Electronic Supplementary Information for

Regioselective copper-catalyzed chlorination and bromination of arenes with O_2 as the oxidant

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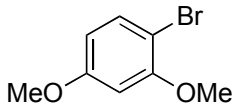
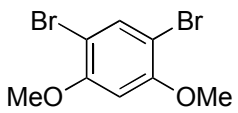
General Procedure for Catalytic Halogenation Reactions.
The amounts of $CuCl_2$ or $CuBr_2$ and LiCl or LiBr designated in Tables 1 and 2 were combined in disposable culture tubes, and the individual tubes were placed in a 48-well rack mounted on a Glas-Col pulsed shaker. The tubes were sealed, and the atmosphere within the tubes was purged with O_2 (1 atm). Solutions of each substrate (0.3 mmol) in AcOH (1 mL) were dispensed into the tubes, and the reaction mixtures were heated to the appropriate temperature while shaking for the times designated in Tables 1 and 2. When the reaction was complete, the reaction mixture was diluted with 10 mL water and 10 mL CH_2Cl_2. The organic layer was washed with saturated Na_2CO_3 (15 mL) and brine solution (15 mL). The organic layer was dried over Na_2SO_4 and concentrated under vacuum. The residue was purified by column chromatography (see conditions for each product below).

Product Characterization Data.



1b

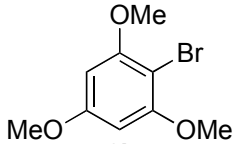
84% yield; oil (elution solvent – hexane:ether = 5:1). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.40 (d, J = 8.7 Hz, 1H), 6.48 (d, J = 2.8 Hz, 1H), 6.39 (dd, J = 8.9, 2.5 Hz, 1H), 3.86 (s, 3H), 3.79 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 160.5, 156.8, 133.3, 106.1, 102.7, 100.2, 56.3, 55.8; HRMS (EI-EMM): Calcd for $C_8H_9O_2Br$ (^{79}Br) *m/z* = 215.9781 found 215.9782.



1c

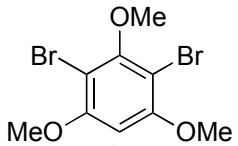
100% yield; solid (purified without chromatography). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.65 (s, 1H), 6.48 (s, 1H), 3.90 (s, 6H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 156.4, 136.1, 102.6,

97.6, 56.7; melting point: 138-139°C; HRMS (EI-EMM): Calcd for $C_8H_8O_2Br_2$ (^{79}Br) *m/z* = 293.8886 found 293.8899.



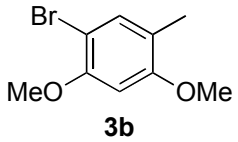
2b

82% yield, solid (elution solvent – gradient, hexane:ethyl acetate = 10:1 →5:1) product obtained as inseparable mixture of **2b**:**2c** (82:8%). ^1H NMR: (300 Hz, $CDCl_3$): δ 6.17 (s, 1H), 3.87 (s, 6H), 3.81 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 160.7, 157.6, 92.2, 91.8, 56.5, 55.7; HRMS (EI-EMM): Calcd for $C_9H_{11}O_2Br$ (^{79}Br) *m/z* = 245.9887 found 245.9892.



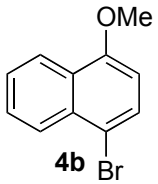
2c

93% yield; solid (purified without chromatography). ^1H NMR: (300 Hz, $CDCl_3$): δ 6.35 (s, 1H), 3.91 (s, 6H), 3.87 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 156.8, 155.9, 99.2, 93.4, 60.7, 56.8; melting point: 128-129°C; HRMS (EI-EMM): Calcd for $C_9H_{10}O_3Br_2$ (^{79}Br) *m/z* = 323.8992 found 323.8996.



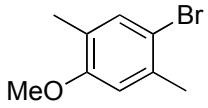
3b

75% yield; solid (elution solvent – hexane:ethyl acetate =10:1). ^1H NMR: (300 Hz, $CDCl_3$): δ 7.25 (d, J = 0.7 Hz, 1H), 6.44 (s, 1H), 3.88 (s, 3H), 3.83 (s, 3H), 2.12 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 158.0, 154.9, 134.2, 120.5, 101.4, 96.7, 56.7, 55.8, 15.3; melting point: 89-90°C; HRMS (EI-EMM): Calcd for $C_9H_{11}O_2Br$ (^{79}Br) *m/z* = 229.9937 found 229.9932.



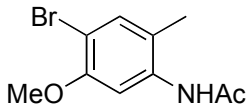
4b

80% yield, oil (elution solvent – hexane:ethyl acetate = 100:1). ^1H NMR: (300 Hz, $CDCl_3$): δ 8.27 (d, J = 8.4 Hz, 1H), 8.16 (d, J = 7.9 Hz, 1H), 7.9 (d, J = 8.8 Hz, 1H), 7.62-7.57 (m, 1H), 7.57-7.45 (m, 1H), 6.66 (d, J = 8.1 Hz, 1H), 3.97 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 155.5, 132.6, 129.7, 127.9, 127.0, 126.2, 122.6, 133.5, 104.7, 55.9; HRMS (EI-EMM): Calcd for $C_{11}H_9BrO$ (^{79}Br) *m/z* = 235.9832, found 235.9824.



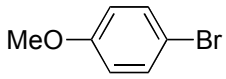
5b

96% yield; oil (purified without chromatography). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.25 (s, 1H), 6.67 (s, 1H), 3.79 (s, 3H), 2.35 (s, 3H), 2.15 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 157.1, 135.9, 133.9, 126.3, 114.8, 112.7, 55.7, 23.1, 15.7; HRMS (EI-EMM): Calcd for $C_9H_{11}BrO$ (^{79}Br) *m/z* = 213.9988, found 213.9981.



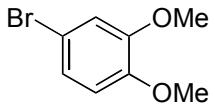
6b

93% yield, solid (Additional purification conditions: The reaction mixture was diluted with 10 mL water and 10 mL CH_2Cl_2, and the phases were separated. Saturated Na_2CO_3 (20 mL) was added to the aqueous layer, which was then extracted with CH_2Cl_2. The organic layer was washed with 15 mL of staturated Na_2CO_3, followed by brine solution. column elution solvent – gradient, hexane:ethyl acetate =1:1 → 1:2). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.69 (s, 1H), 7.32 (s, 1H), 6.97 (s, 1H), 3.87 (s, 3H), 2.21 (s, 3H), 2.18 (s, 3H); ^{13}C NMR (500 Hz, $CDCl_3$): δ 168.5, 154.6, 136.1, 134.3, 121.0, 106.7, 56.6, 24.9, 16.7; melting point: 194-195°C. HRMS (EI-EMM): Calcd for $C_{10}H_{12}BrNO_2$ (^{79}Br) *m/z* = 257.0046 found 257.0040.



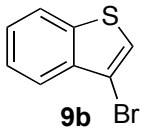
7b

78% yield, oil (elution solvent – hexane: dichloromethane = 5:1). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.40-7.34 (m, 2H), 6.80-6.74 (m, 2H), 3.78 (s, 3H); ^{13}C NMR (500 Hz, $CDCl_3$): δ 158.9, 132.4, 115.9, 113.0, 55.6; HRMS (EI-EMM): Calcd for C_7H_7BrO (^{79}Br) *m/z* = 185.9675 found 185.9681.



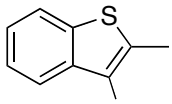
8b

89% yield, oil (elution solvent – hexane:ethyl acetate = 20:1). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.03 (dd, J = 8.6, 2.4 Hz, 1H), 6.98 (d, J = 2.4 Hz, 1H), 6.73 (d, J = 8.6 Hz, 1H), 3.87 (s, 3H), 3.86 (s, 3H); ^{13}C NMR (500 Hz, $CDCl_3$): δ 149.7, 148.3, 123.4, 114.8, 112.7, 112.5, 56.1, 56.0; HRMS (EI-EMM): Calcd for $C_8H_9BrO_2$ (^{79}Br) *m/z* = 215.9781 found 215.7980.



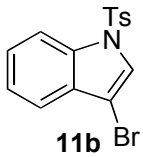
9b

77% yield, oil (elution solvent – pentane). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.87-7.75 (m, 2H), 7.50-7.33 (m, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 138.8, 137.7, 125.5, 125.2, 123.7, 123.4, 122.9, 111.1, 107.9; HRMS (EI-EMM): Calcd for C_8H_5SBr (^{79}Br) *m/z* = 211.9290 found 211.9291.



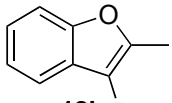
10b

63% yield, solid (elution solvent – hexane). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.73-7.67 (m, 2H), 7.39 (td, J = 7.6, 1.0 Hz, 1H), 7.31 (td, J = 7.6, 1.2 Hz, 1H), 2.54 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 138.6, 137.4, 135.4, 125.1, 124.9, 122.8, 122.3, 106.8, 15.7; melting point: 40-42°C; HRMS (EI-EMM): Calcd for C_9H_7SBr (^{79}Br) *m/z* = 225.9447 found 225.9444.



