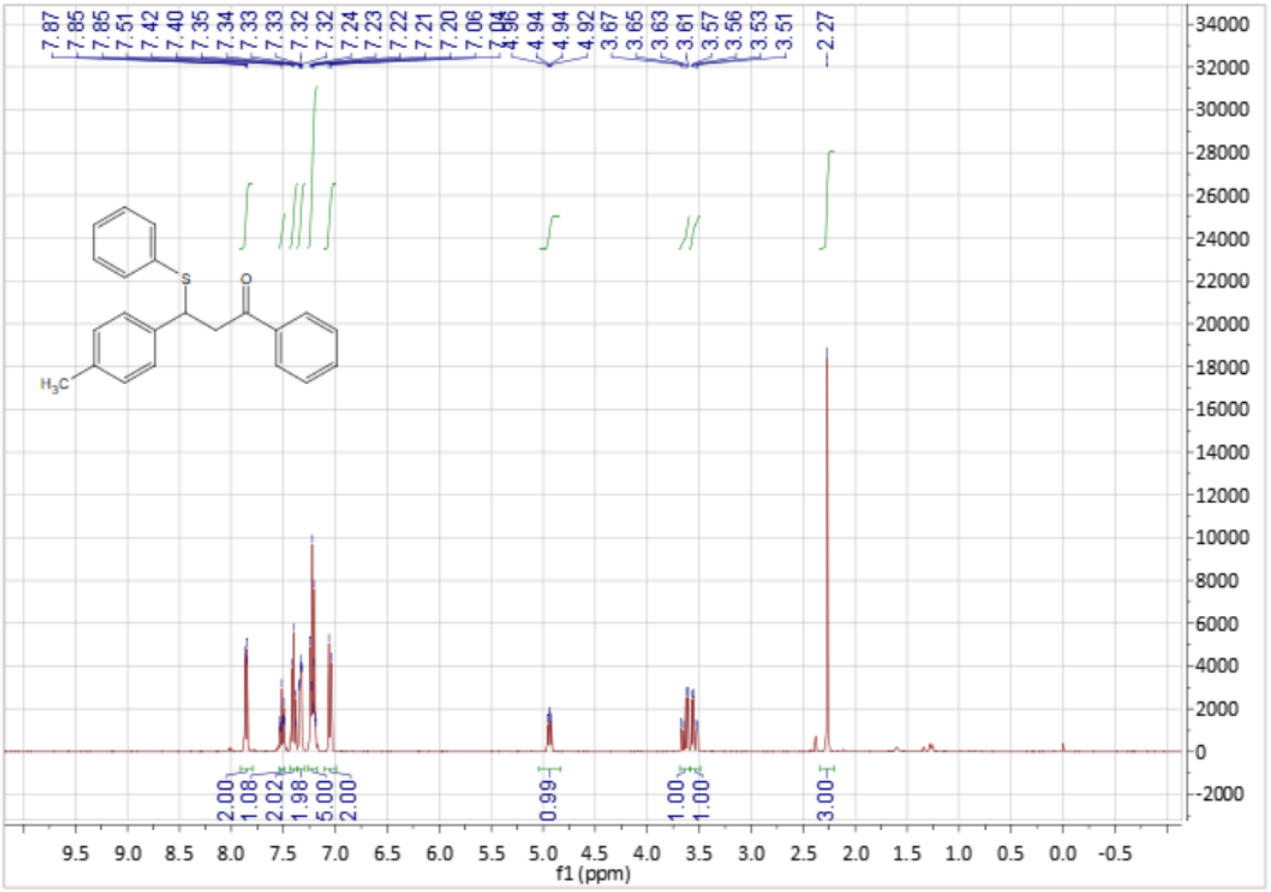
^{1}H NMR spectra of **6a**



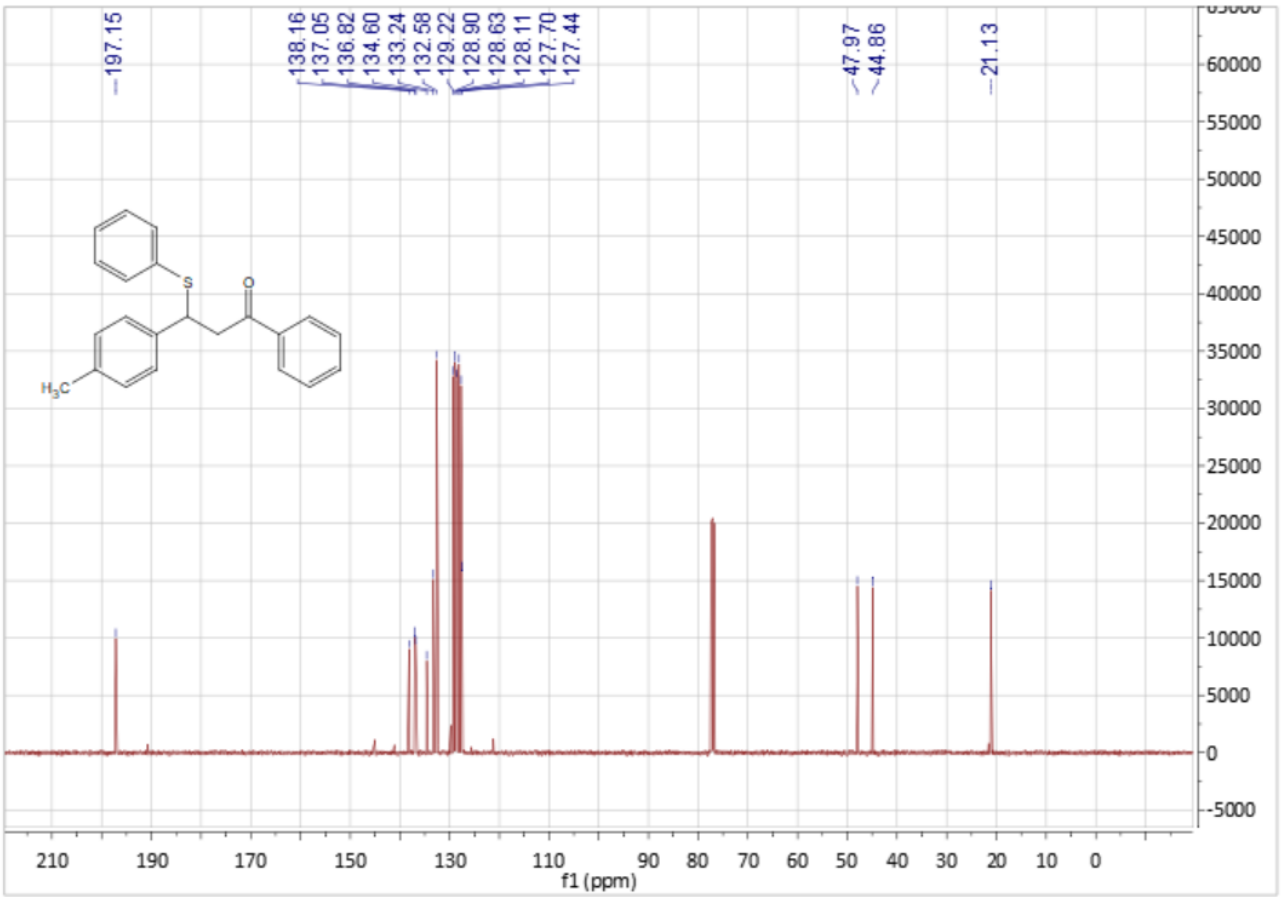
^{13}C NMR spectra of **6a**



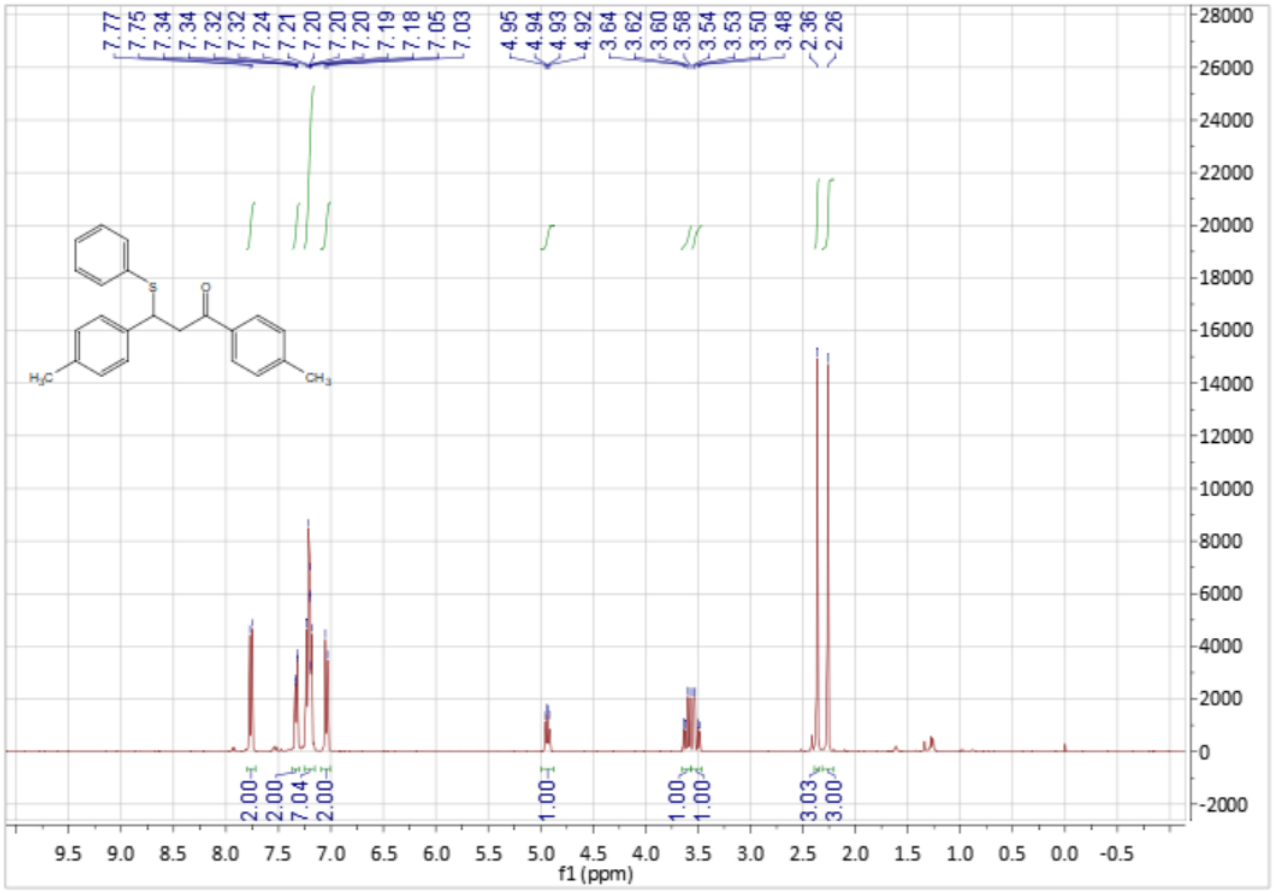
^{1}H NMR spectra of **6b**



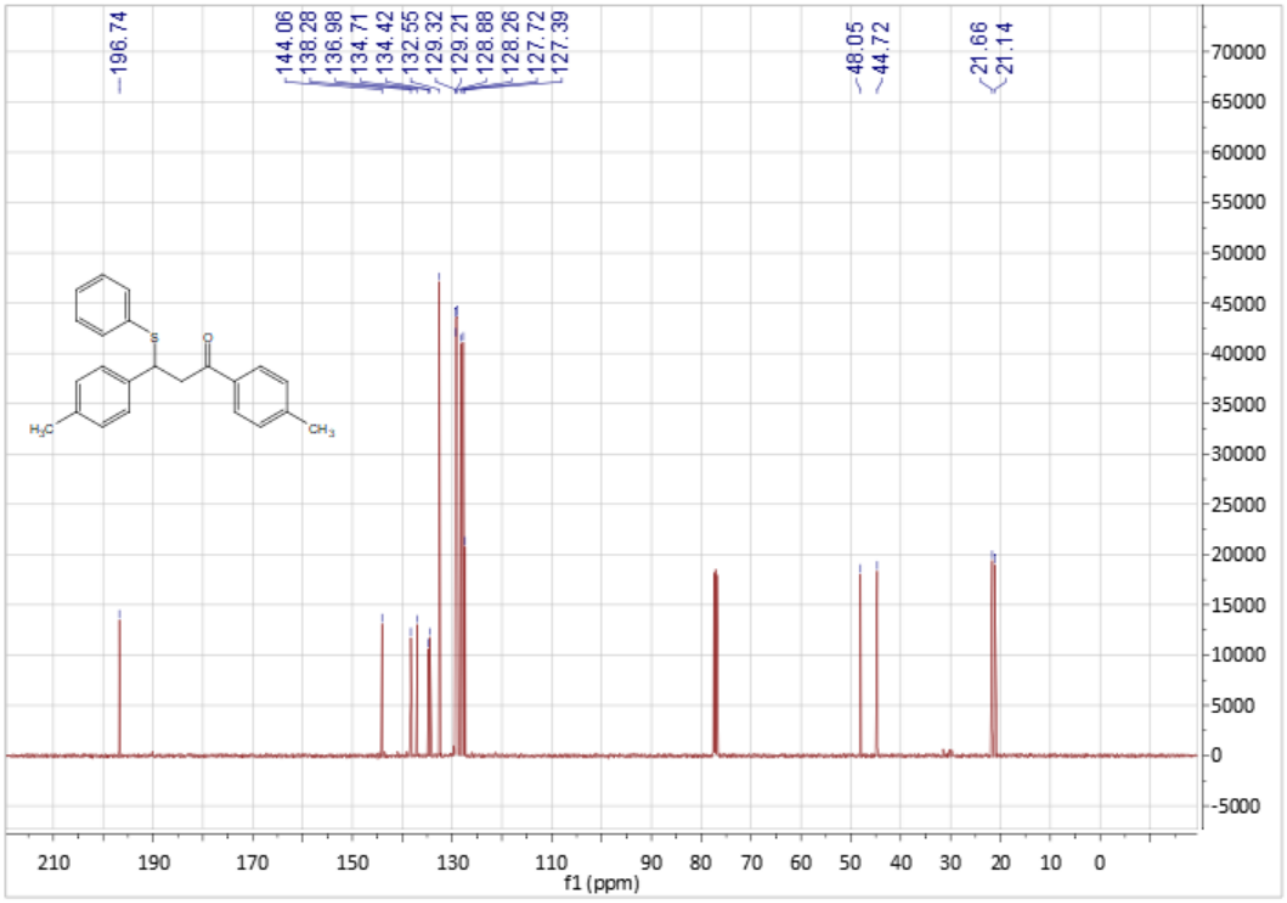
^{13}C NMR spectra of **6b**



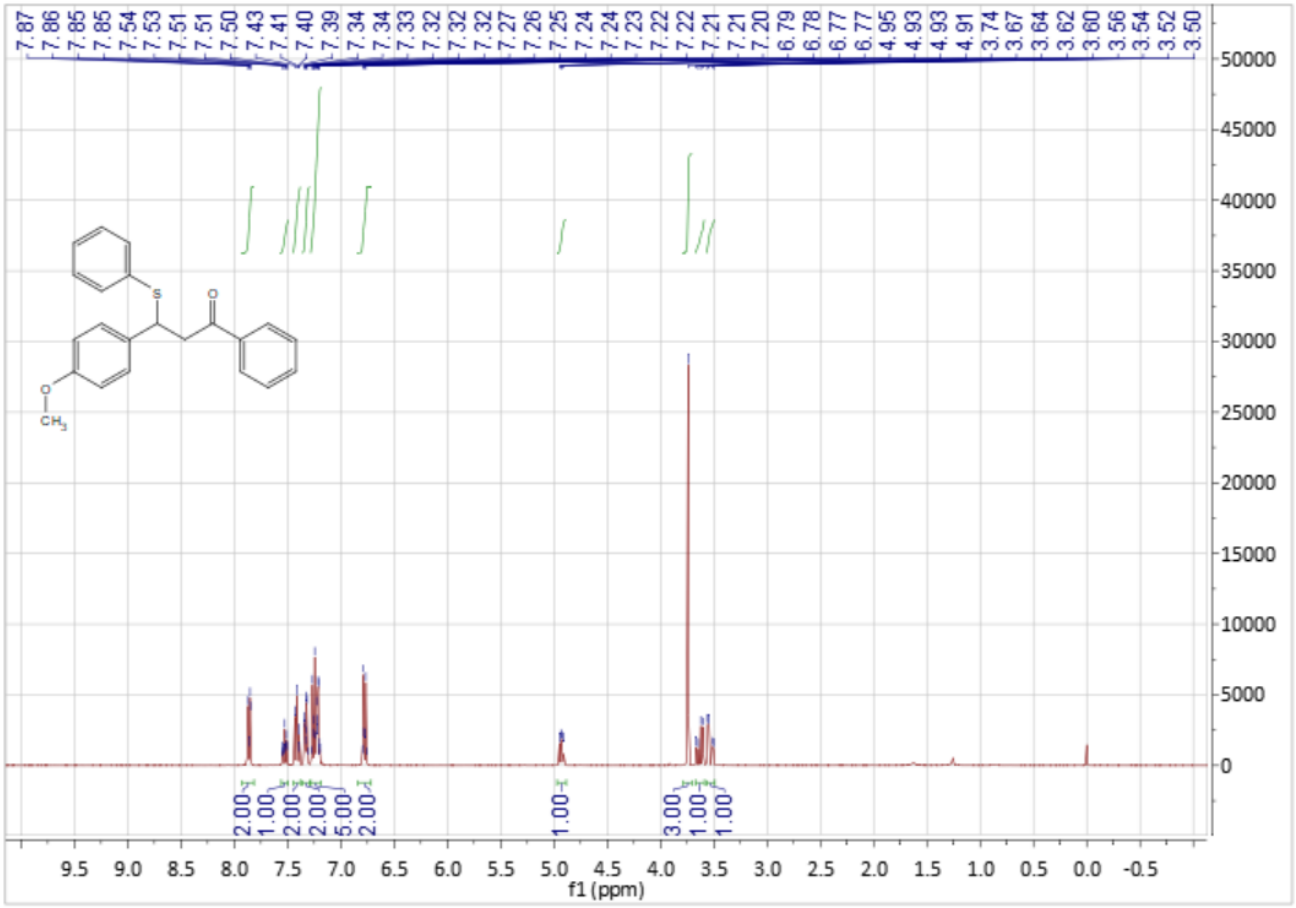
^{1}H NMR spectra of **6c**



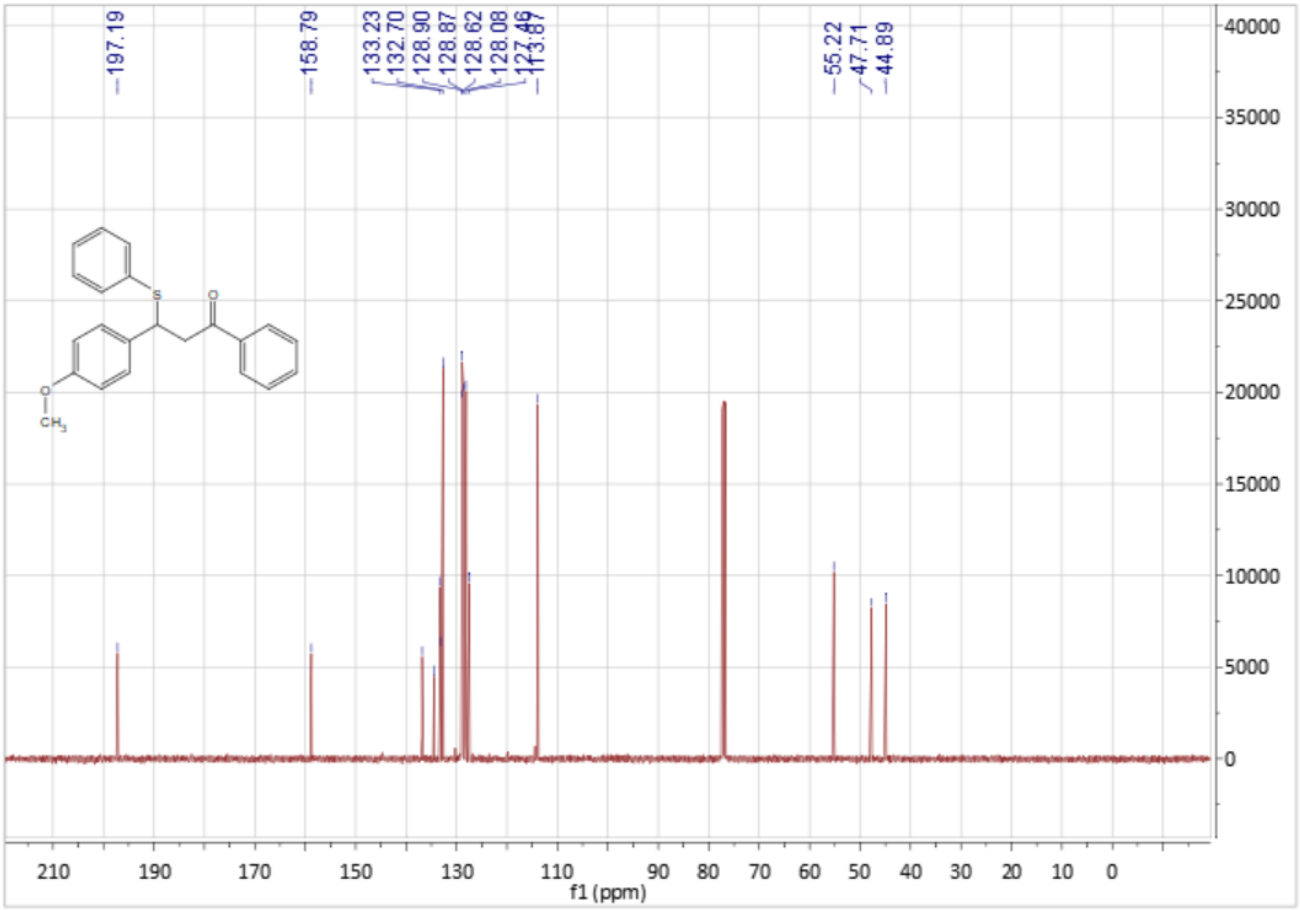