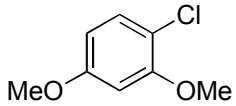
11b

66% yield, solid (elution solvent – hexane:ethyl acetate = 20:1). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.99 (d, *J* = 8.1 Hz, 1H), 7.76 (d, *J* = 8.1 Hz, 2H), 7.62 (s, 1H), 7.50-7.42 (m, 1H), 7.41-7.23 (m, 2H), 7.20 (d, *J* = 8.7 Hz, 2H), 2.31 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 145.6, 135.1, 134.5, 130.2, 130.0, 127.1, 126.0, 125.0, 124.1, 120.3, 113.8, 99.2, 21.8; melting point: 122-123°C; HRMS (EI-EMM): Calcd for $C_{15}H_{12}NBrO_2S$ (^{79}Br) *m/z* = 348.9767 found 348.9782.



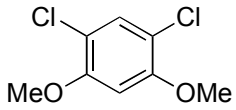
12b

48% yield, oil (elution solvent – hexane:ethyl acetate = 200:1). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.46-7.31 (m, 2H), 7.30-7.17 (m, 2H), 2.47 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 153.7, 152.3, 128.6, 124.6, 123.3, 119.2, 111.2, 94.7, 12.6; HRMS (EI-EMM): Calcd for C_9H_7OBr (^{79}Br) *m/z* = 209.9679 found 209.9675.



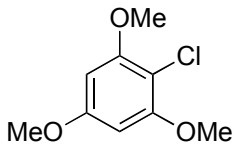
1d

77% yield, oil (condition: hexane:ether = 2:1). ^{1}H NMR (300 Hz, $CDCl_3$): δ 7.24 (d, J = 8.7 Hz, 1H), 6.50 (d, J = 2.9 Hz, 1H), 6.43 (dd, J = 8.9, 2.7 Hz, 1H), 3.87 (s, 3H), 3.79 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 159.6, 155.8, 130.2, 114.2, 105.3, 100.1, 56.1, 55.7; HRMS (EI-EMM): Calcd for $C_8H_9ClO_2$ (^{35}Cl) *m/z* = 172.0286 found 172.0287.



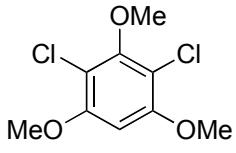
1e

88% yield, solid (elution solvent – hexane:ether = 1:1). ^{1}H NMR: (300 Hz, $CDCl_3$), δ 7.34 (s, 1H), 6.524 (s, 1H), 3.91 (s, 6H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 154.8, 130.8, 114.3, 98.0, 56.8; melting point: 119-121°C; HRMS (EI-EMM): Calcd for $C_8H_8Cl_2O$ (^{35}Cl) *m/z* = 205.9896 found 205.9897.



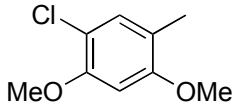
2d

76% yield, solid (elution solvent – hexane:ethyl acetate = 4:1) product obtained as inseparable mixture of **2d**:**2e** (76:12%). ^{1}H NMR: (300 Hz, $CDCl_3$), δ 6.18 (s, 2H), 3.88 (s, 6H), 3.81 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 159.6, 156.8, 91.8, 56.5, 55.7; HRMS (EI-EMM): Calcd for $C_9H_{11}ClO_3$ (^{35}Cl) *m/z* = 202.0392 found 202.0385.



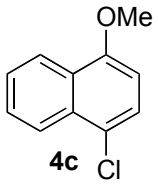
2e

90% yield, solid (elution solvent – hexane:ethyl acetate = 20:1). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 6.37 (s, 1H), 3.91 (s, 6H), 3.89 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 155.0, 154.1, 109.9, 93.5, 60.8, 56.7:; melting point: 126-127°C; HRMS (EI-EMM): Calcd for $C_9H_{10}Cl_2O_3$ (^{35}Cl) *m/z* = 236.0002 found 235.9995.



3c

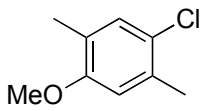
75% yield, oil (elution solvent – hexane:ethyl acetate = 20:1). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.09 (s, 1H), 6.46 (s, 1H), 3.89 (s, 3H), 3.83 (s, 3H), 2.12 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 157.2, 153.8, 131.4, 119.8, 113.0, 96.8, 56.6, 55.9, 15.3; HRMS (EI-EMM): Calcd for $C_9H_{11}ClO_2$ (^{35}Cl) *m/z* = 186.0443 found186.0443



4c

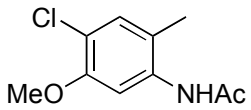
80% yield, oil (elution solvent – hexane:ethyl acetate = 100:1). ^{1}H NMR: (300 Hz, $CDCl_3$): δ 7.48 (m, 1H), 7.44 (d, J = 8.2 Hz, 1H), 6.69 (d, J = 7.9 Hz, 1H), 3.97 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 154.7, 131.5, 127.7, 126.8, 126.1, 125.9, 124.4, 123.4,

122.6, 104.0, 55.9; HRMS (EI-EMM): Calcd for $C_{11}H_9ClO$ (^{35}Cl) *m/z* = 192.03337 found 192.0336.



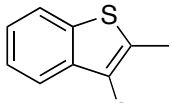
5c

76% yield, oil (elution solvent – hexane: ethyl acetate =3:1), get oil. ^1H NMR: (300 Hz, $CDCl_3$): δ 7.08 (s, 1H), 6.66 (s, 1H), 3.79 (s, 3H), 2.33 (s, 3H), 2.15 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 156.4, 133.9, 130.8, 125.9, 124.9, 112.7, 55.7, 20.2, 15.8; HRMS (EI-EMM): Calcd for $C_9H_{11}ClO(^{35}Cl)$ *m/z* = 170.0493, found 170.0494.



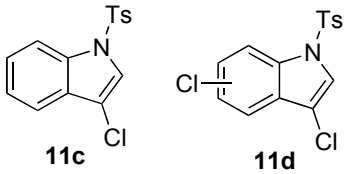
6c

73% yield, solid (Additional purification conditions: The reaction mixture was diluted with 10 mL water and 10 mL CH_2Cl_2, and the phases were separated. Saturated Na_2CO_3 (20 mL) was added to the aqueous layer, which was then extracted with CH_2Cl_2. The organic layer was washed with 15 mL of staturated Na_2CO_3, followed by brine solution. column elution solvent – gradient, hexane:ethyl acetate =1:1 → 1:2) ^1H NMR: (300 Hz, $CDCl_3$), δ 7.66 (s, 1H), 7.15 (s, 1H), 7.02 (s, 1H), 3.87 (s, 3H), 2.21 (s, 3H), 2.16 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 168.8, 153.7, 135.3, 131.4, 121.1, 118.0, 107.2, 56.5, 24.7, 16.8; HRMS (EI-EMM): Calcd for $C1_0H_{12}ClNO_2$ (^{35}Cl) *m/z* = 213.0552 found 213.0558.



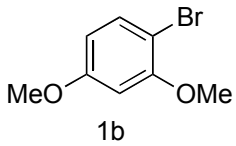
10c

63% yield, oil (elution solvent – hexane). ^1H NMR: (300 Hz, $CDCl_3$): δ 7.72 (d, J = 8.5 Hz, 2H), 7.40 (td, J = 7.6, 1.0 Hz, 1H), 7.32 (td, J = 7.6, 1.2 Hz, 1H), 2.54 (s, 3H); ^{13}C NMR (300 Hz, $CDCl_3$): δ 137.2, 136.6, 133.5, 124.9, 124.9, 122.4, 121.4, 111.0, 14.0; HRMS (EI-EMM): Calcd for C_9H_7SCl (^{35}Cl) *m/z* = 181.9952 found 181.9951.