^{13}C NMR spectra of **6c**



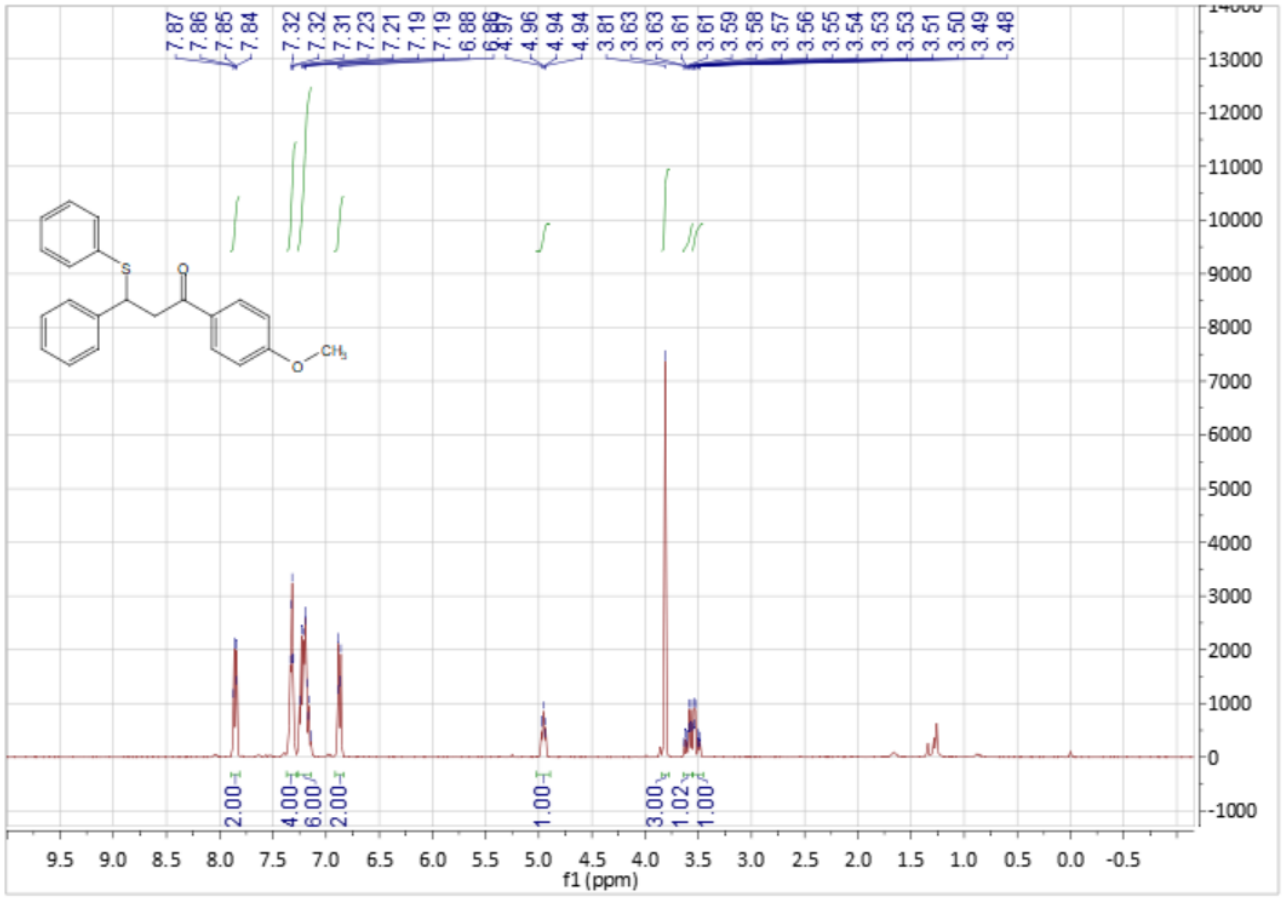
^{1}H NMR spectra of **6d**



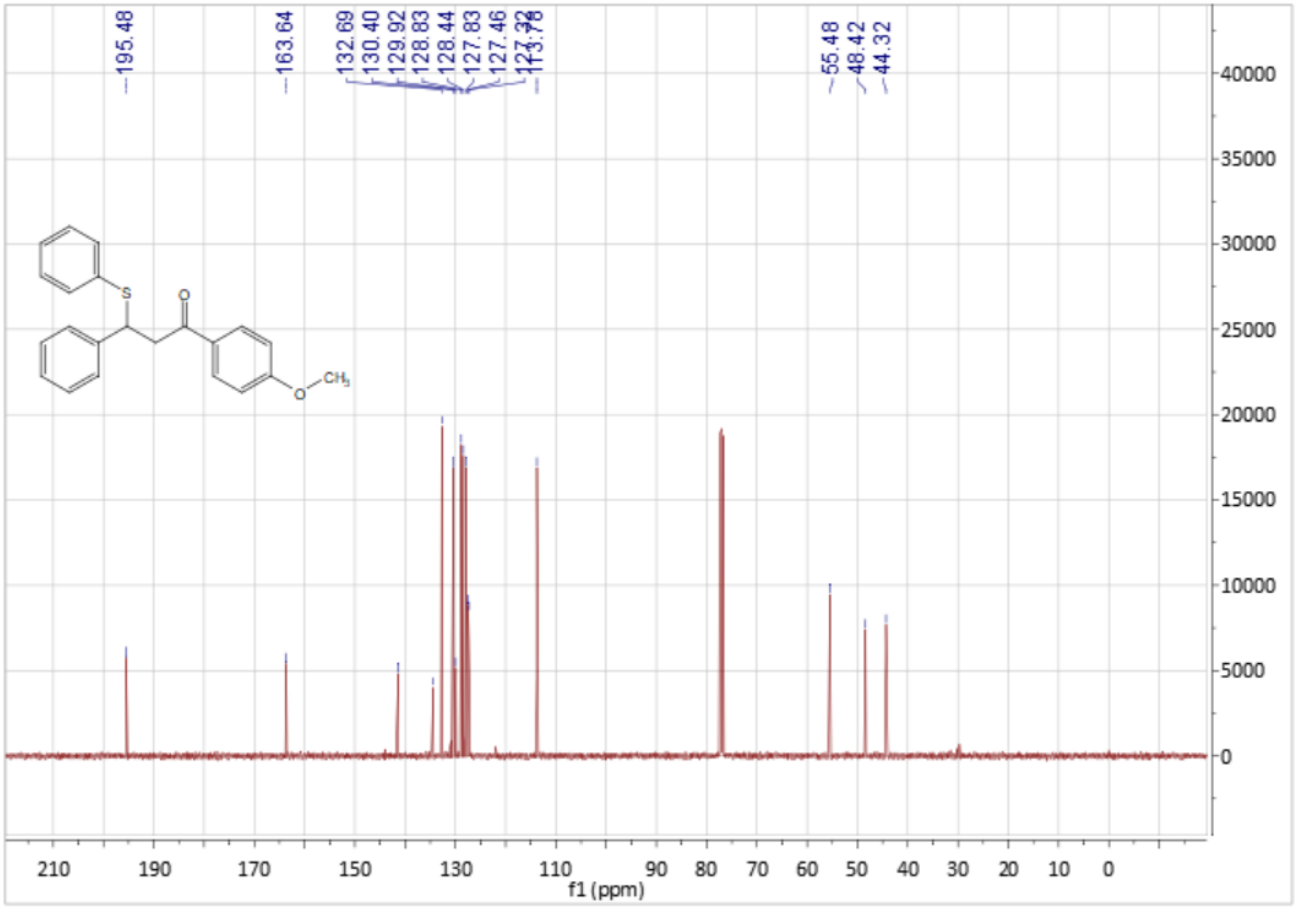
^{13}C NMR spectra of **6d**



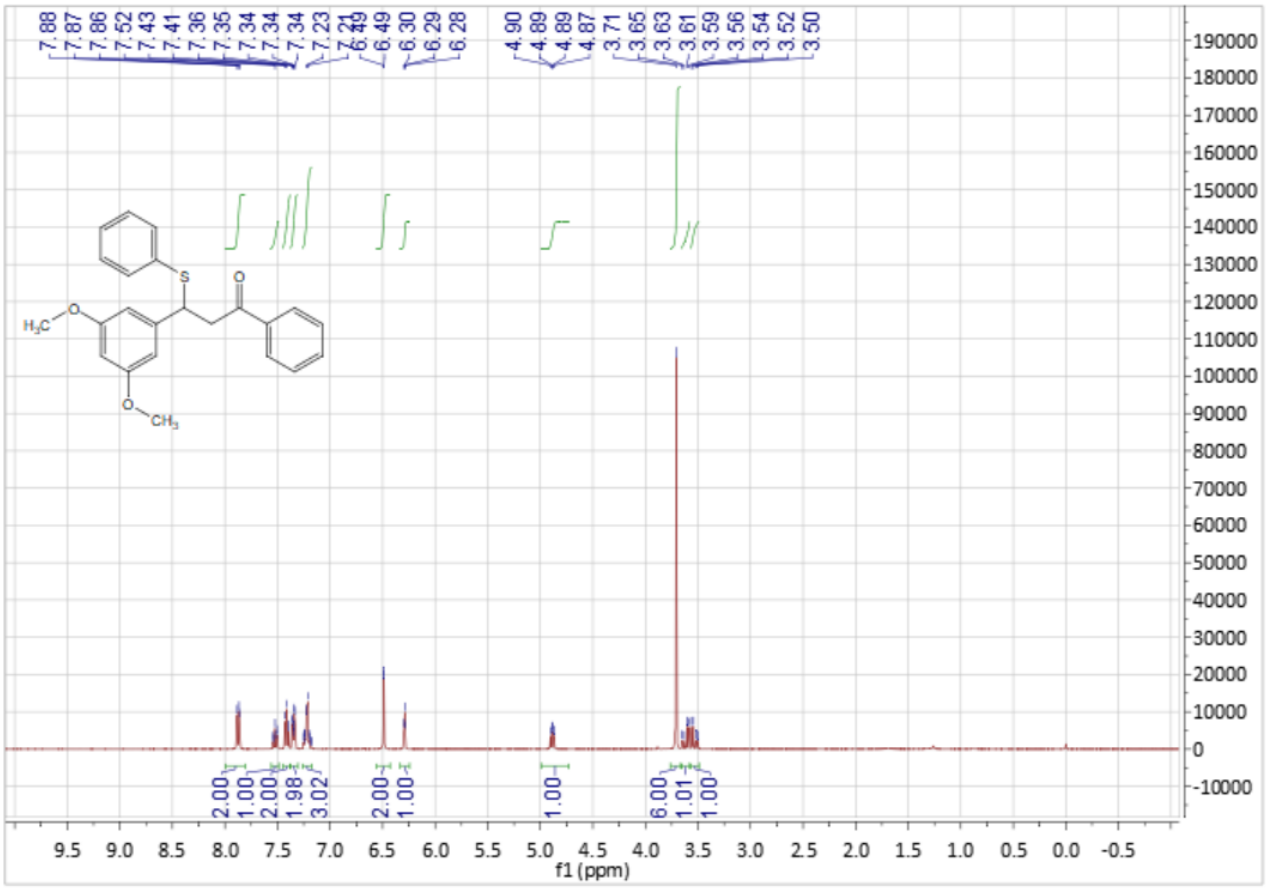
^{1}H NMR spectra of **6e**



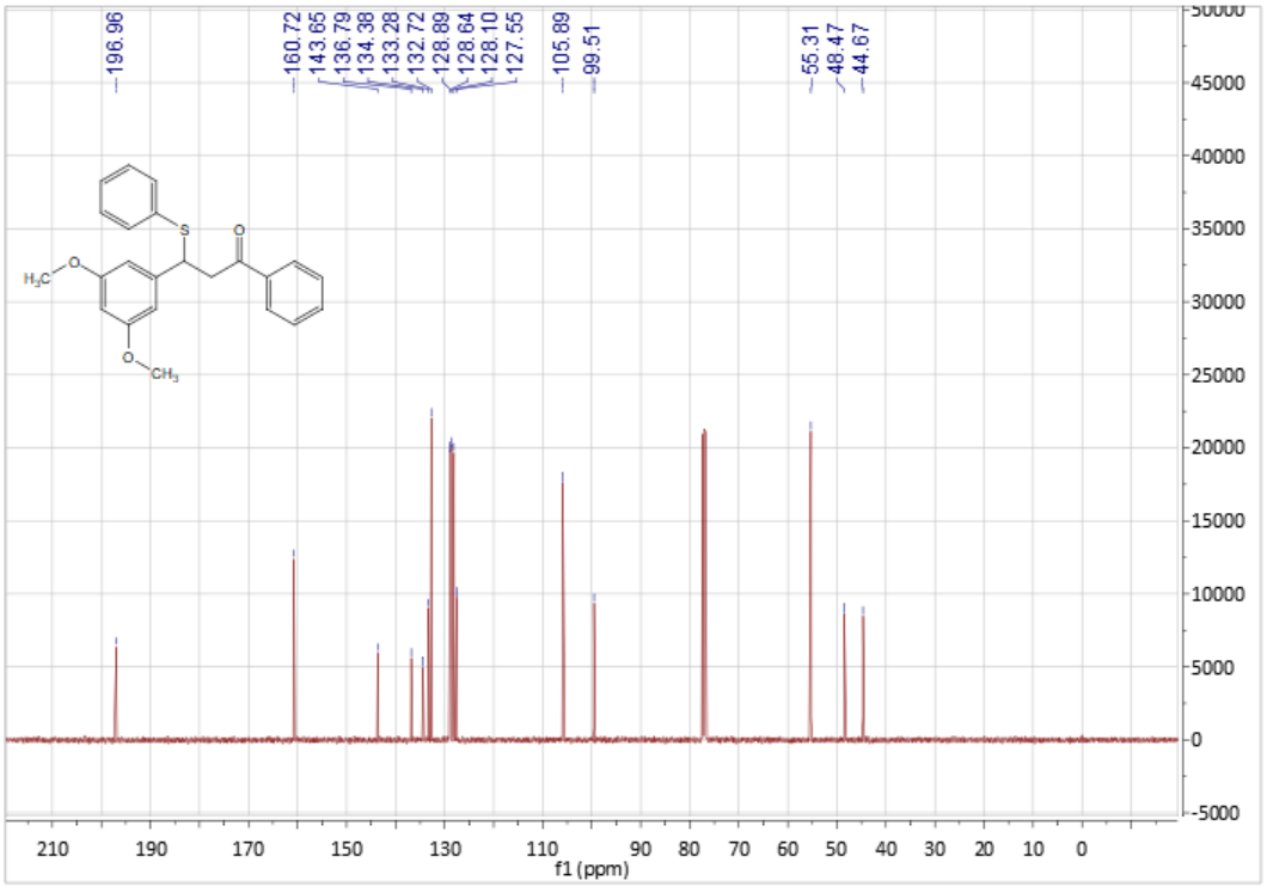
^{13}C NMR spectra of **6e**



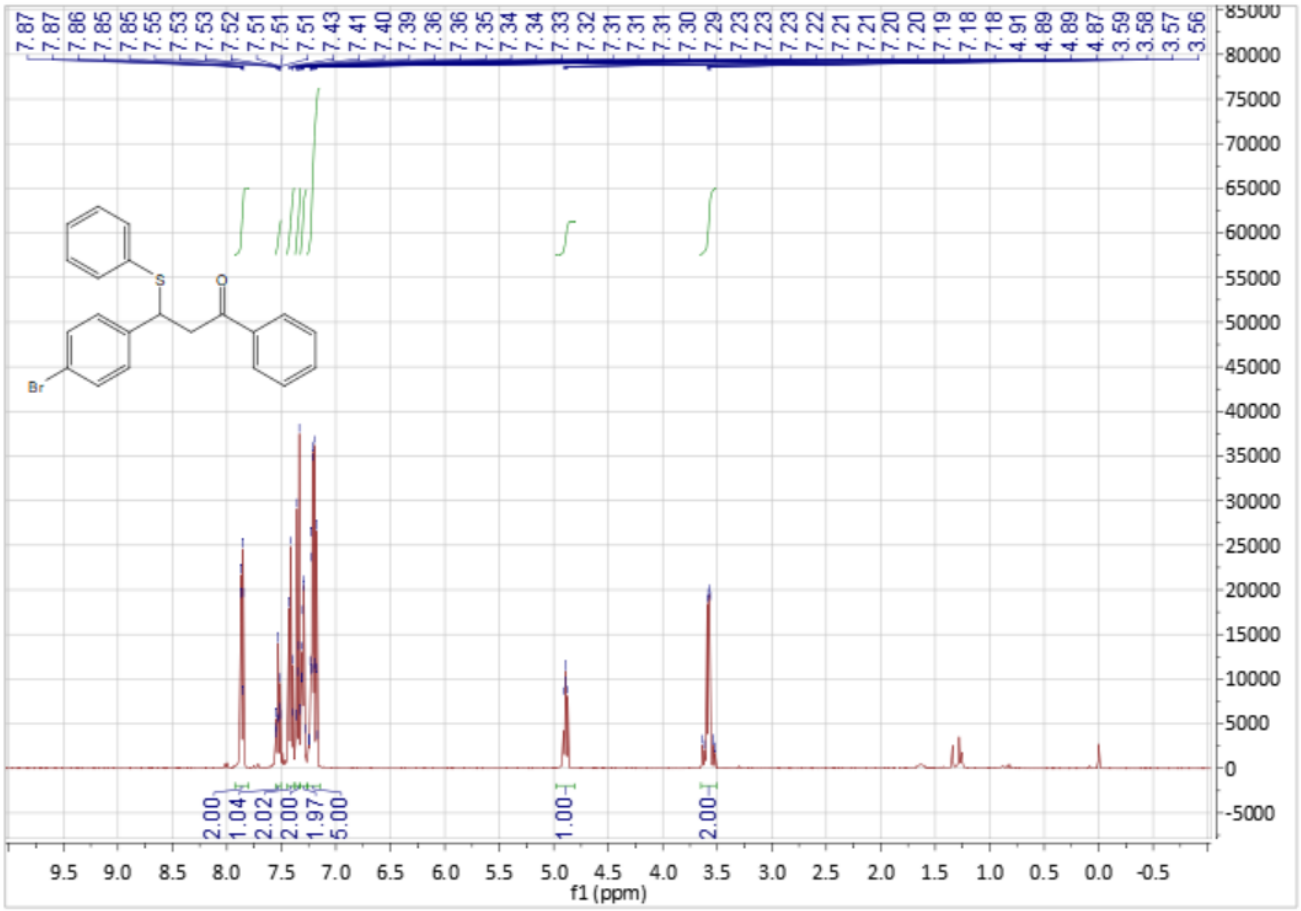
^{1}H NMR spectra of **6f**



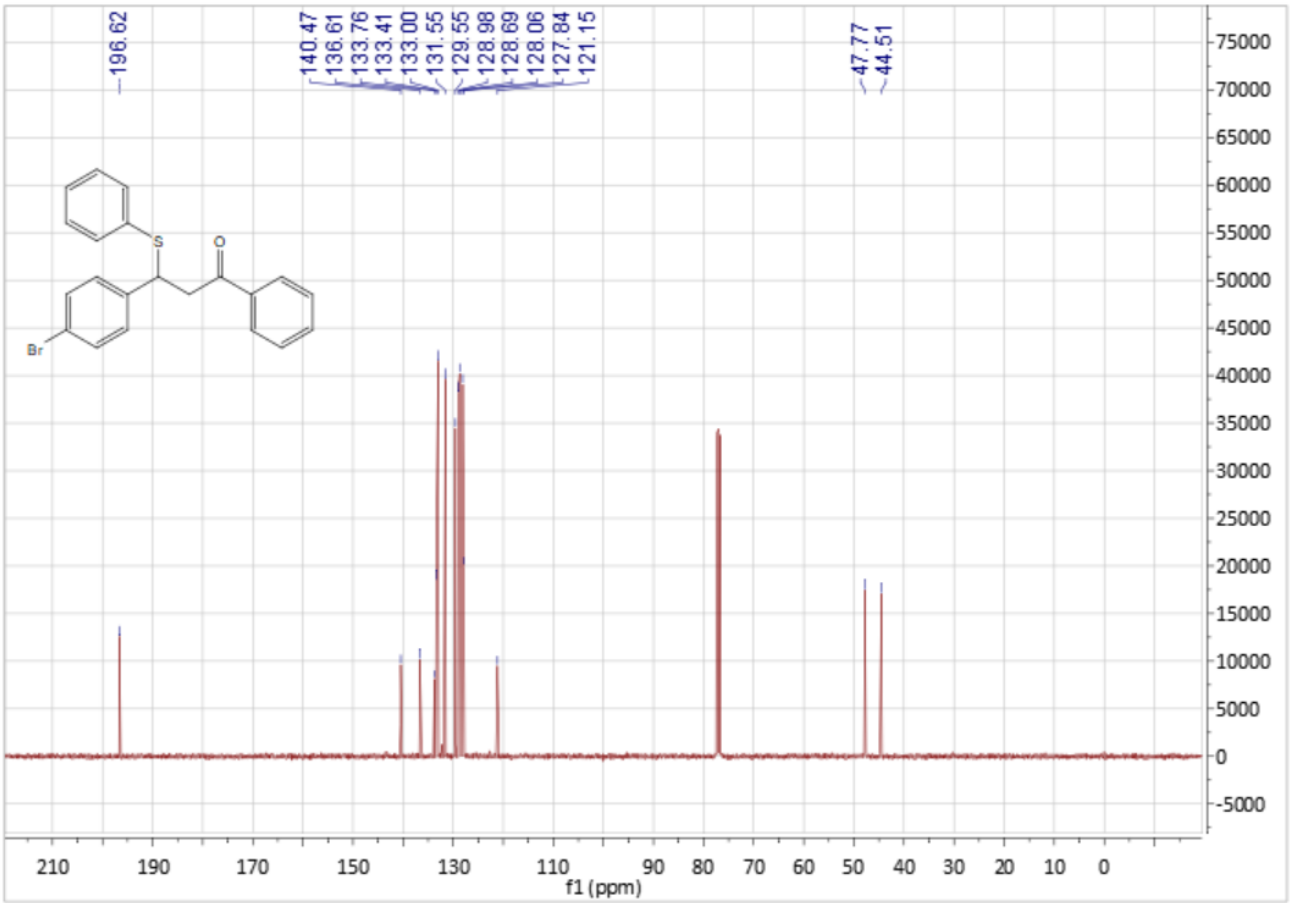
^{13}C NMR spectra of **6f**



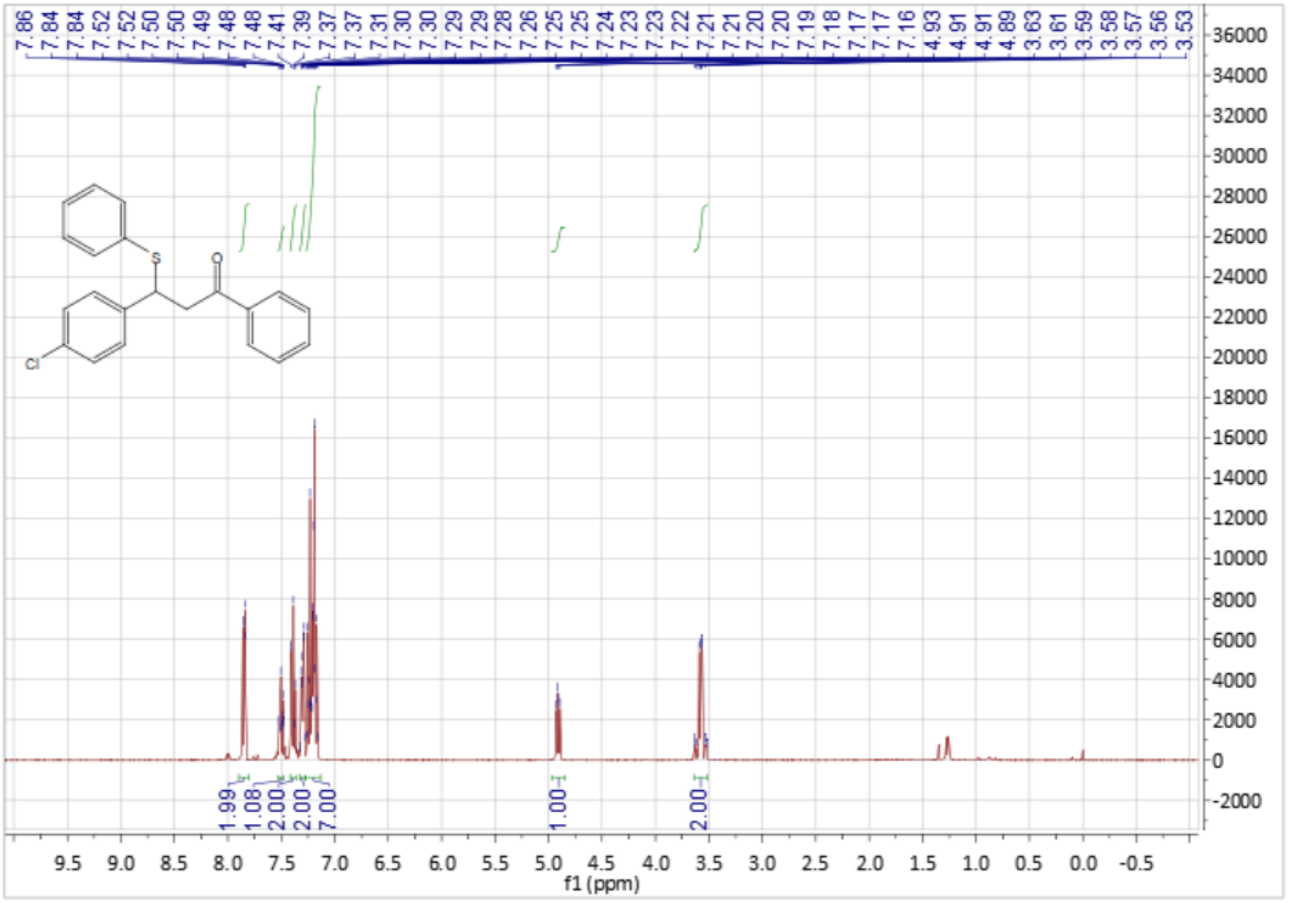
^{1}H NMR spectra of **6g**



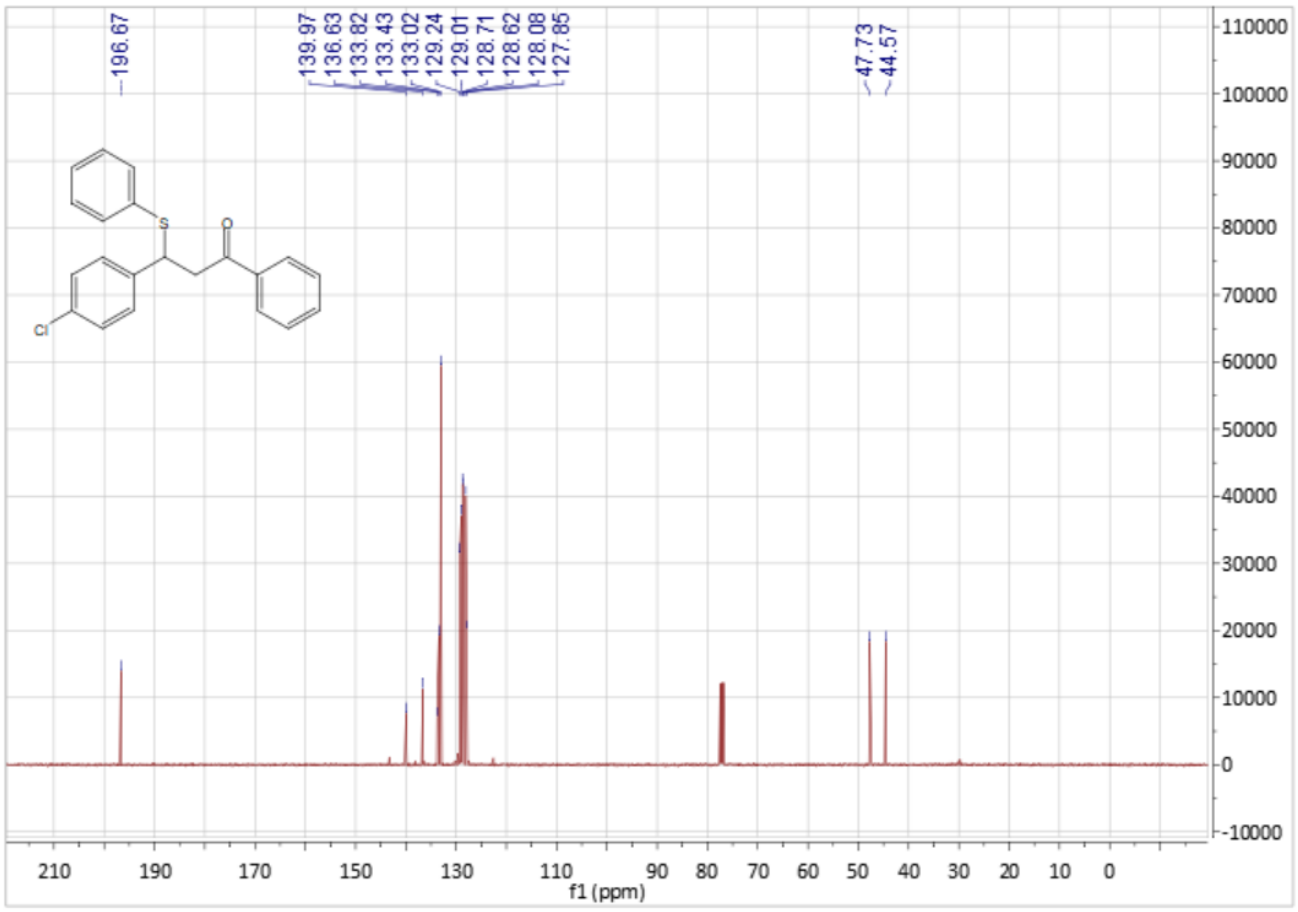
^{13}C NMR spectra of **6g**



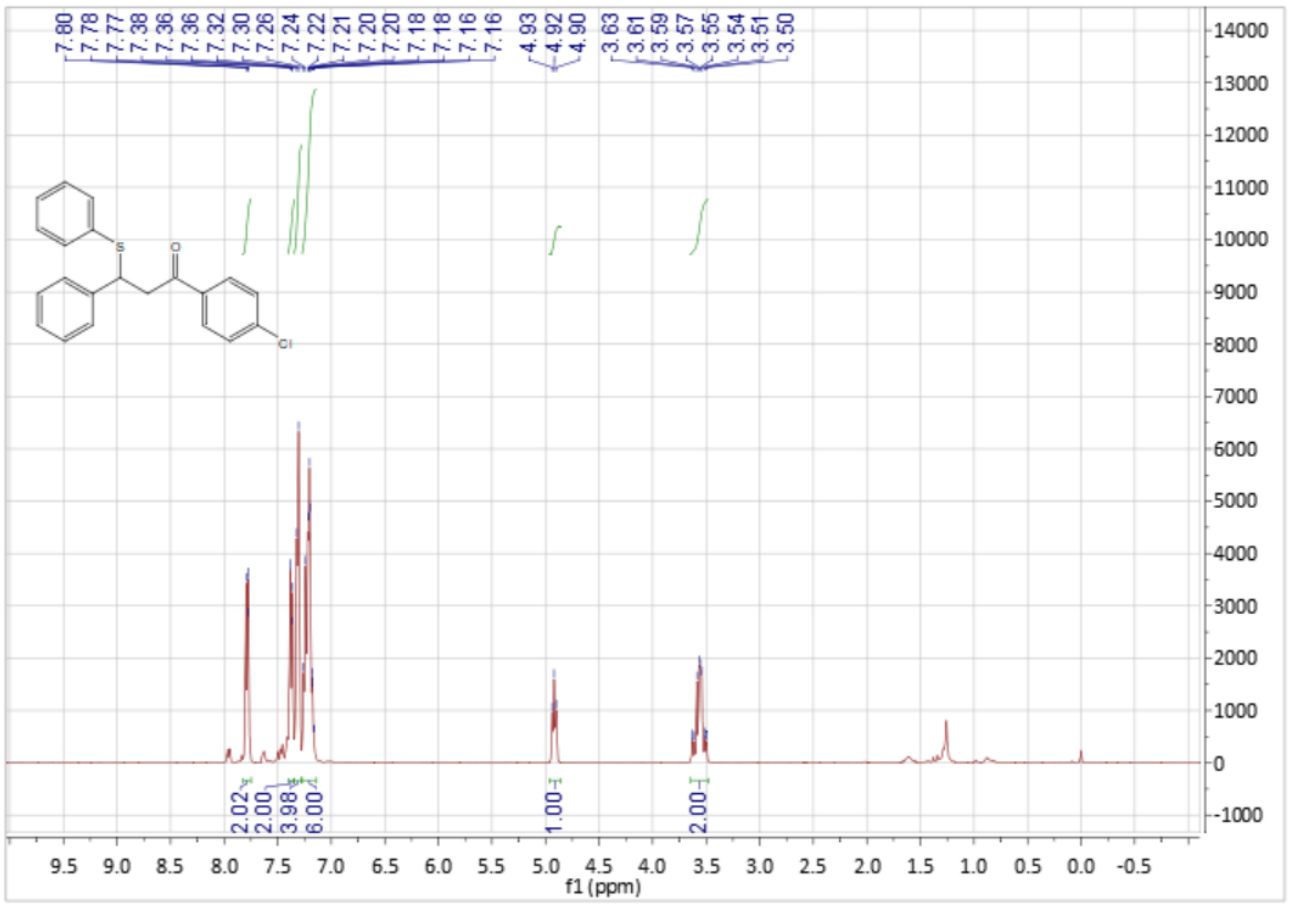
^{1}H NMR spectra of **6h**



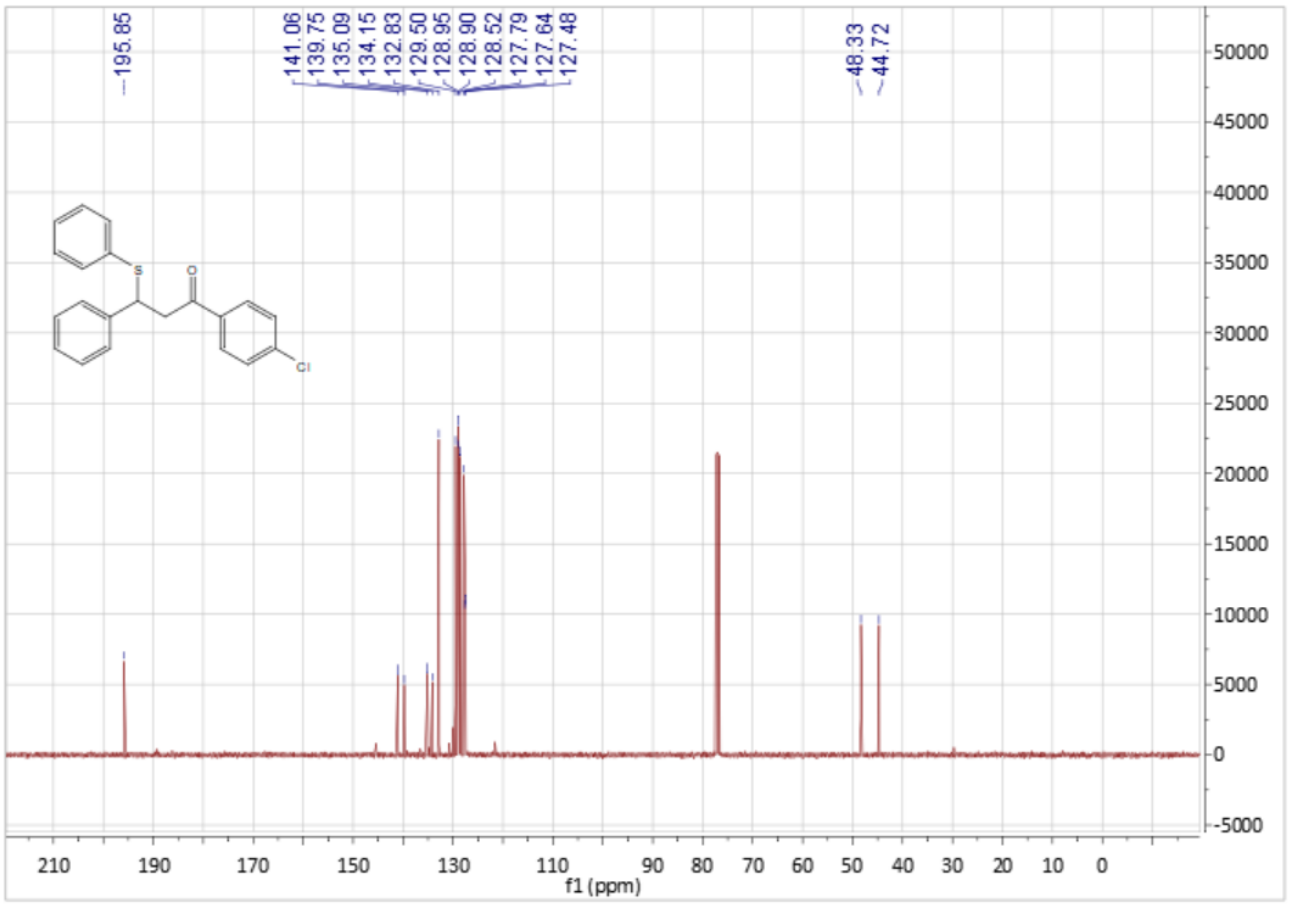
^{13}C NMR spectra of **6h**