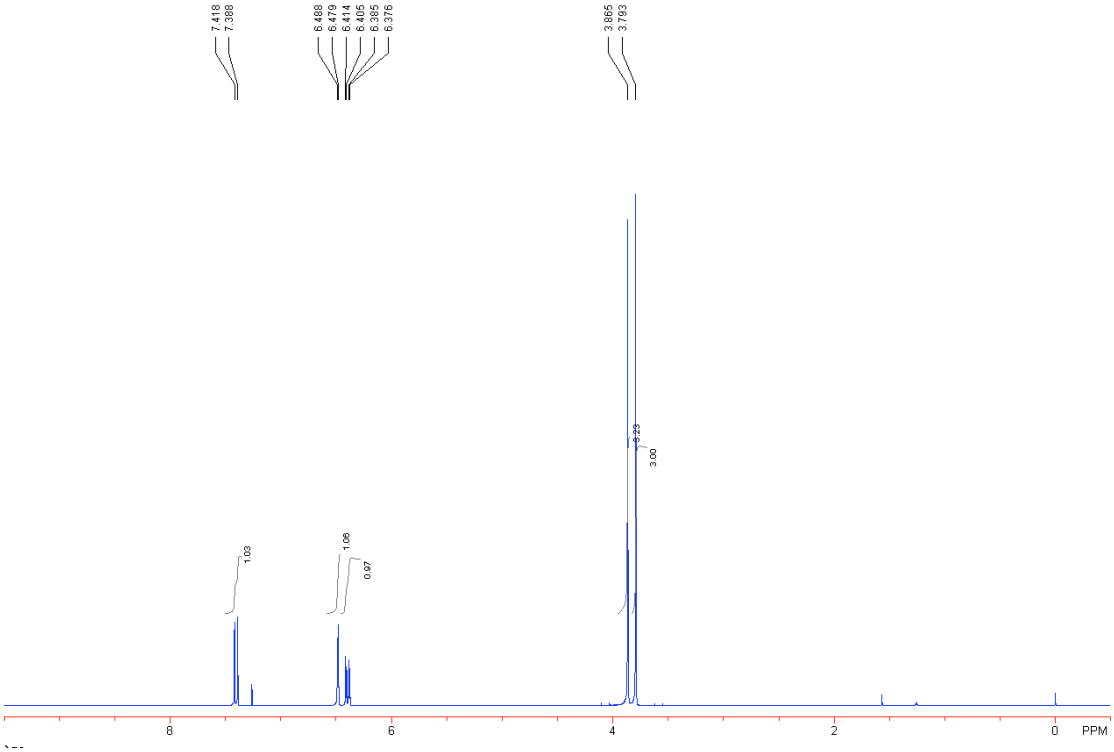


11c **11d**

Isolated as a 7/45/15% mixture of **11a**, **11c**, and **11d** (elution solvent – hexane:ethyl acetate = 20:1). **11c**: HRMS (EI-EMM): Calcd for $C_{15}H_{12}ClNO_2S$ (^{35}Cl) *m/z* = 305.0272 found 305.0276.


Br
MeO
OMe

1b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6.488
6.479
6.414
6.405
6.385
6.376
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3.793
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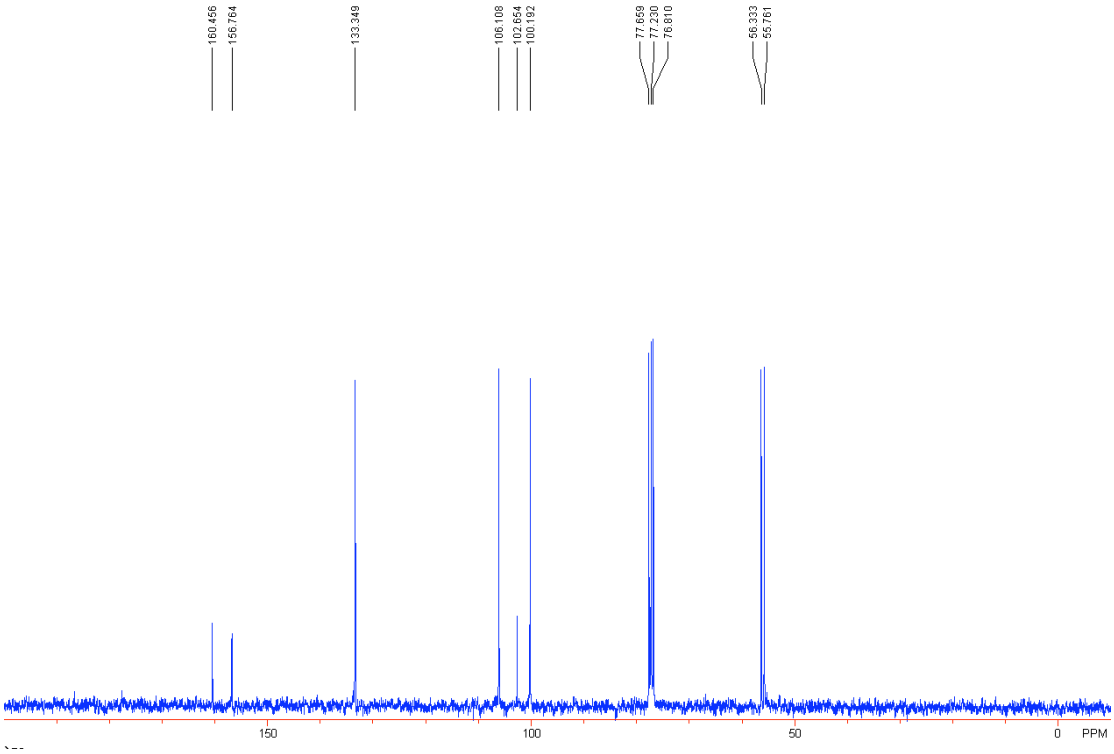
3.00
1.03
1.06
0.87
8
6
4
2
0
PPM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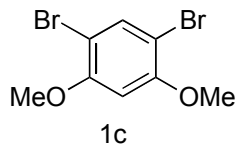
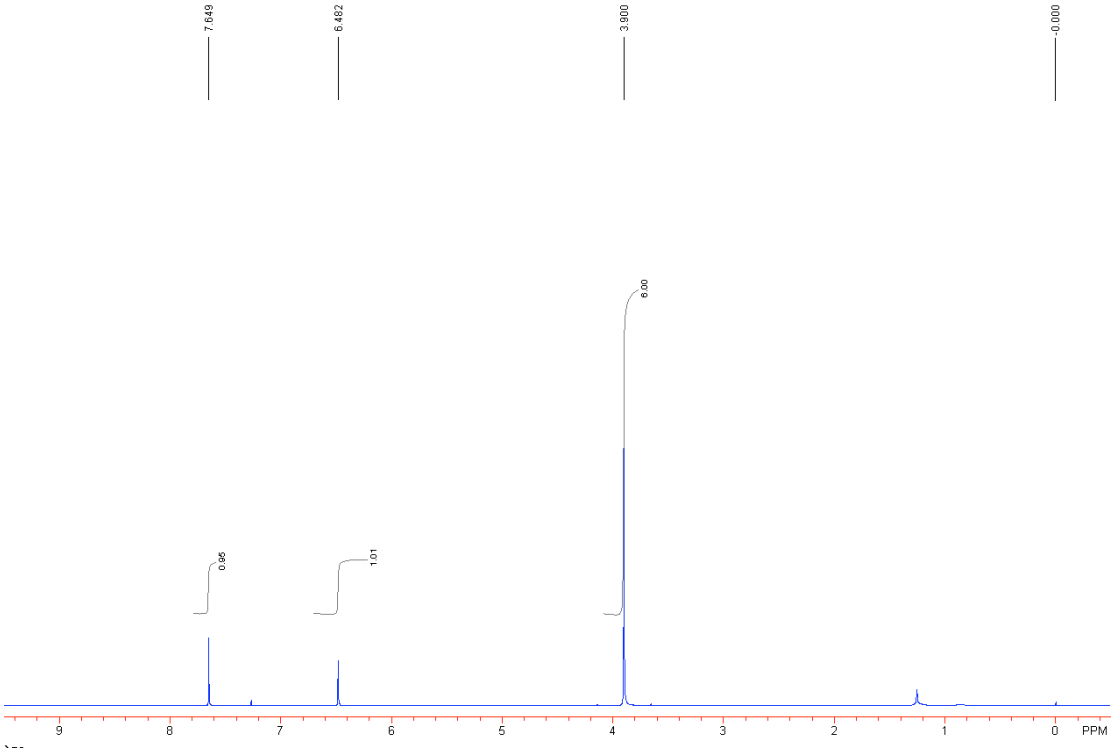
156.764
133.349
106.108
102.654
100.192
77.659
77.230
76.810
56.333
55.761
150
100
50
0
PPM