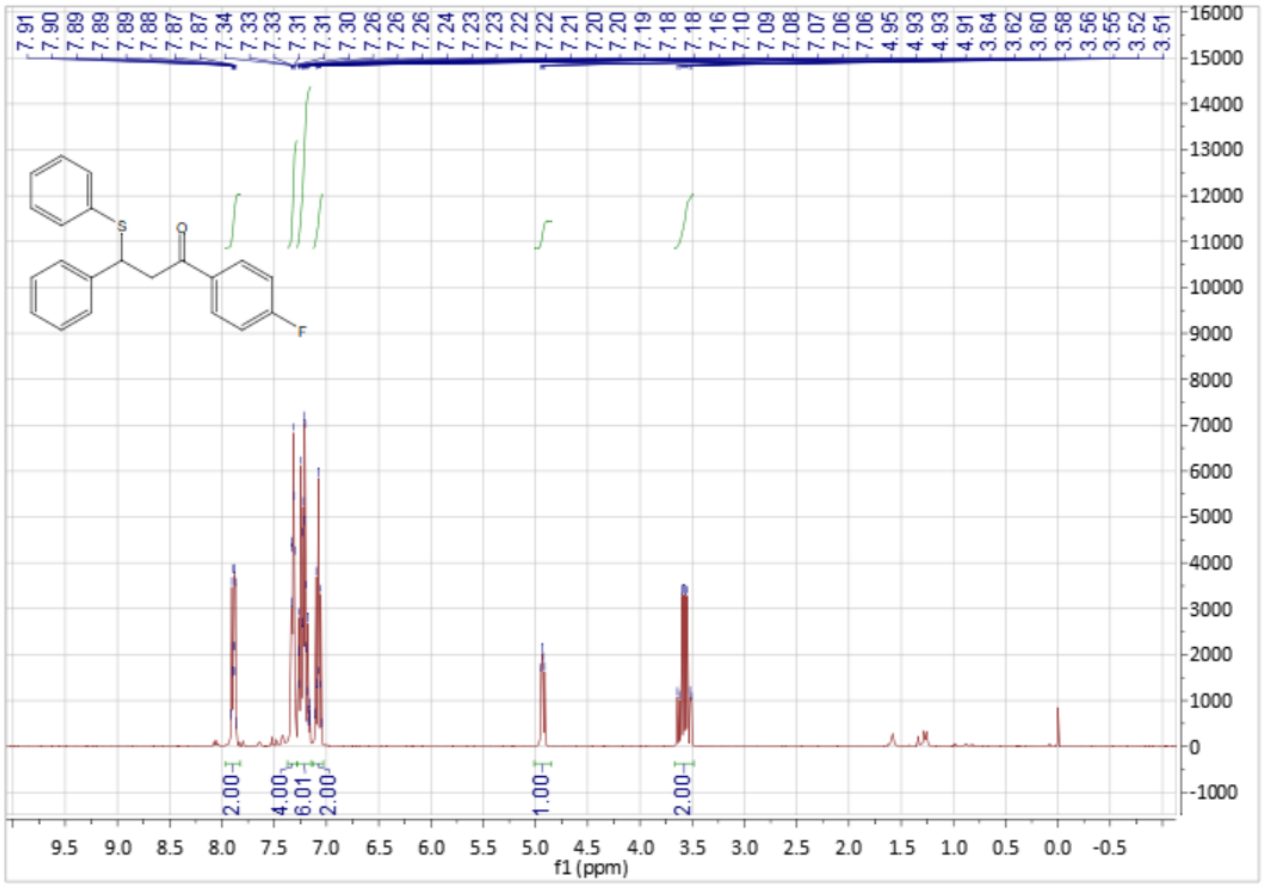
^{1}H NMR spectra of **6i**



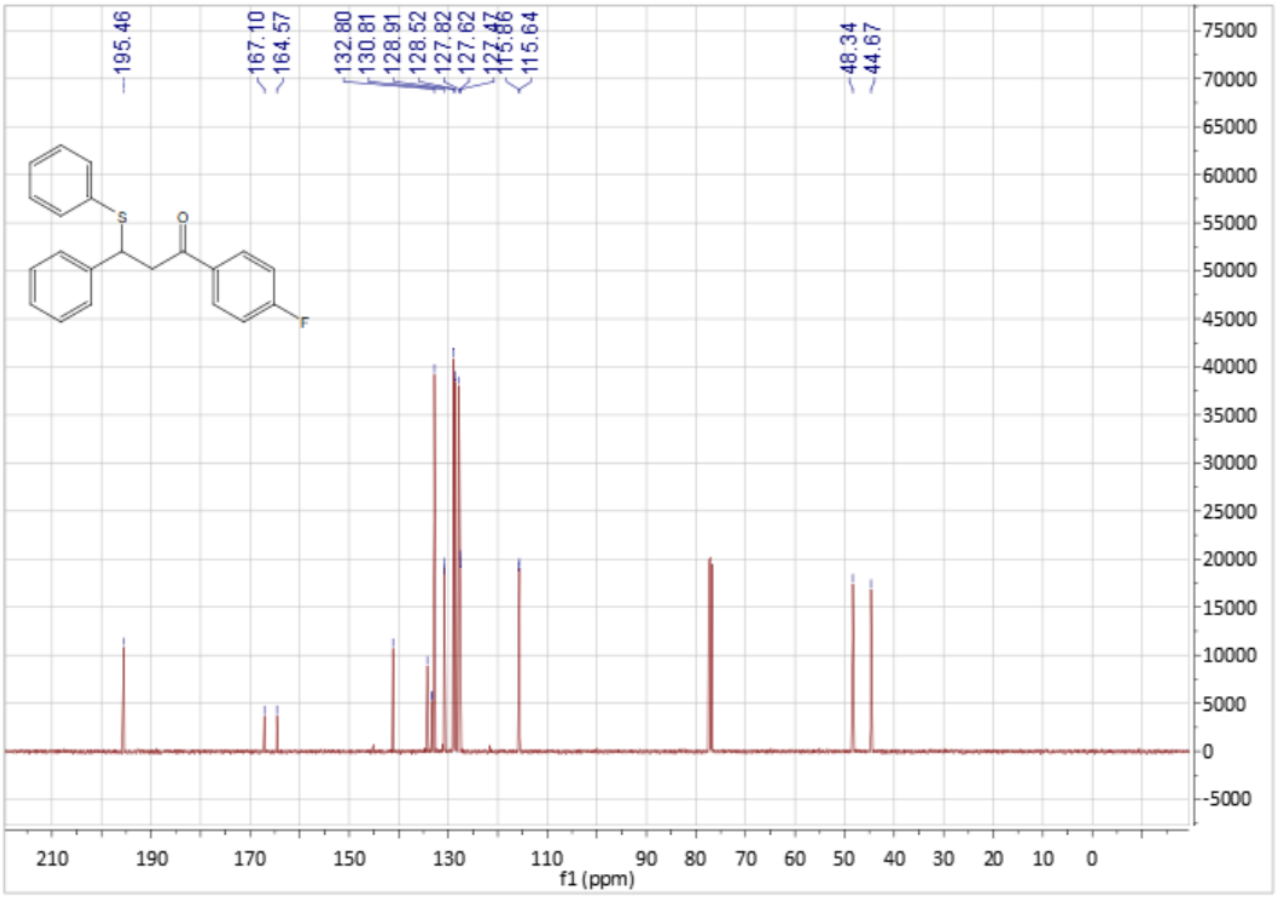
^{13}C NMR spectra of **6i**



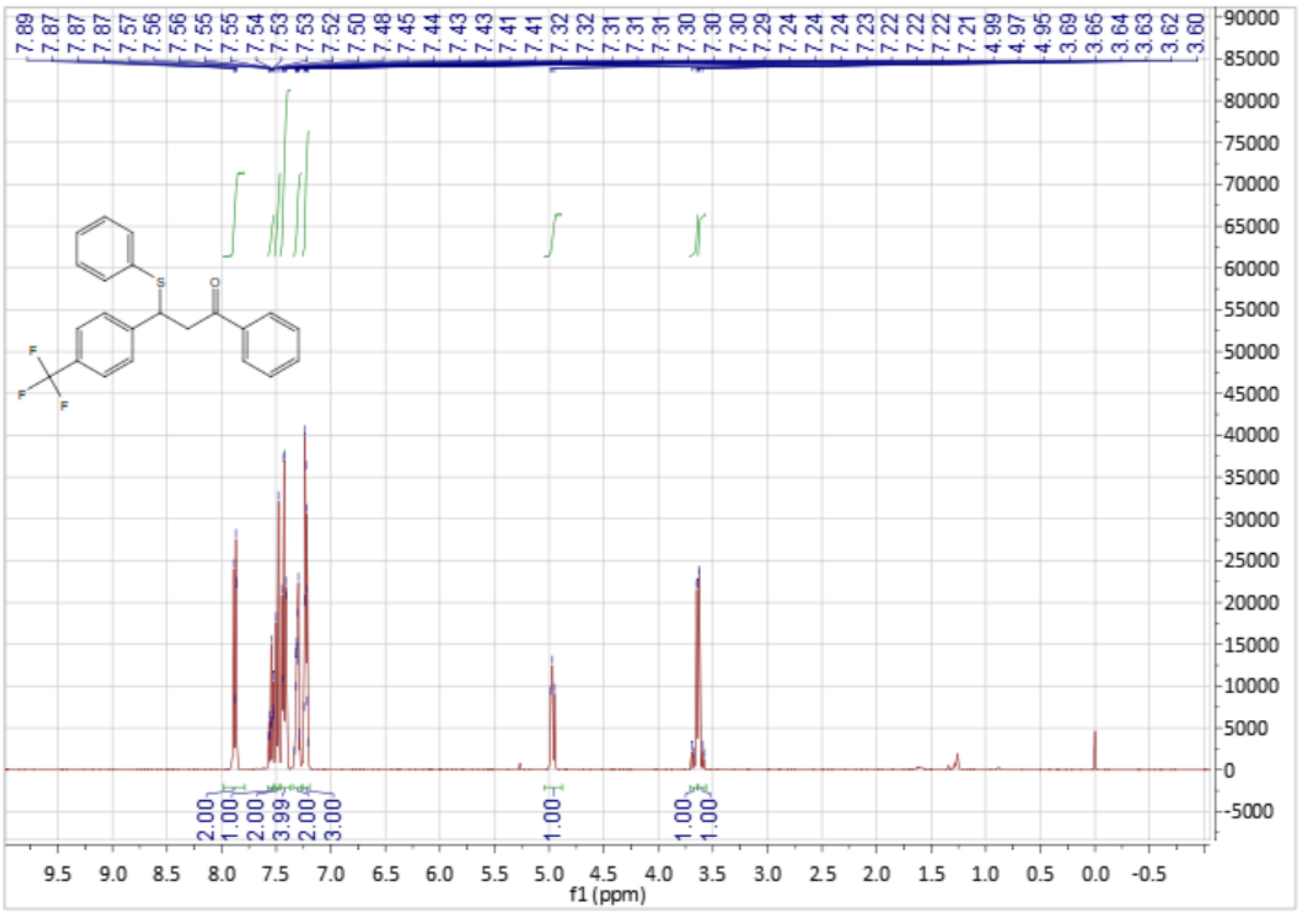
^{1}H NMR spectra of **6j**



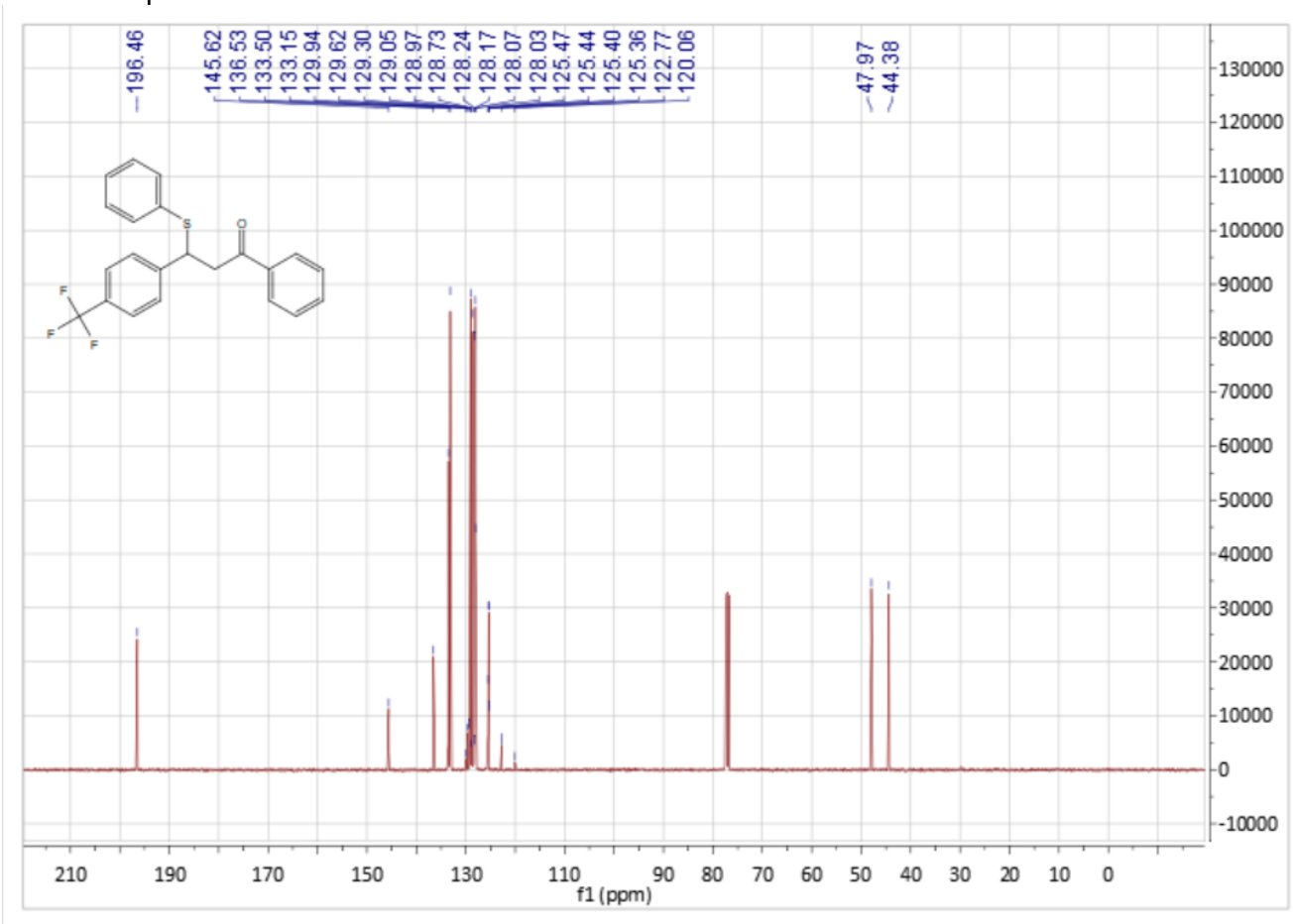
^{13}C NMR spectra of **6j**



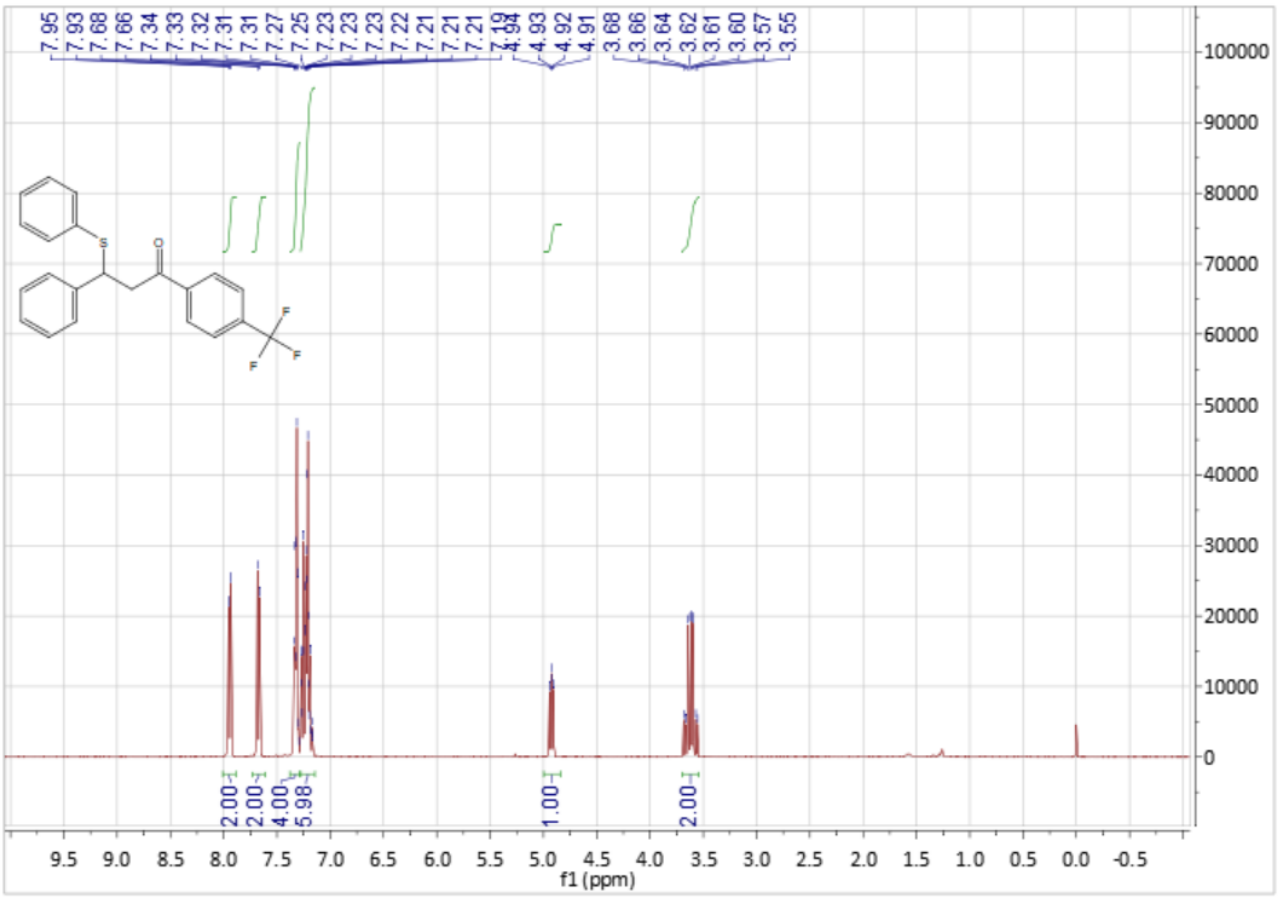
^{1}H NMR spectra of **6k**



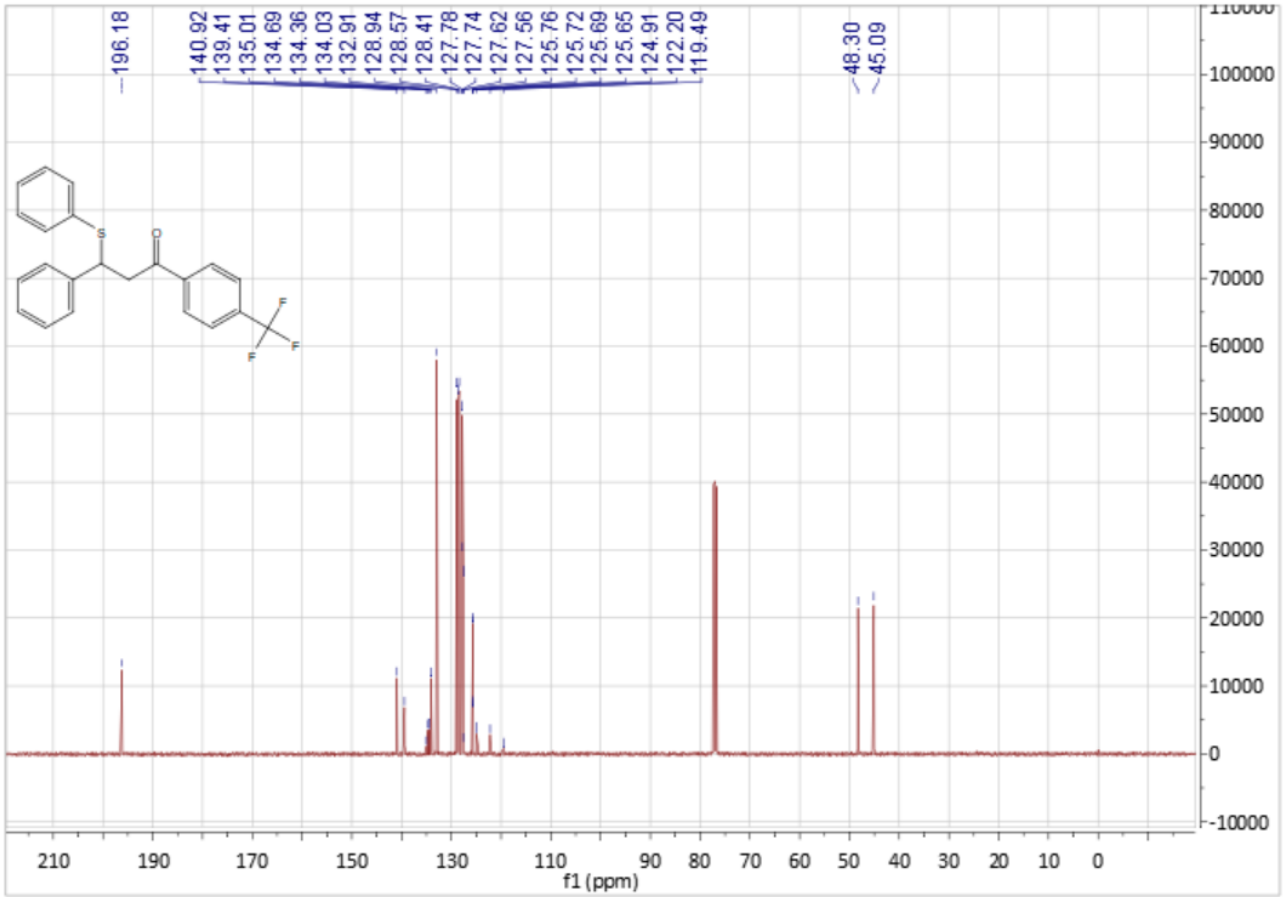
^{13}C NMR spectra of **6k**



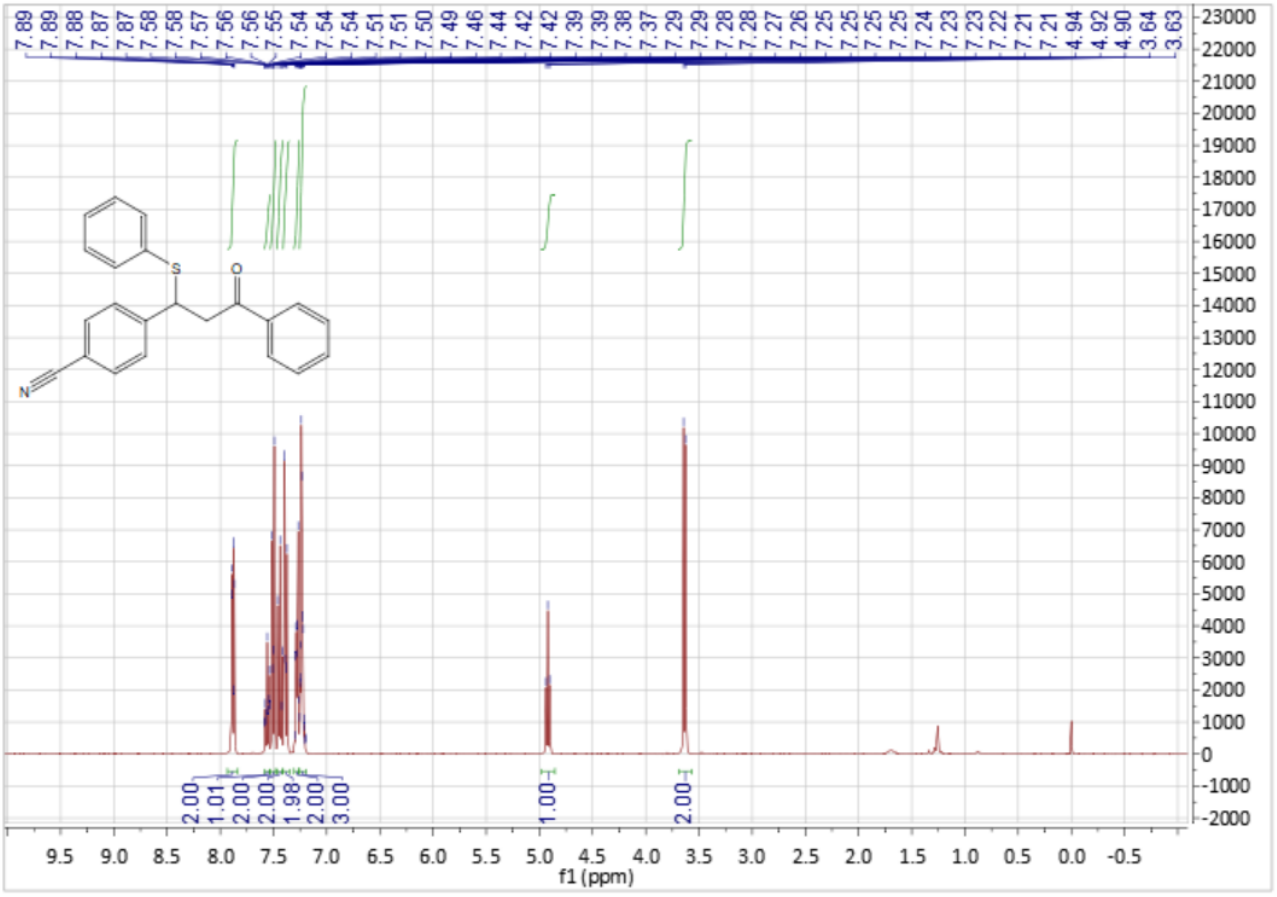
^{1}H NMR spectra of **6l**



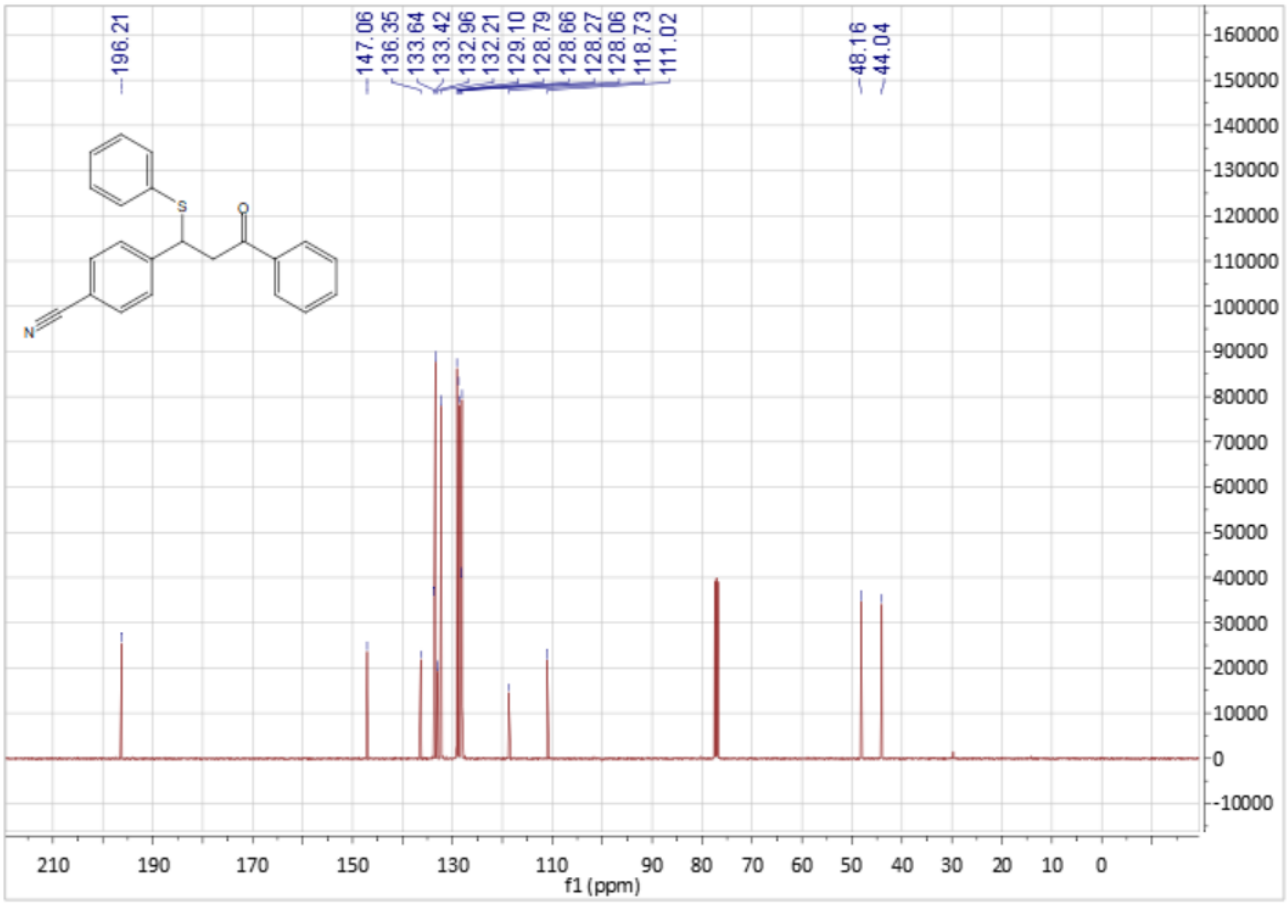
^{13}C NMR spectra of **6l**



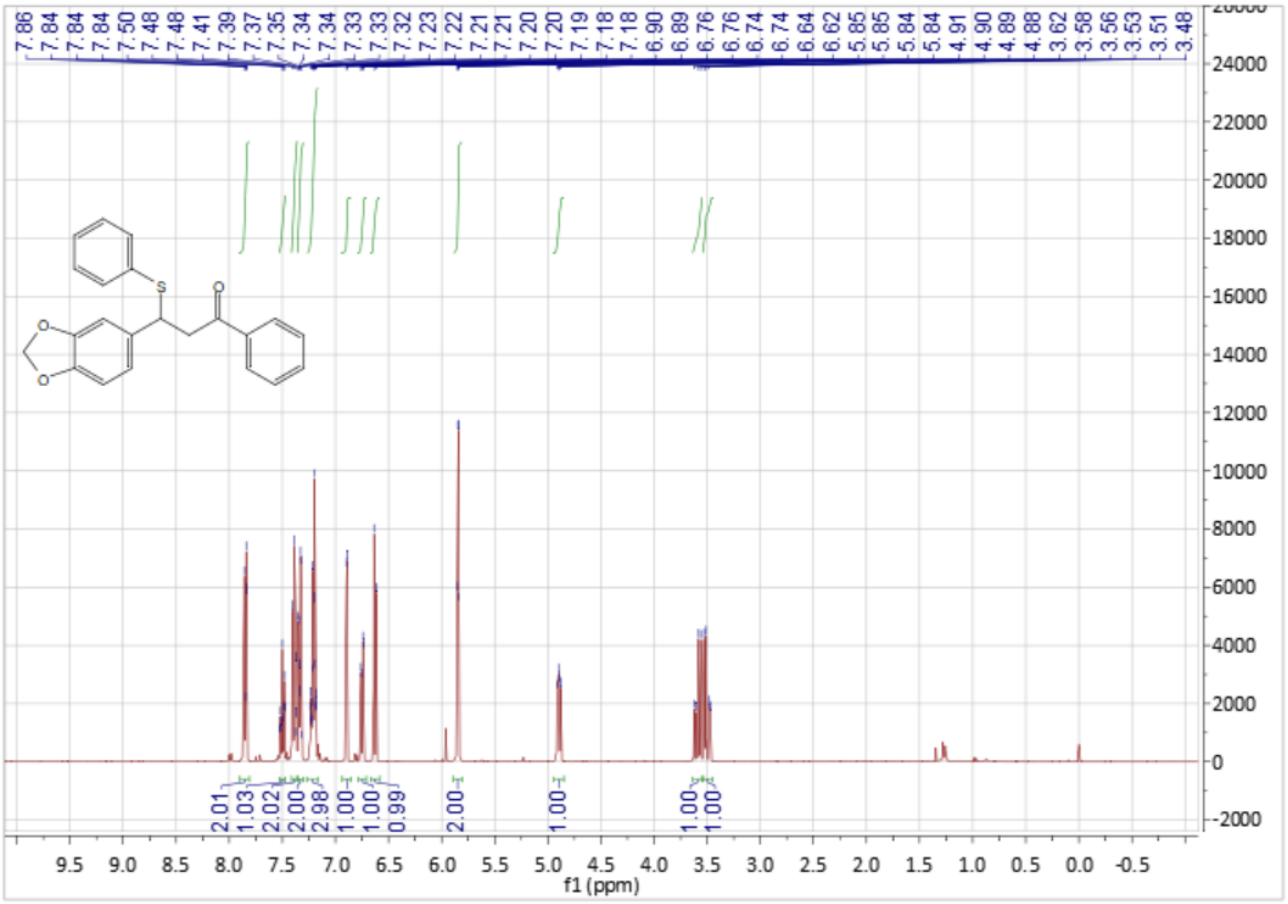
^{1}H NMR spectra of **6m**



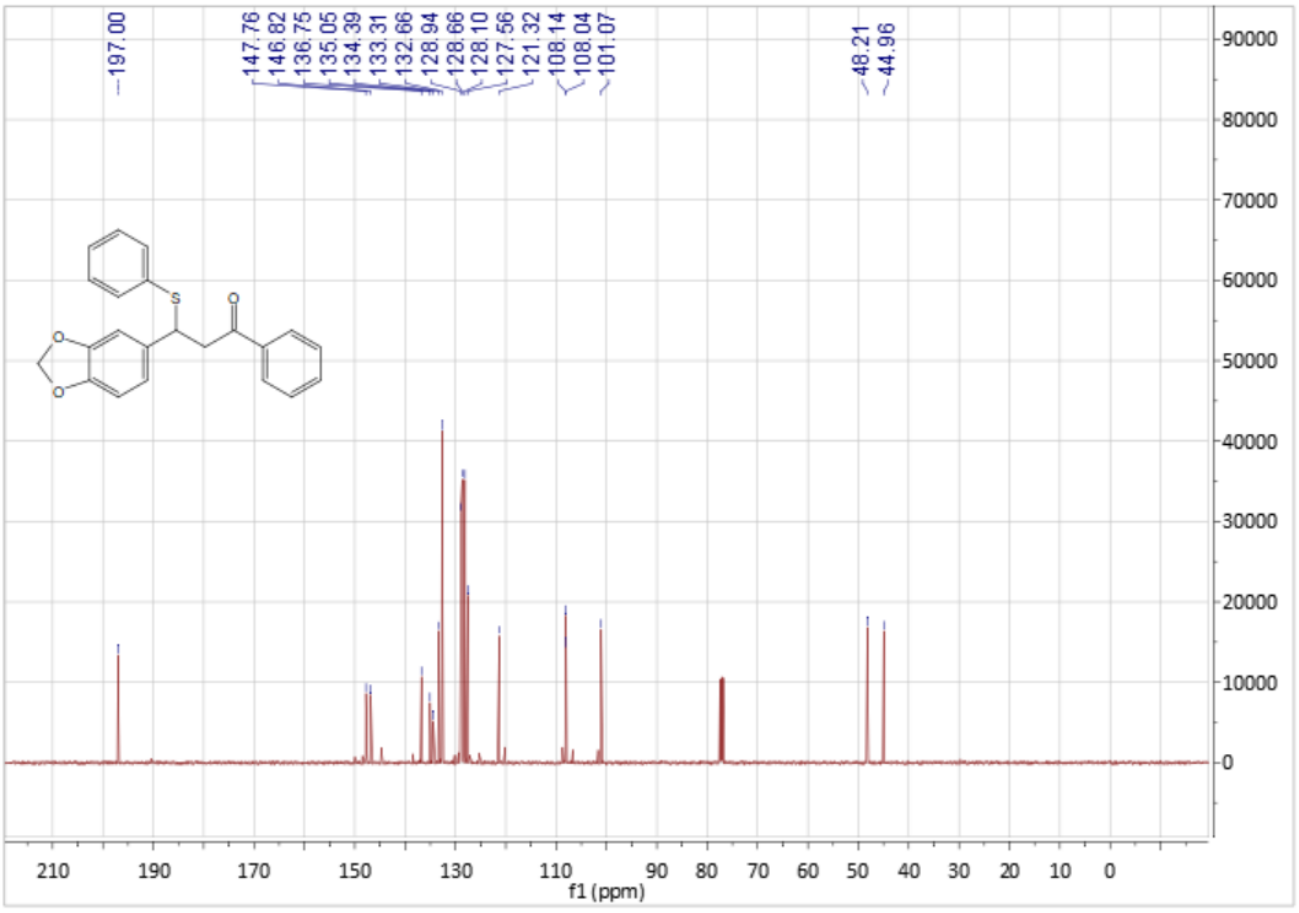
^{13}C NMR spectra of **6m**



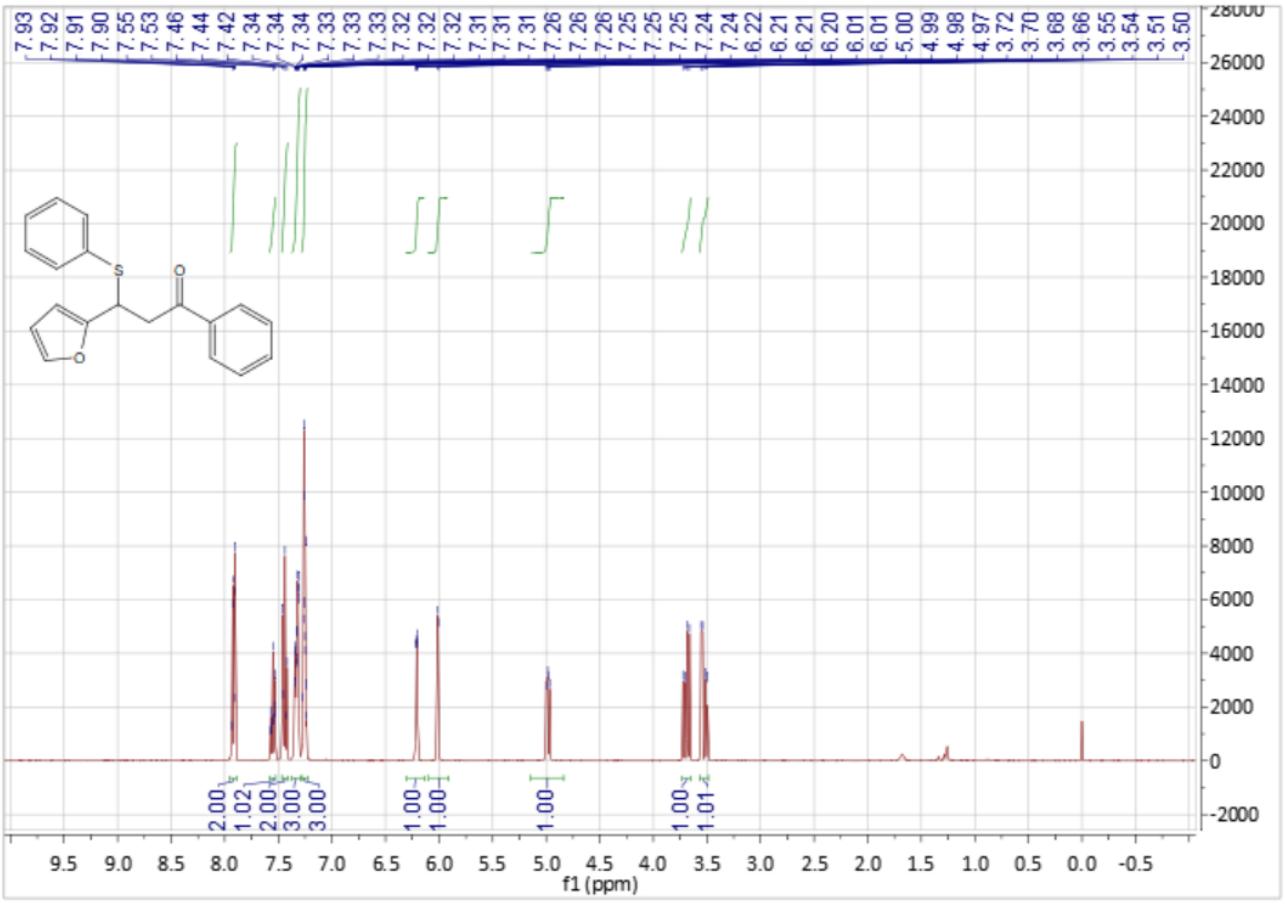