Br
Br
MeO
OMe

1c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1.01
9
8
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6
5
4
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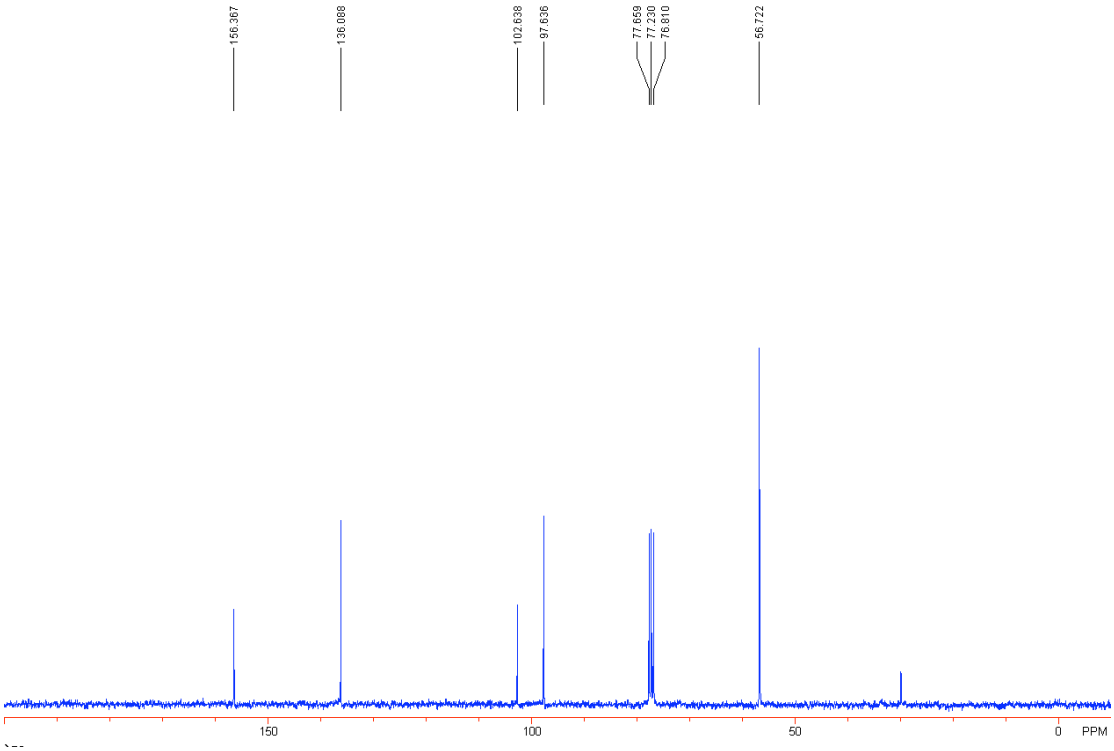
2
1
0
PPM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77.659
77.230
76.810
56.722
150
100
50
0
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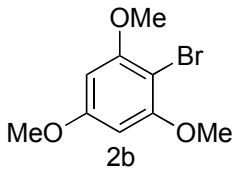
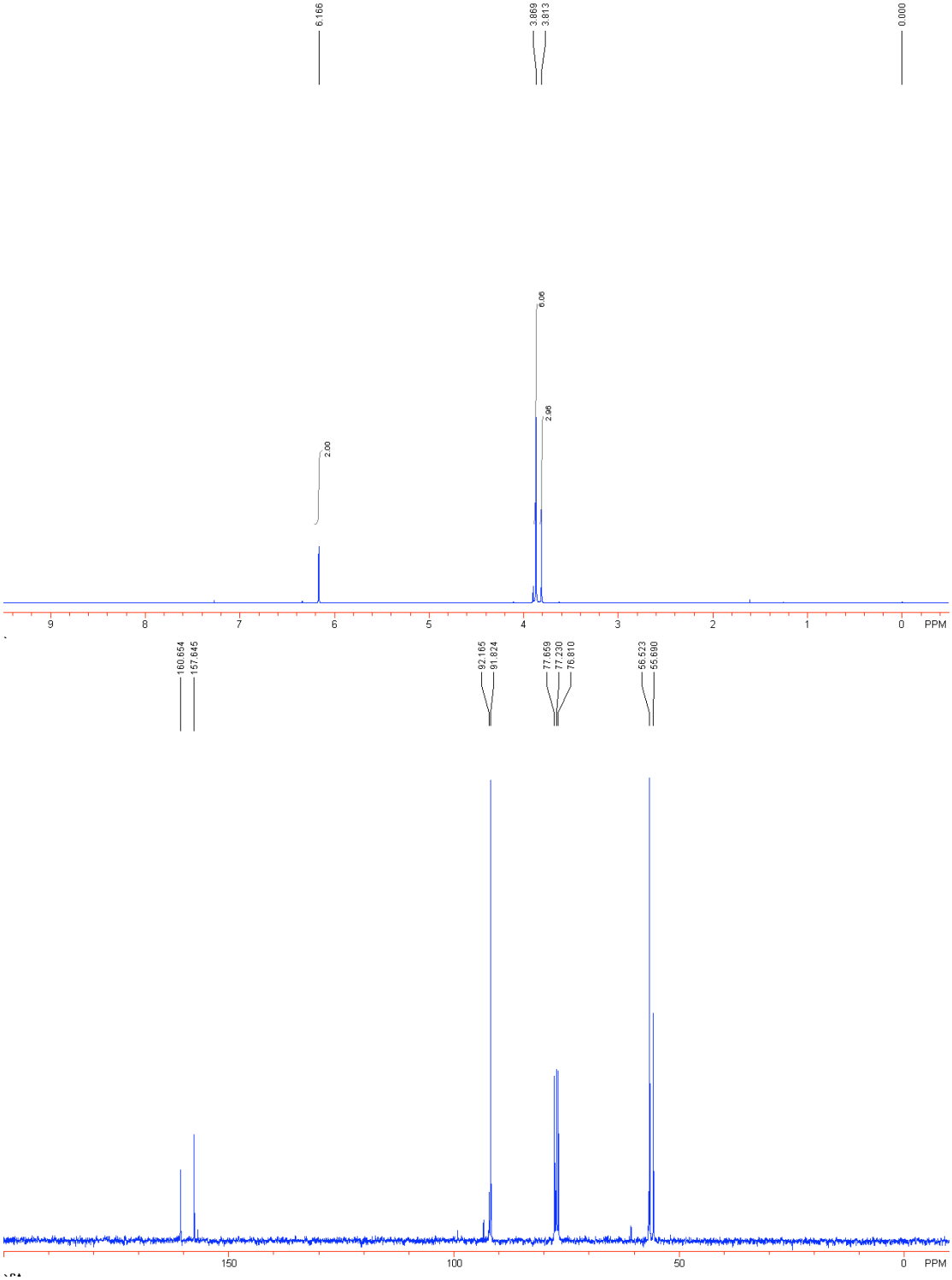

OMe
Br
MeO
OMe

2b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3.869
3.813
0.000
6.00
2.00
2.96
9
8
7
6
5
4
3
2
1
0
PPM
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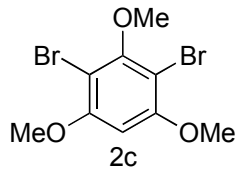
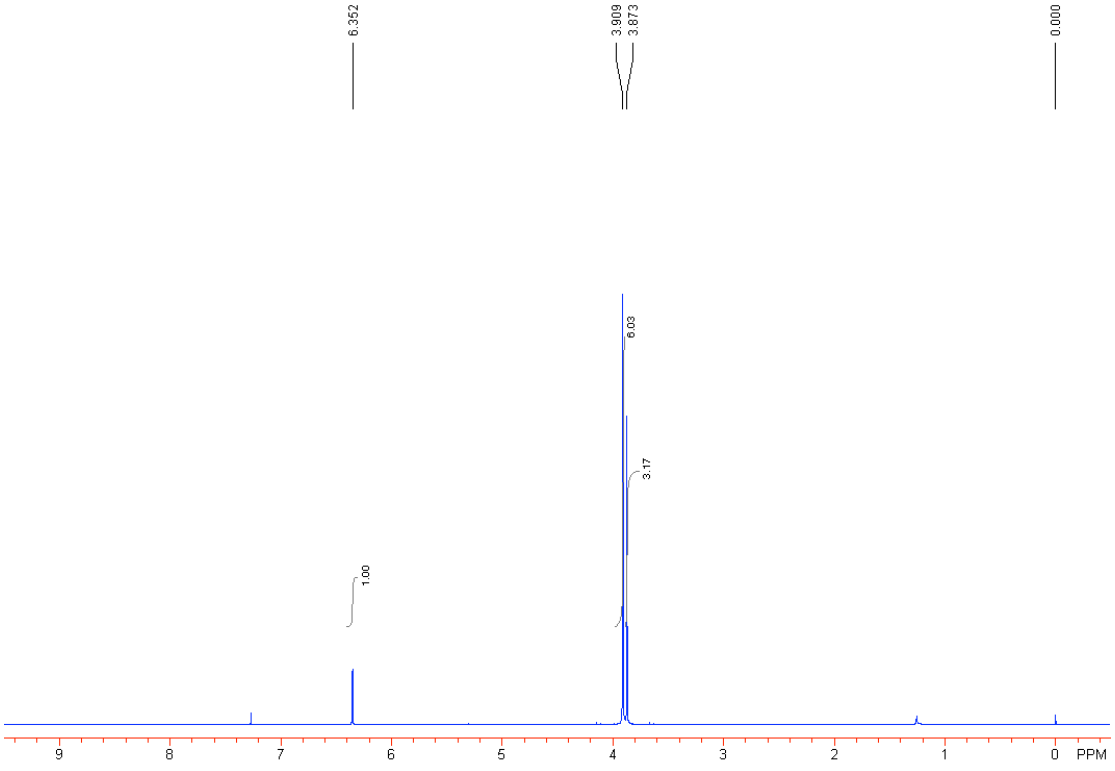
92.165
91.824
77.659
77.230
76.810
56.523
55.690
150
100
50
0
PPM