^{1}H NMR spectra of **6n**



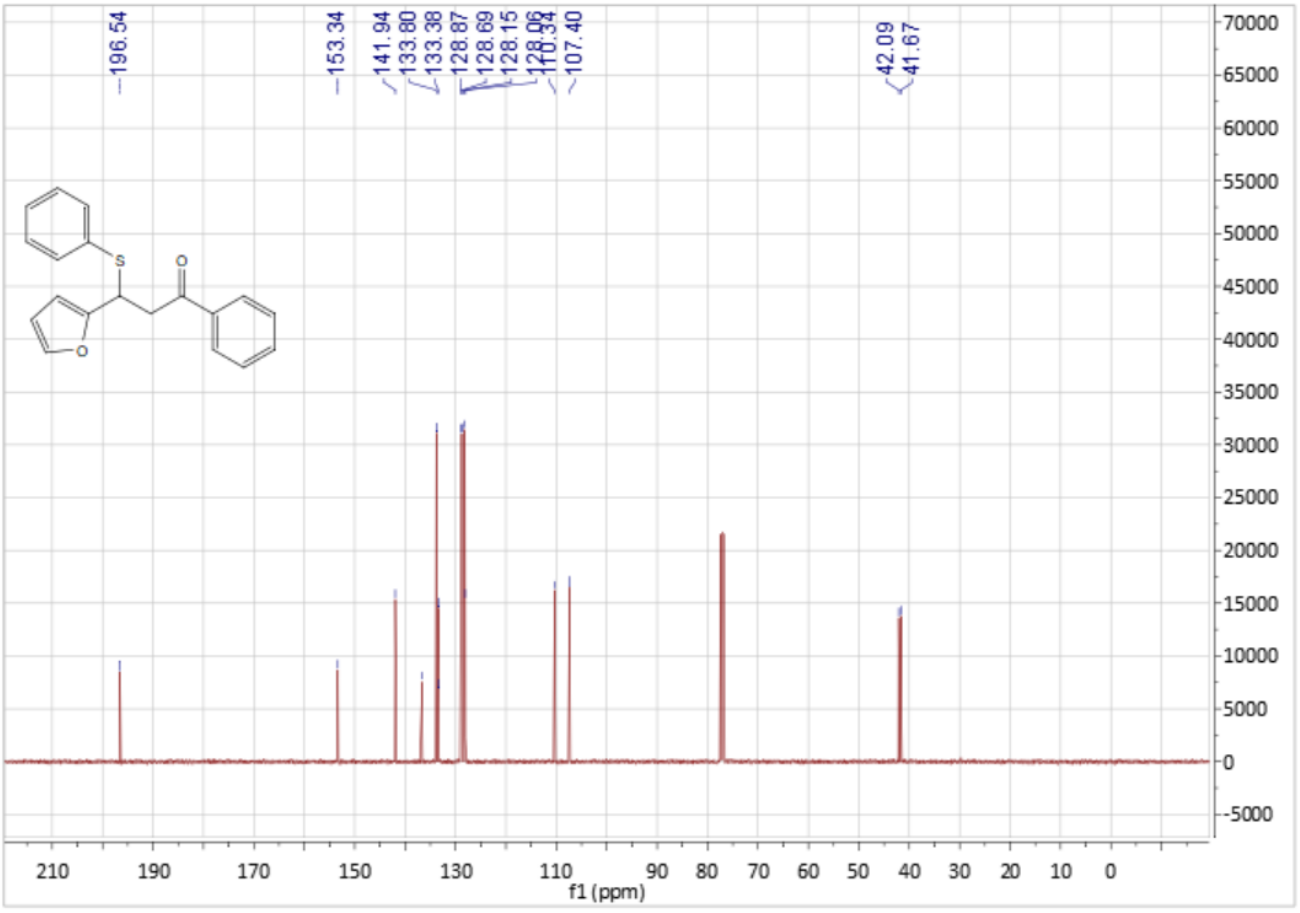
^{13}C NMR spectra of **6n**



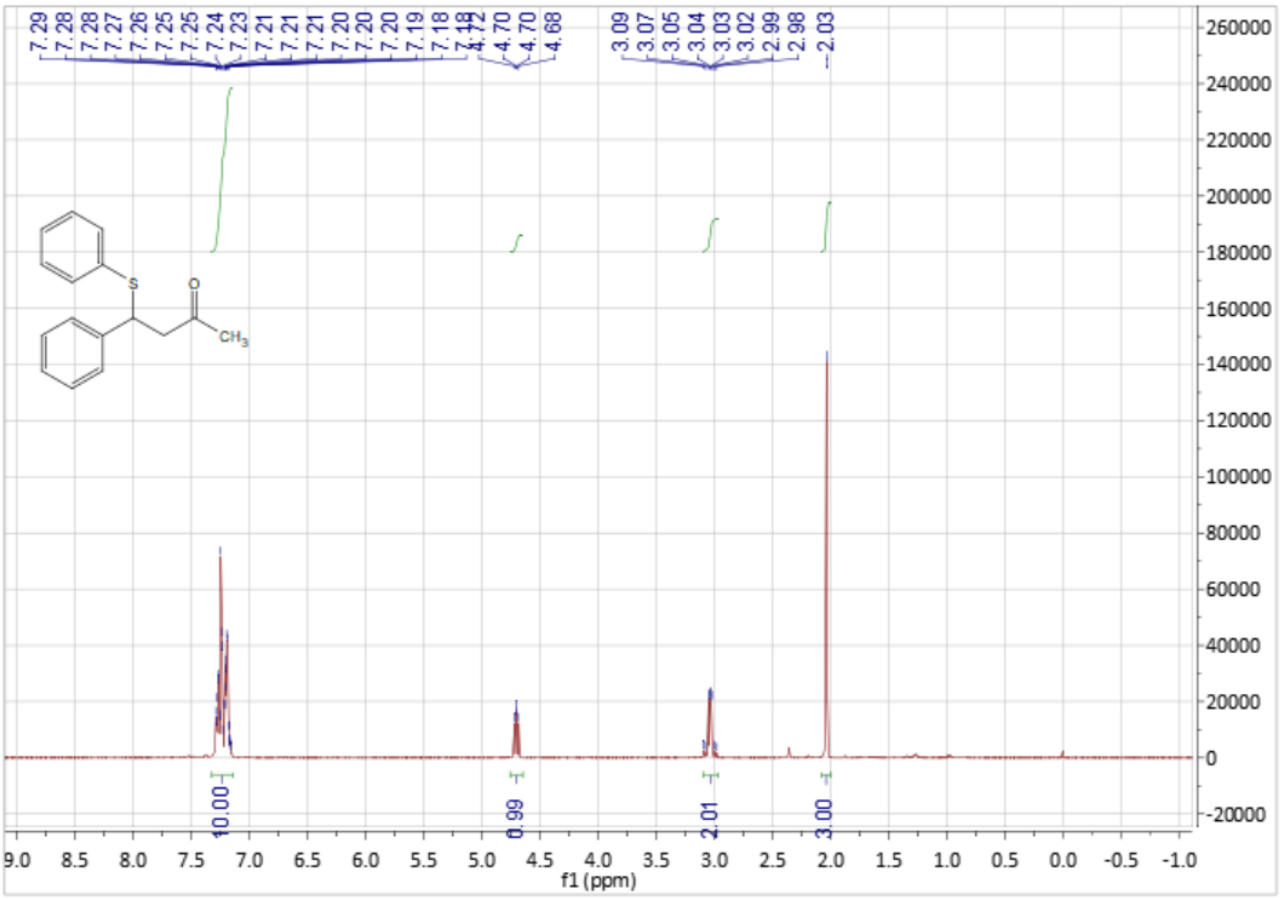
^{1}H NMR spectra of **6o**



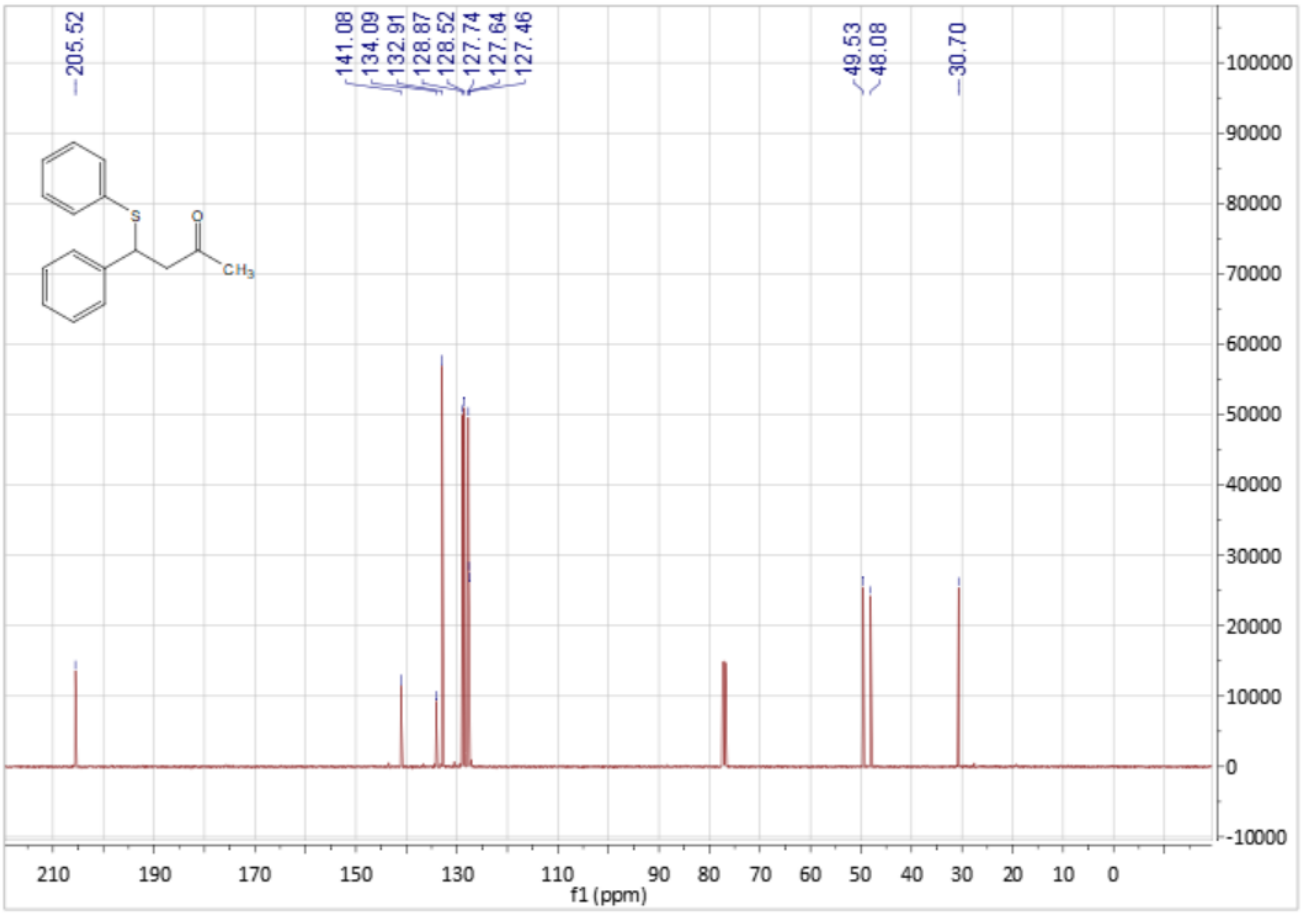
^{13}C NMR spectra of **6o**



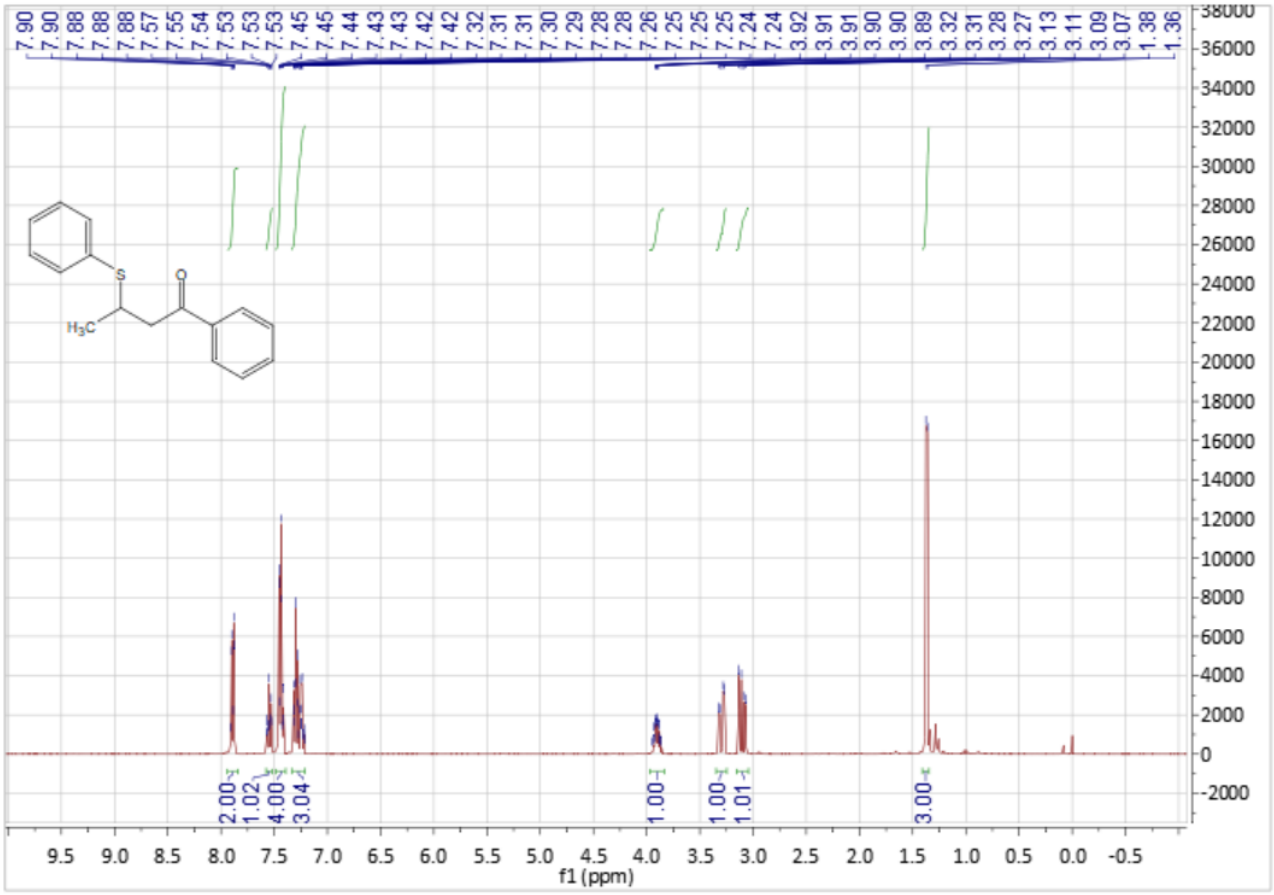
^{1}H NMR spectra of **6p**



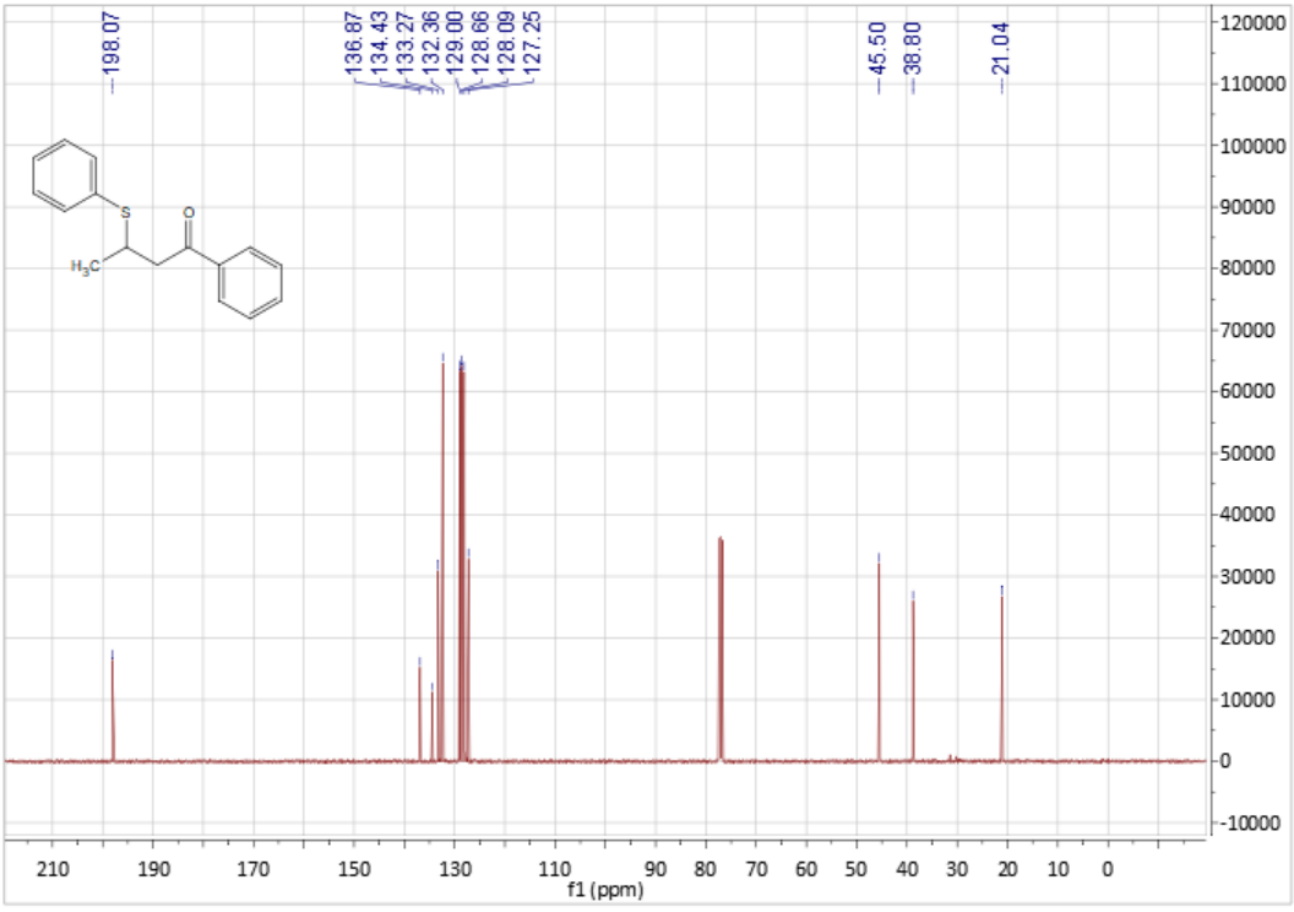
^{13}C NMR spectra of **6p**



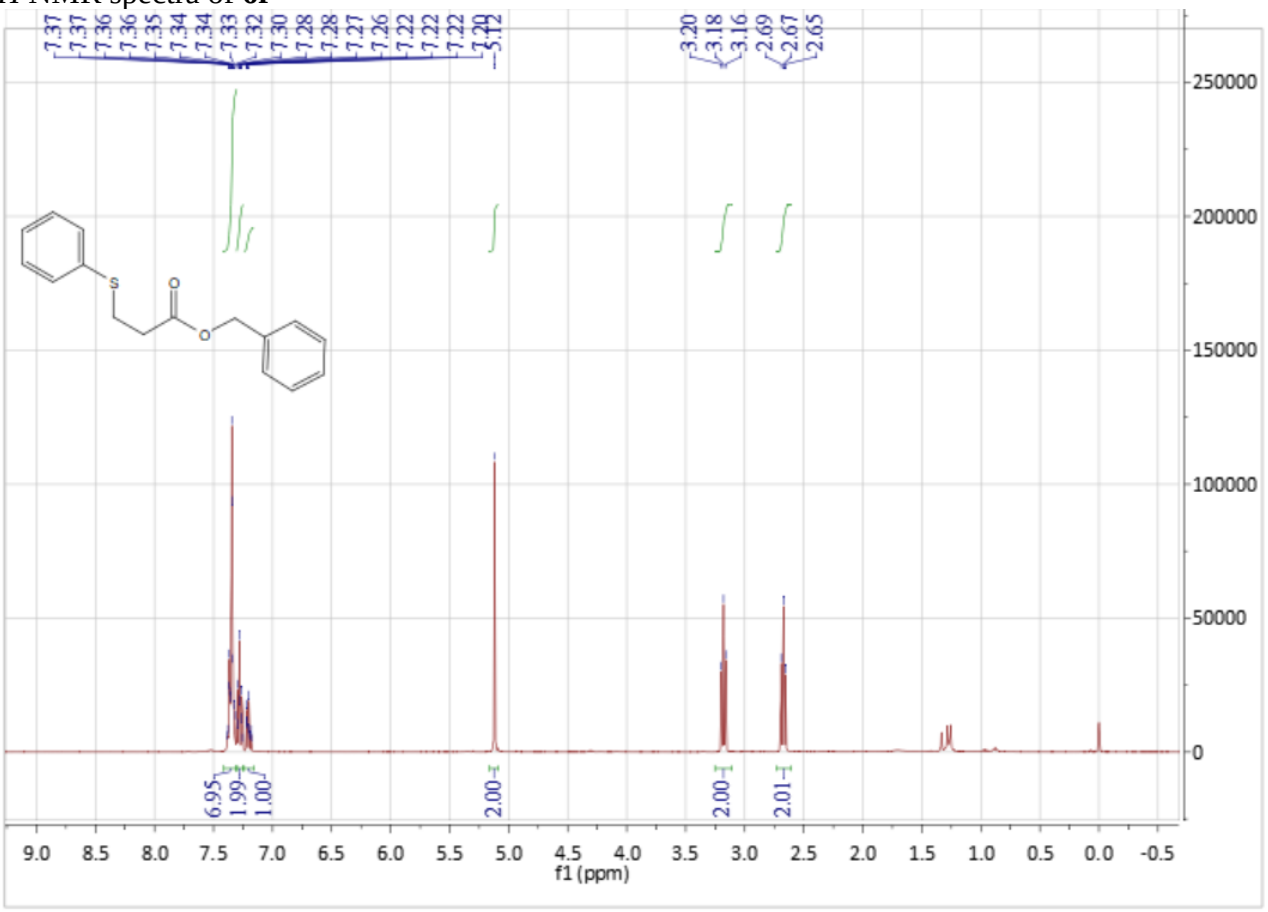
^{1}H NMR spectra of **6q**



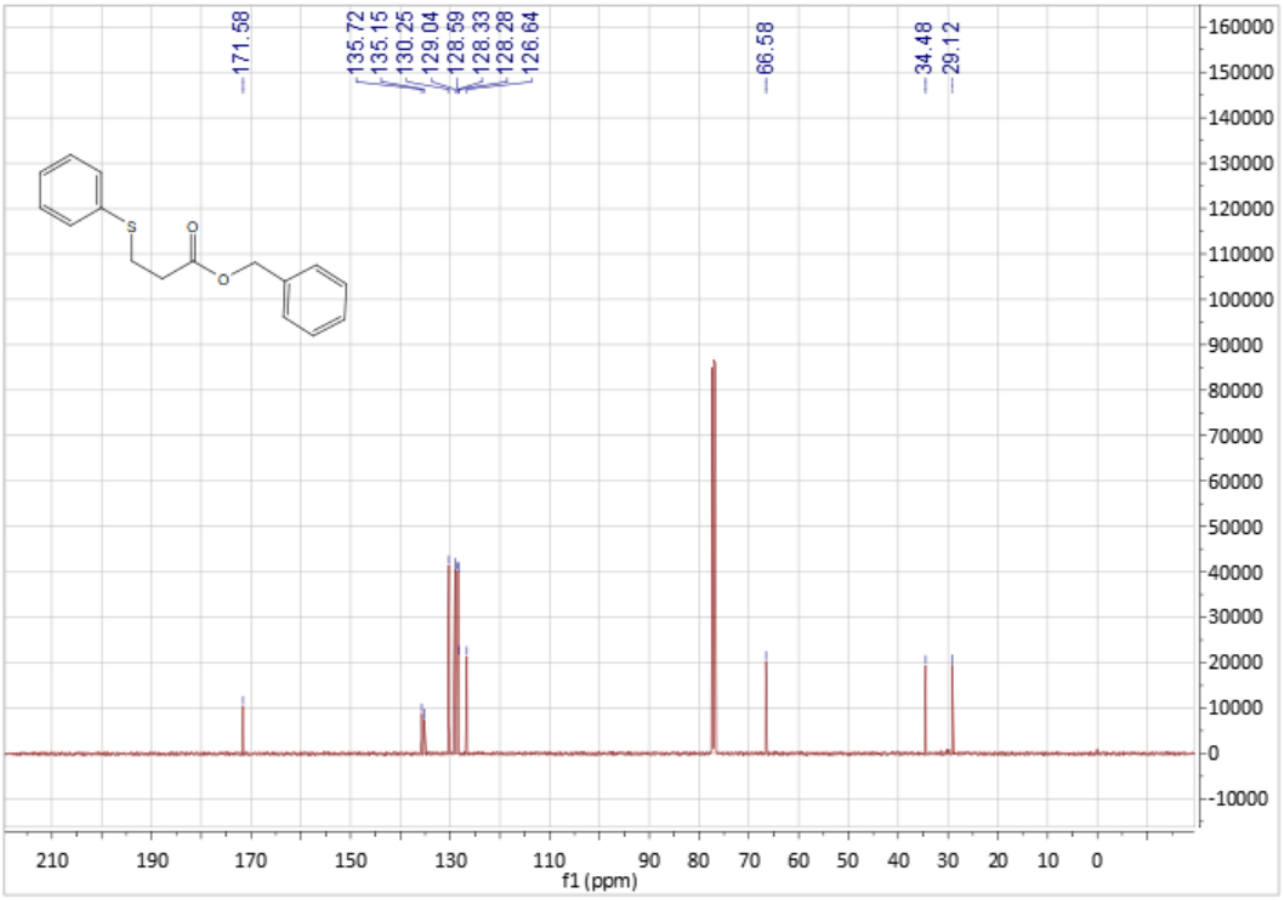
^{13}C NMR spectra of **6q**



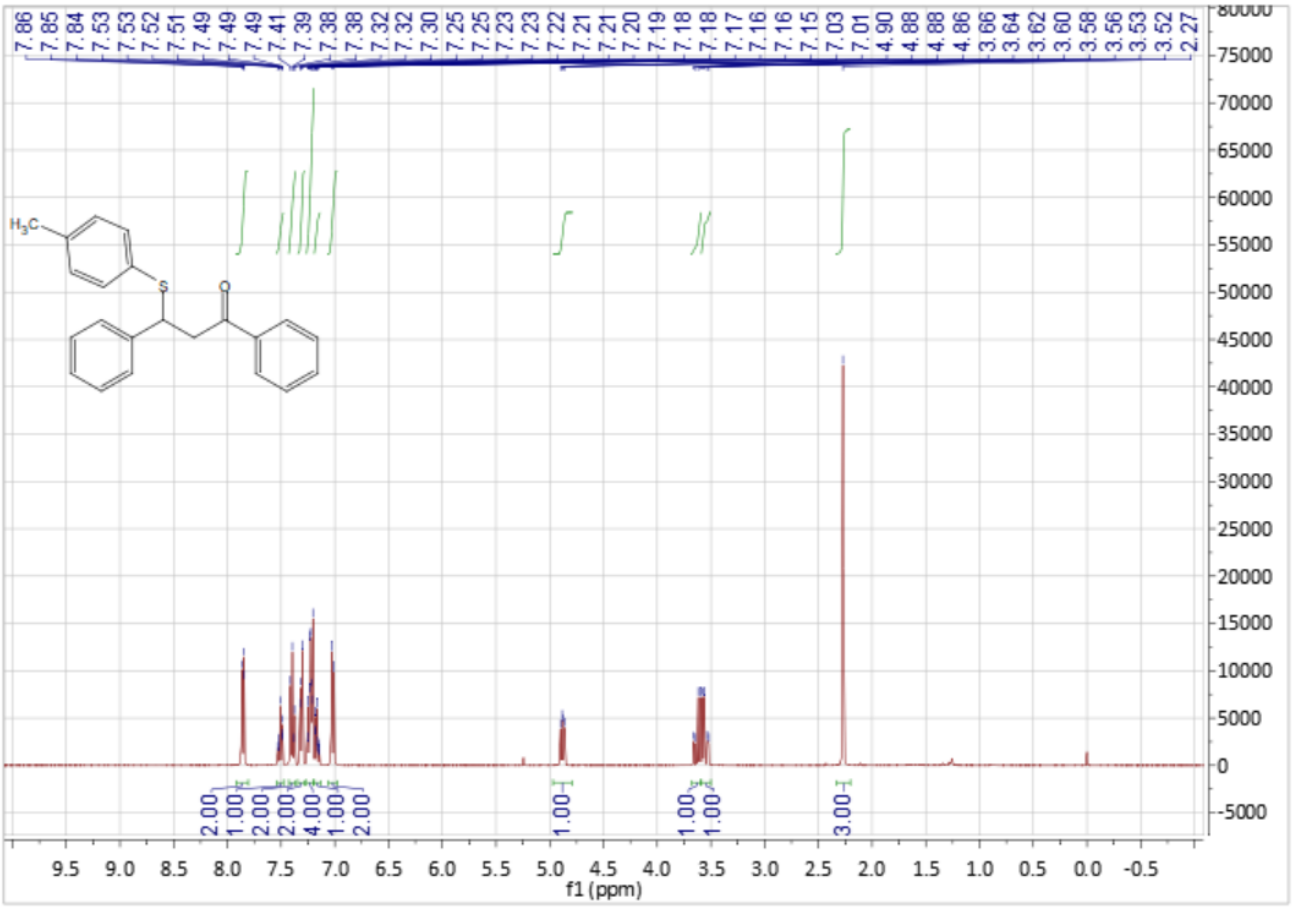
^{1}H NMR spectra of **6r**



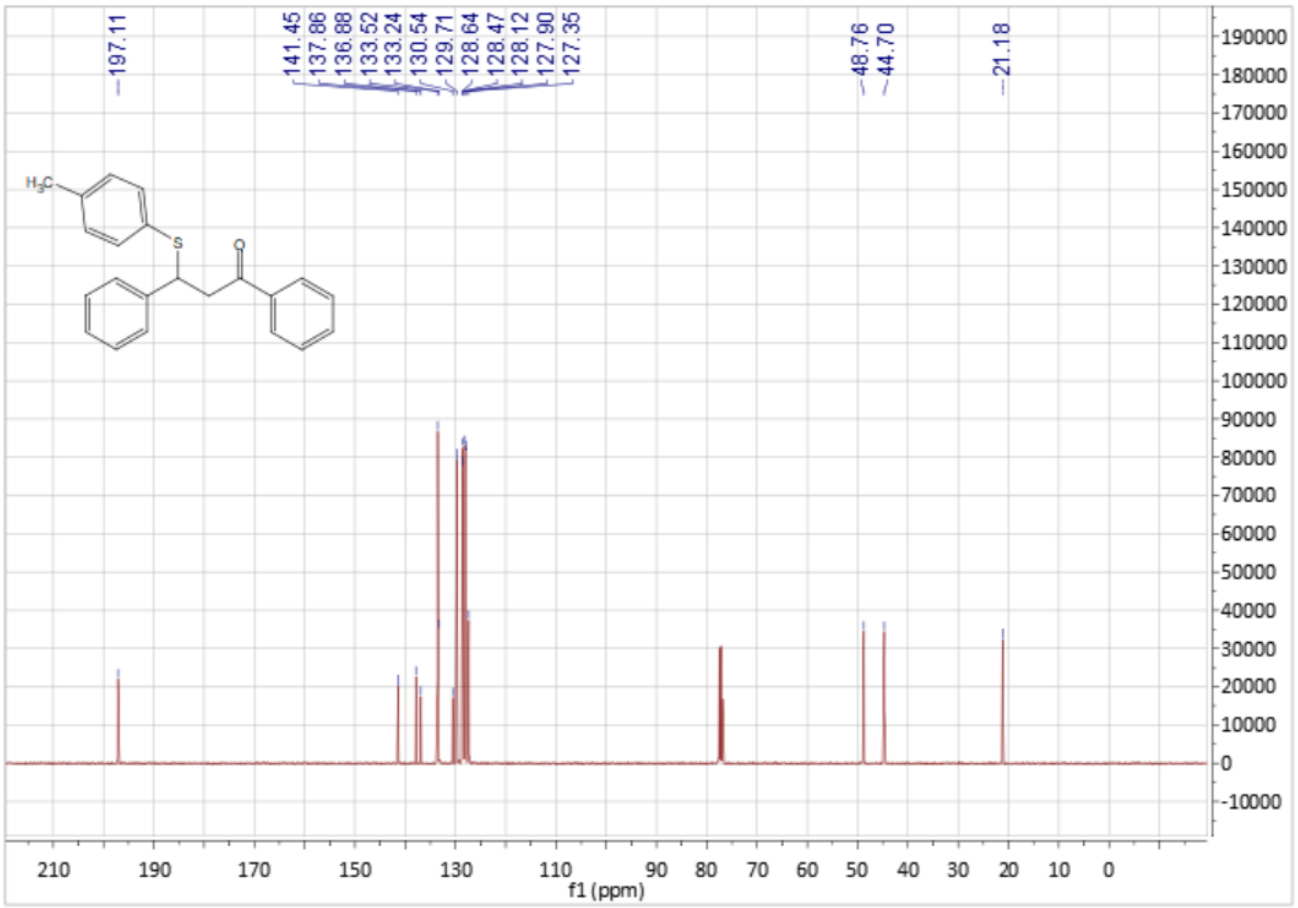
^{13}C NMR spectra of **6r**



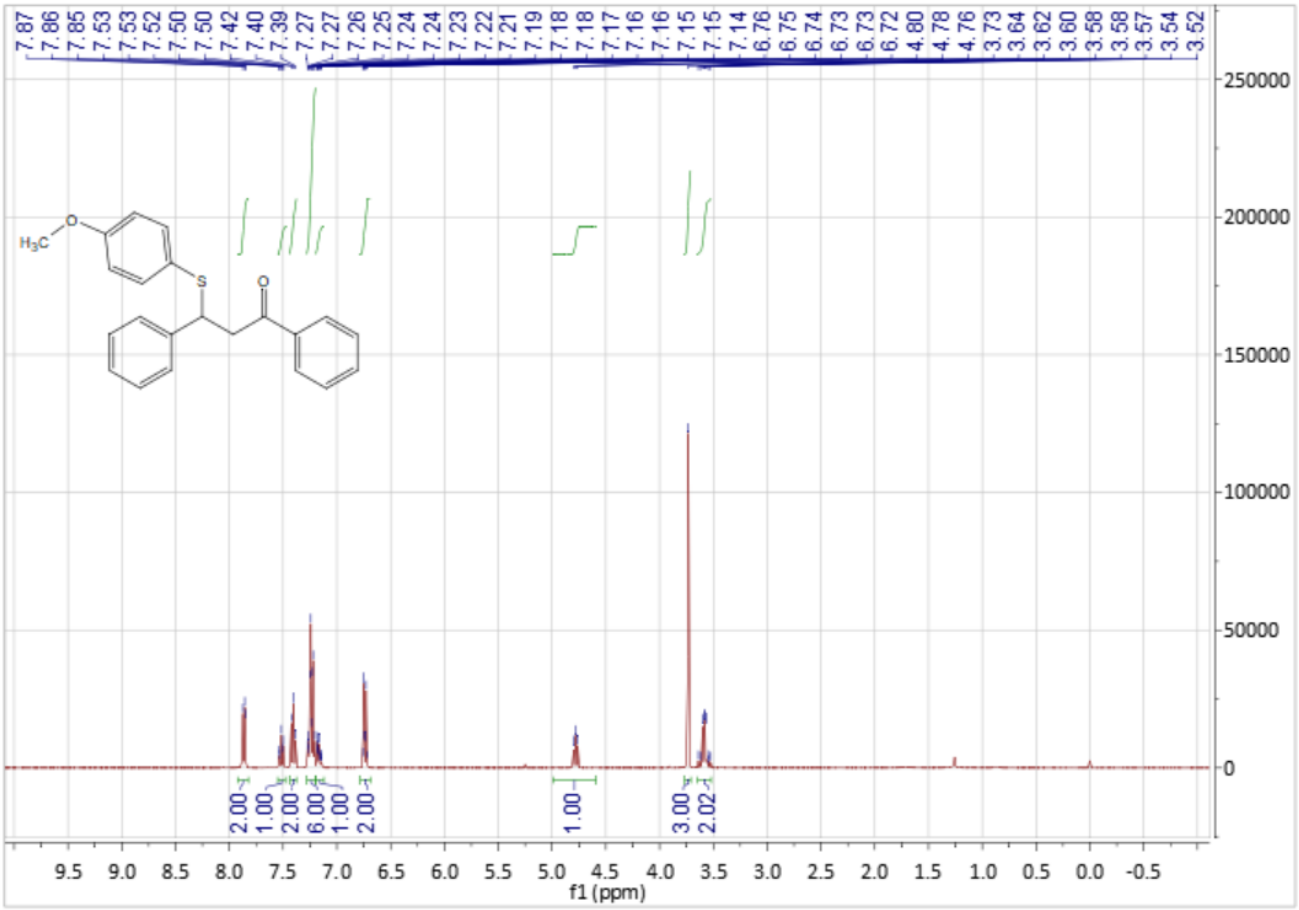
^{1}H NMR spectra of **6u**