OMe
Br
Br
MeO
OMe

2c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3.909
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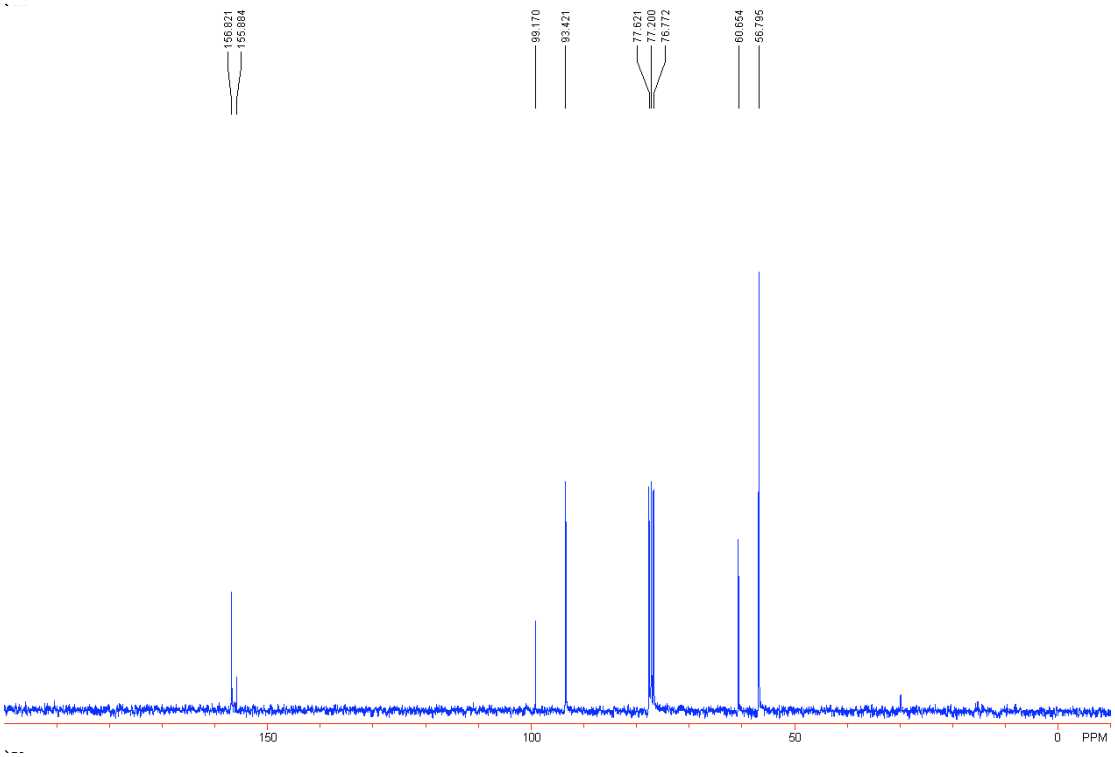
3.17
1.00
9
8
7
6
5
4
3
2
1
0
PPM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93.421
77.621
77.200
76.772
60.654
56.795
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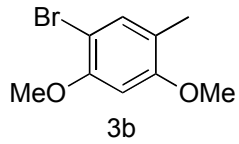
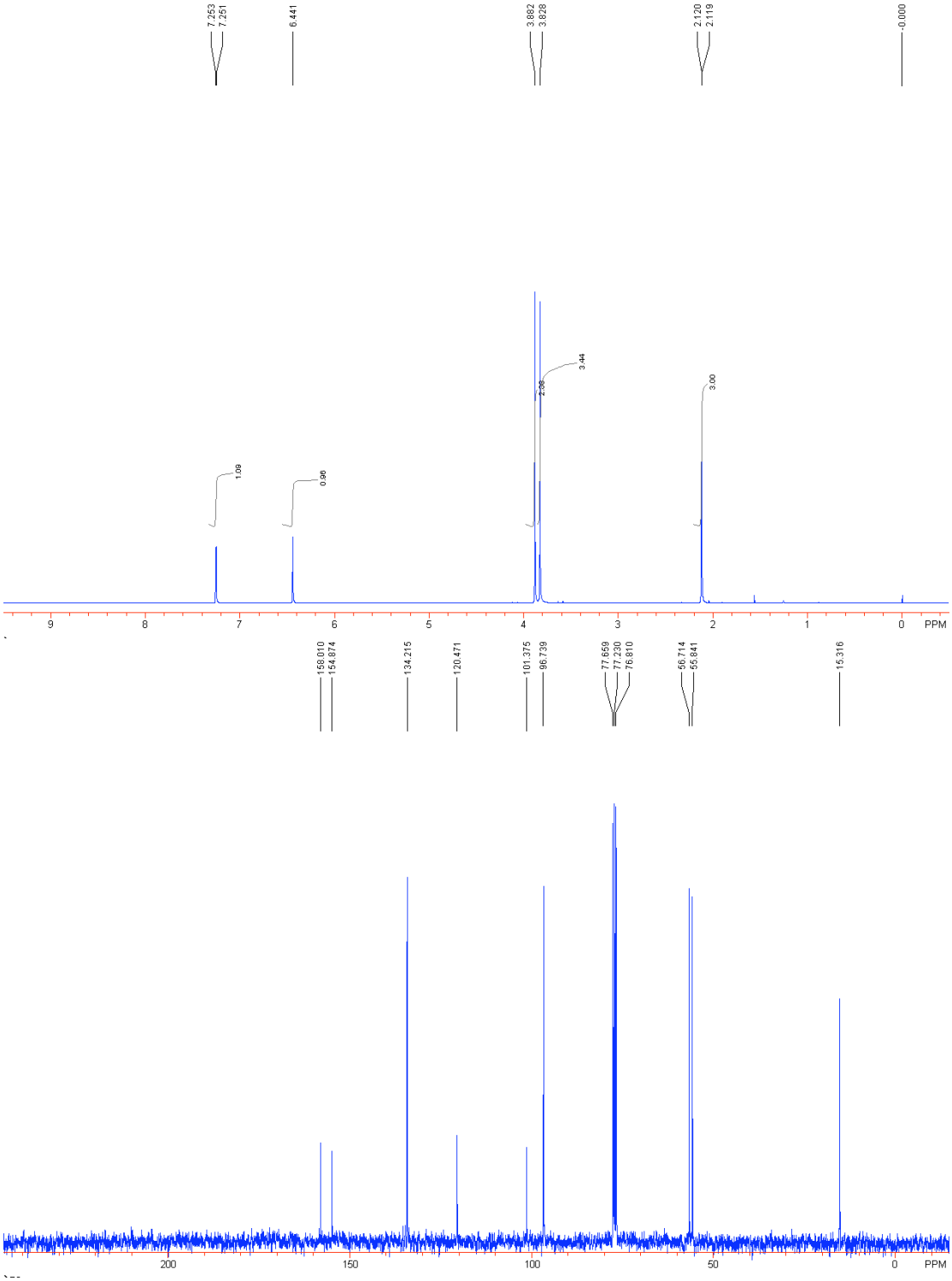
100
50
0
PPM


Br
MeO
OMe

3b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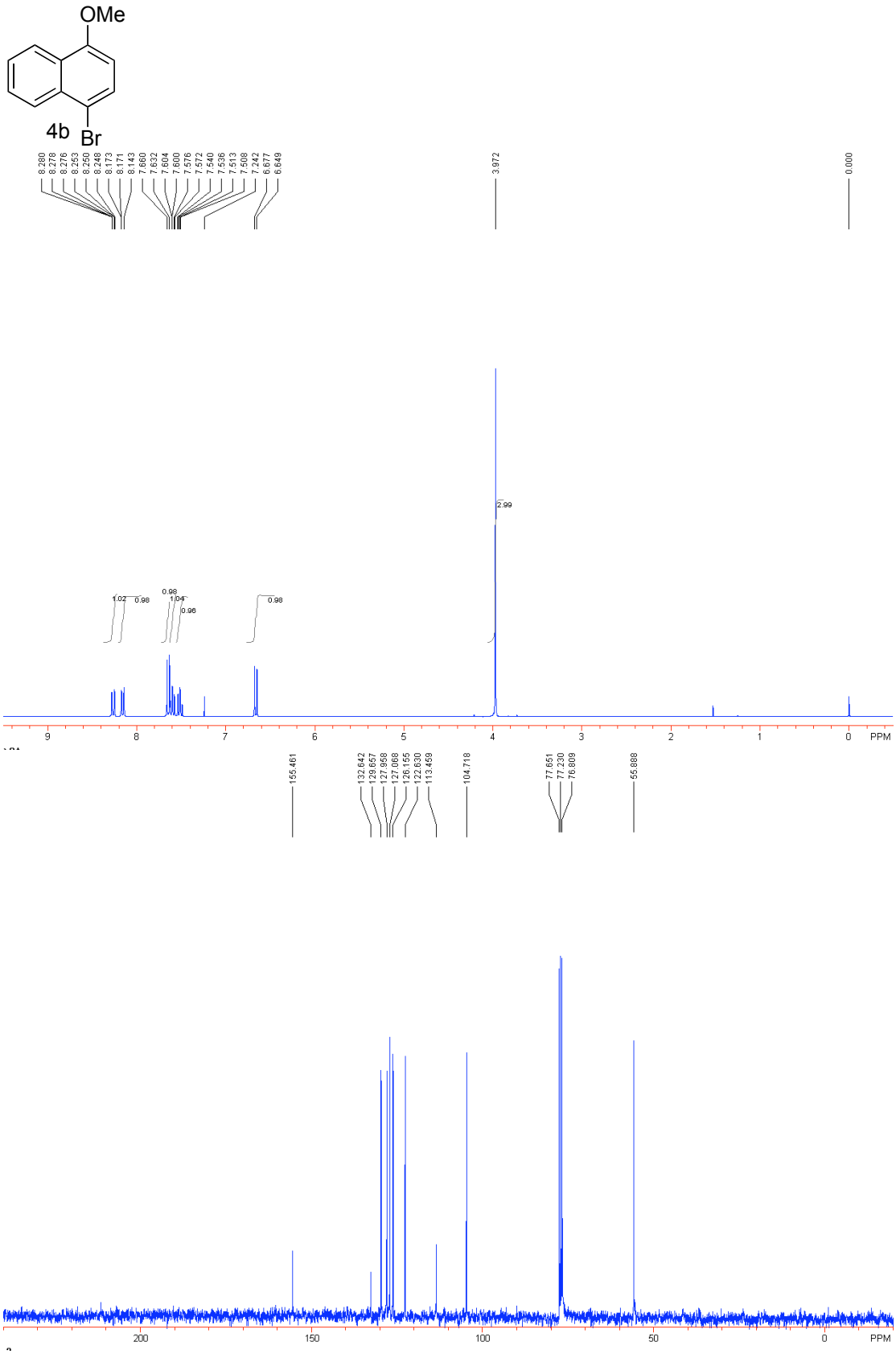
7.251
6.441
3.882
3.828
2.120
2.119
0.000
1.09
0.96
2.06
3.44
3.00
PPM
158.010
154.874
134.215
120.471
101.375
96.739
77.659
77.230
76.810
56.714
55.841
15.316
200
150
100
50
0
PPM


OMe
4b
Br
8.280
8.278
8.276
8.253
8.250
8.248
8.173
8.171
8.143
7.660
7.632
7.604
7.600
7.576
7.572
7.540
7.536
7.513
7.508
7.242
6.677
6.649
3.972
0.000
2.99
1.02
0.98
0.98
1.04
0.96
0.98
9
8
7
6
5
4
3
2
1
0
PPM
155.461
132.642
129.657
127.958
127.068
126.155
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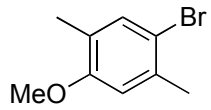
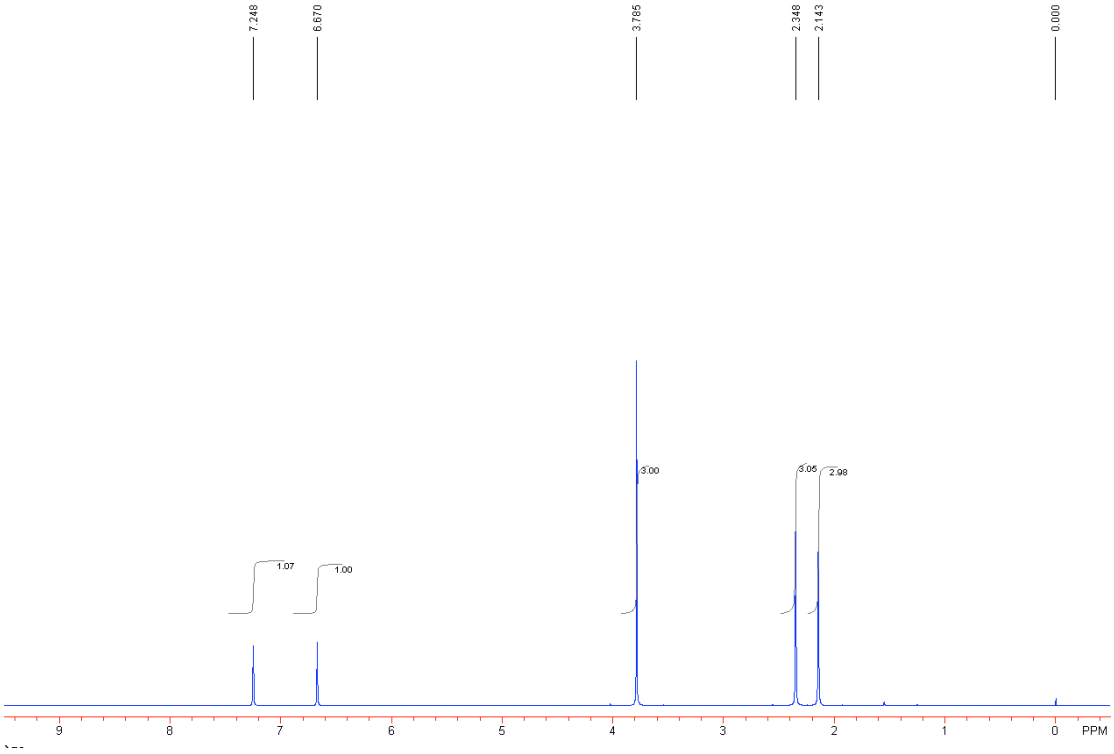
113.459
104.718
77.651
77.230
76.809
55.888
200
150
100
50
0
PPM