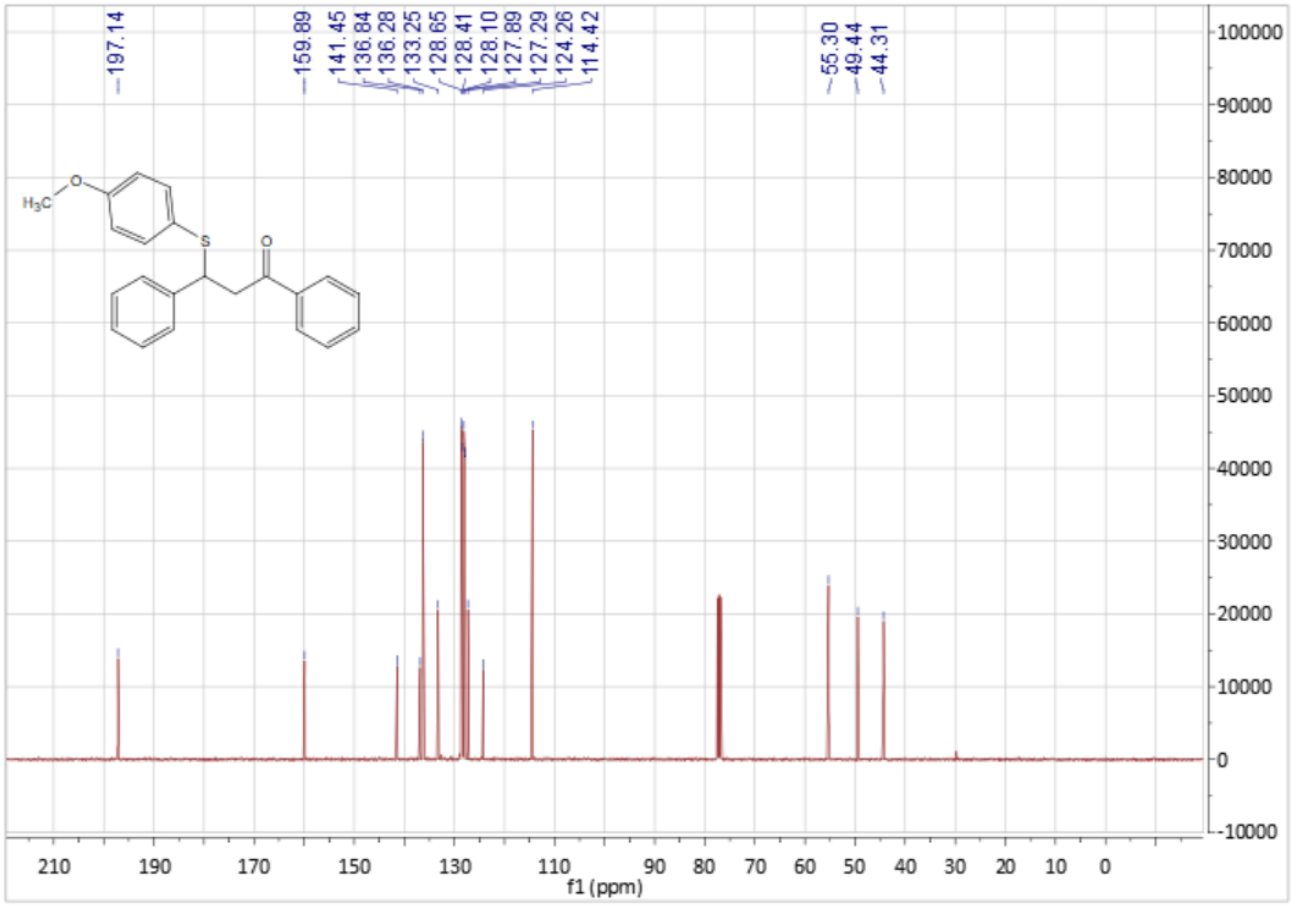
^{13}C NMR spectra of **6u**



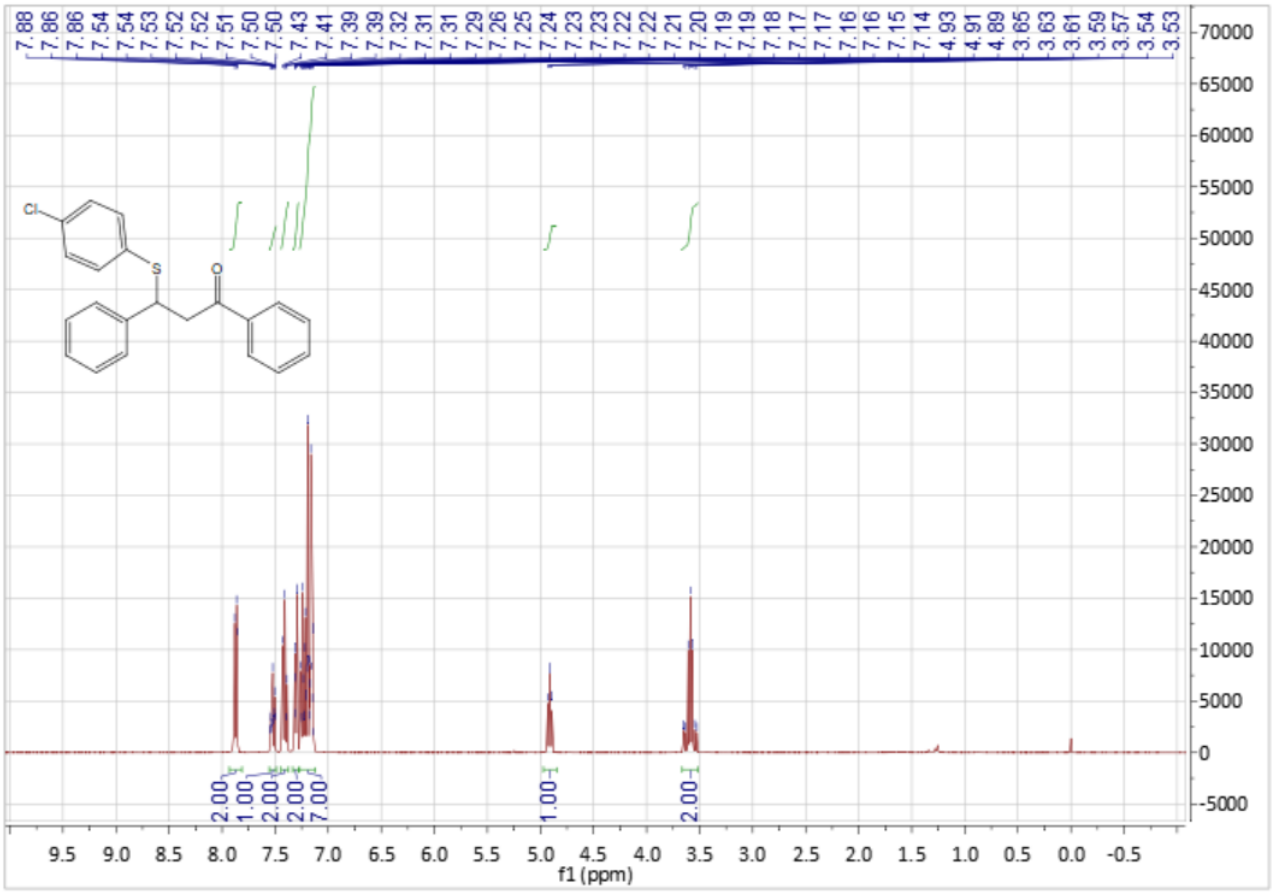
^{1}H NMR spectra of **6v**



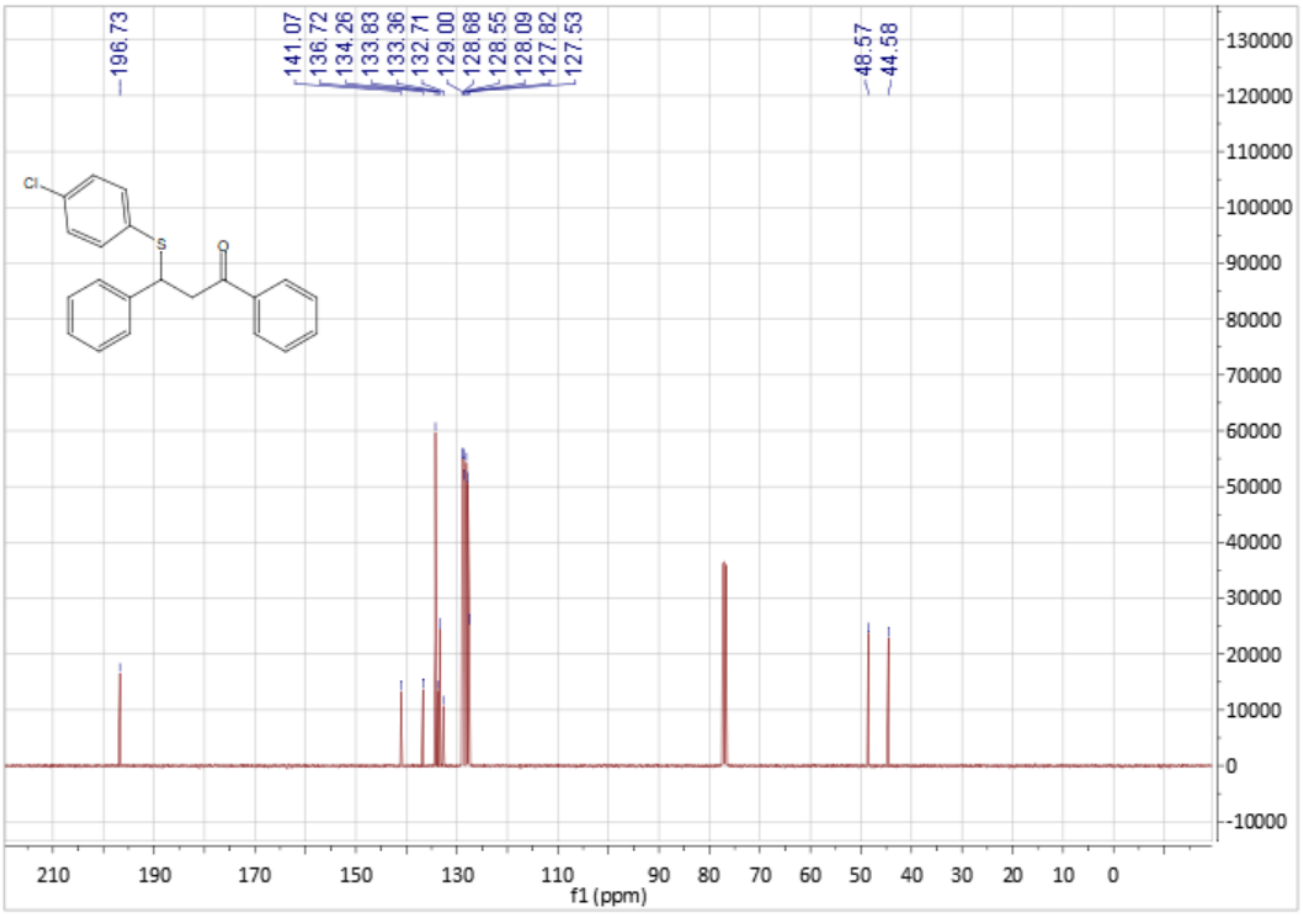
^{13}C NMR spectra of **6v**



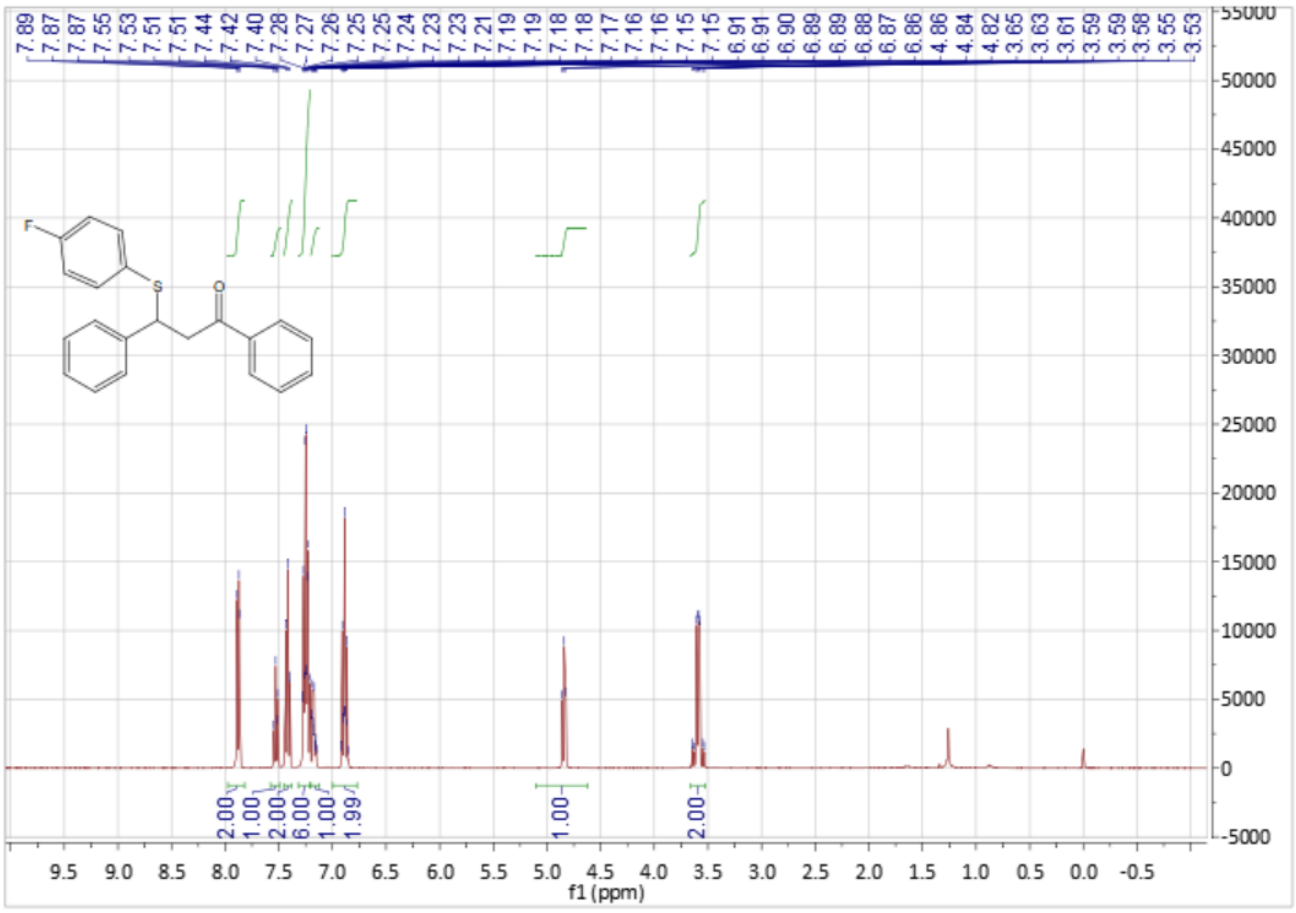
^{1}H NMR spectra of **6w**



^{13}C NMR spectra of **6w**



^{1}H NMR spectra of **6x**



^{13}C NMR spectra of **6x**