Br
MeO

5b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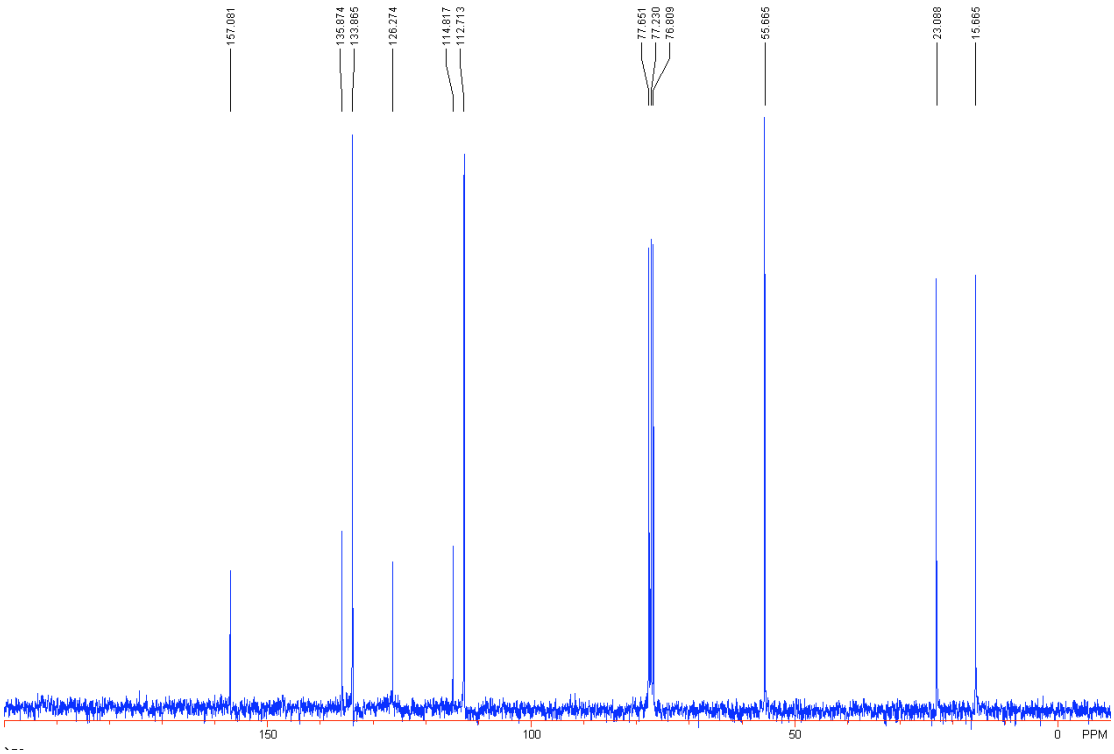
6.670
3.785
2.348
2.143
0.000
3.00
3.05
2.98
1.07
1.00
9
8
7
6
5
4
3
2
1
0
PPM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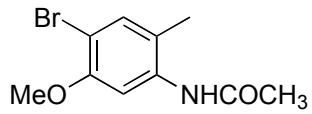
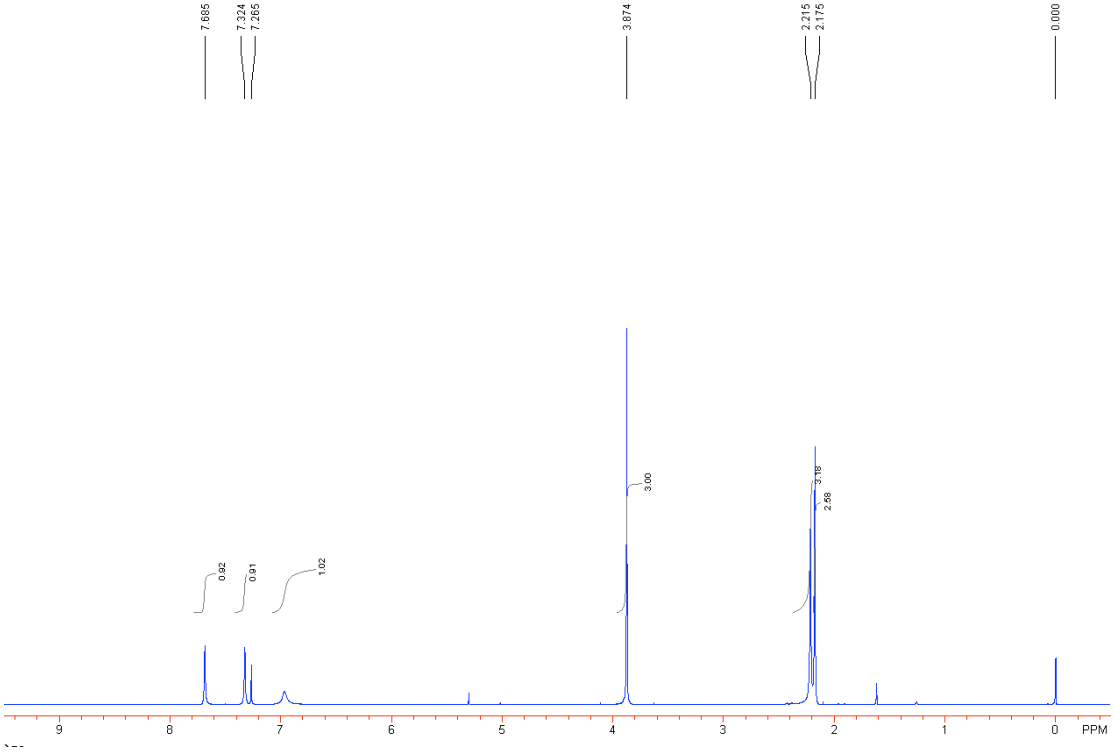
135.874
133.865
126.274
114.817
112.713
77.651
77.230
76.809
55.665
23.088
15.665
150
100
50
0
PPM


Br
MeO
NHCOCH3

6b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7.324
7.265
3.674
2.215
2.175
0.000
0.92
0.91
1.02
3.00
3.18
2.66
9
8
7
6
5
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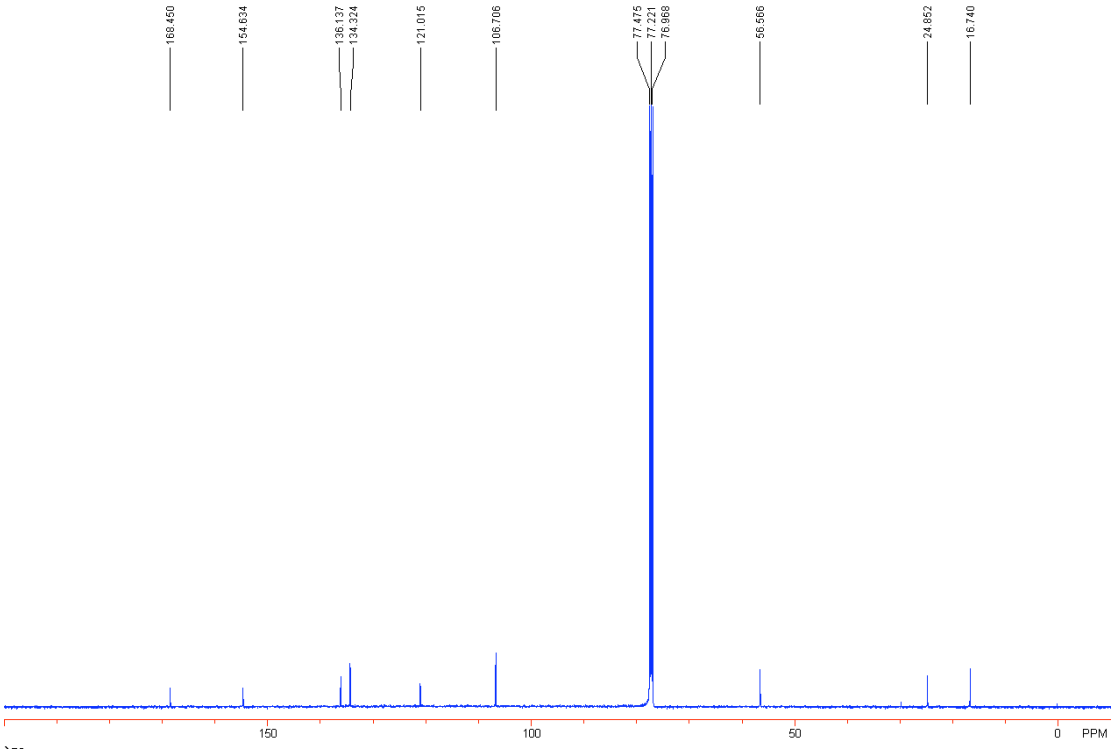
3
2
1
0
PPM


168.450
154.634
136.137
134.324
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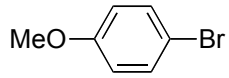
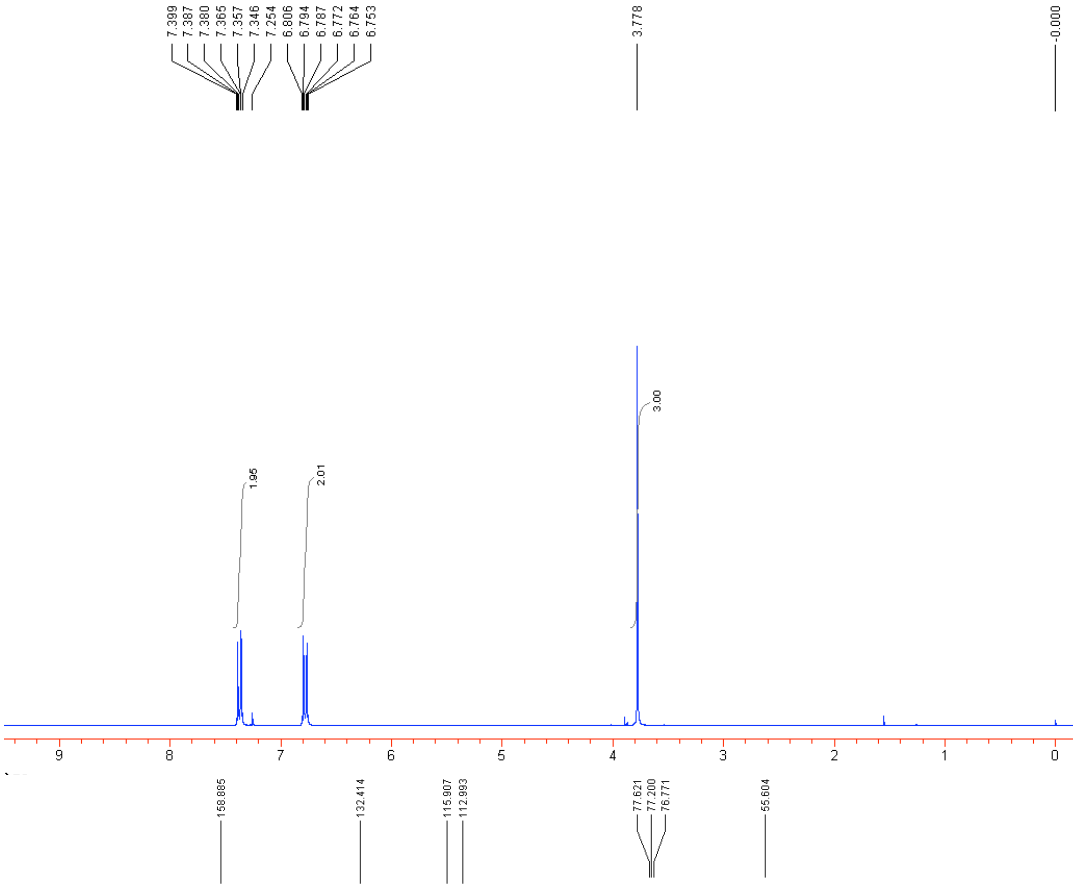
77.475
77.221
76.968
56.566
24.852
16.740
150
100
50
0
PPM


MeO
Br

7b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7.387
7.380
7.365
7.357
7.346
7.254
6.806
6.794
6.787
6.772
6.764
6.753
3.778
-0.000
3.00
1.95
2.01
9
8
7
6
5
4
3
2
1
0
PPM
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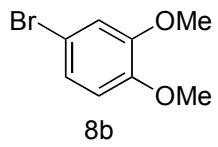
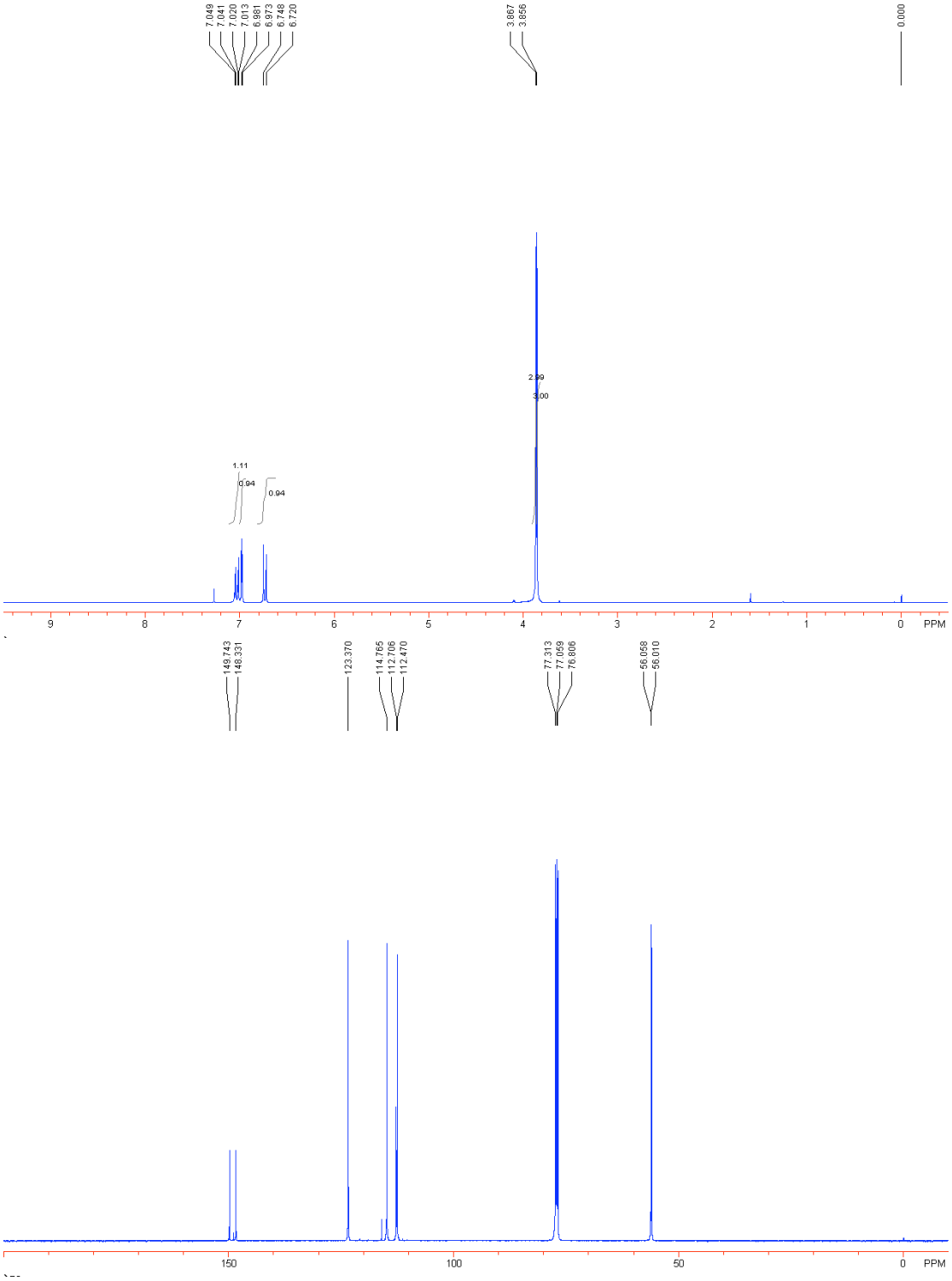
132.414
115.907
112.983
77.621
77.200
76.771
55.604
150
100
50
0
PPM


Br
OMe
OMe

8b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7.020
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6.973
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3.867
3.856
0.000
2.99
3.00
1.11
0.94
0.94
9
8
7
6
5
4
3
2
1
0
PPM
149.743
148.331
123.370
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112.706
112.470
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77.059
76.806
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100
50
0
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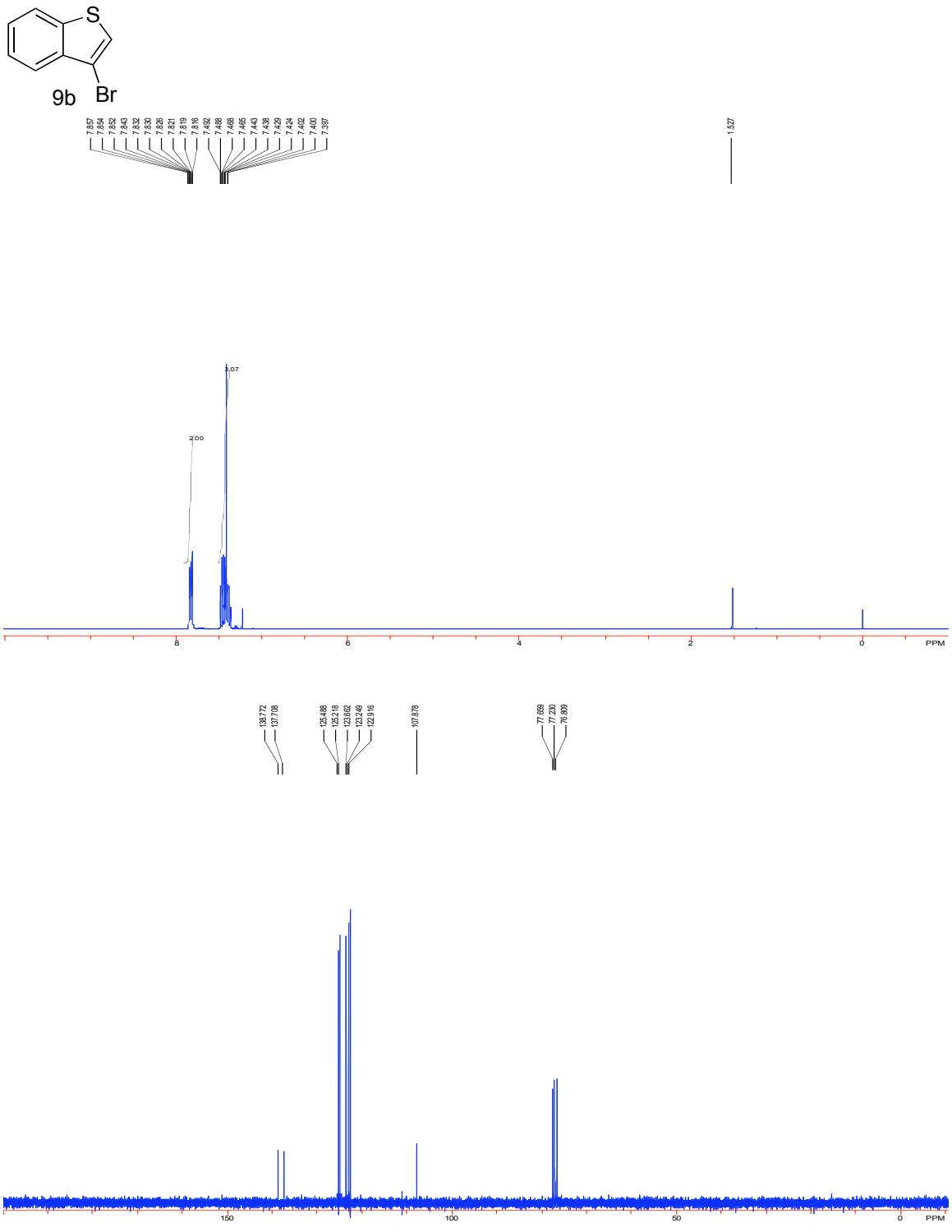
S
9b
Br
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7.830
7.826
7.821
7.819
7.816
7.492
7.488
7.468
7.465
7.443
7.438
7.429
7.424
7.402
7.400
7.397
1.527
3.07
2.00
8
6
4
2
0
PPM
138.772
137.706
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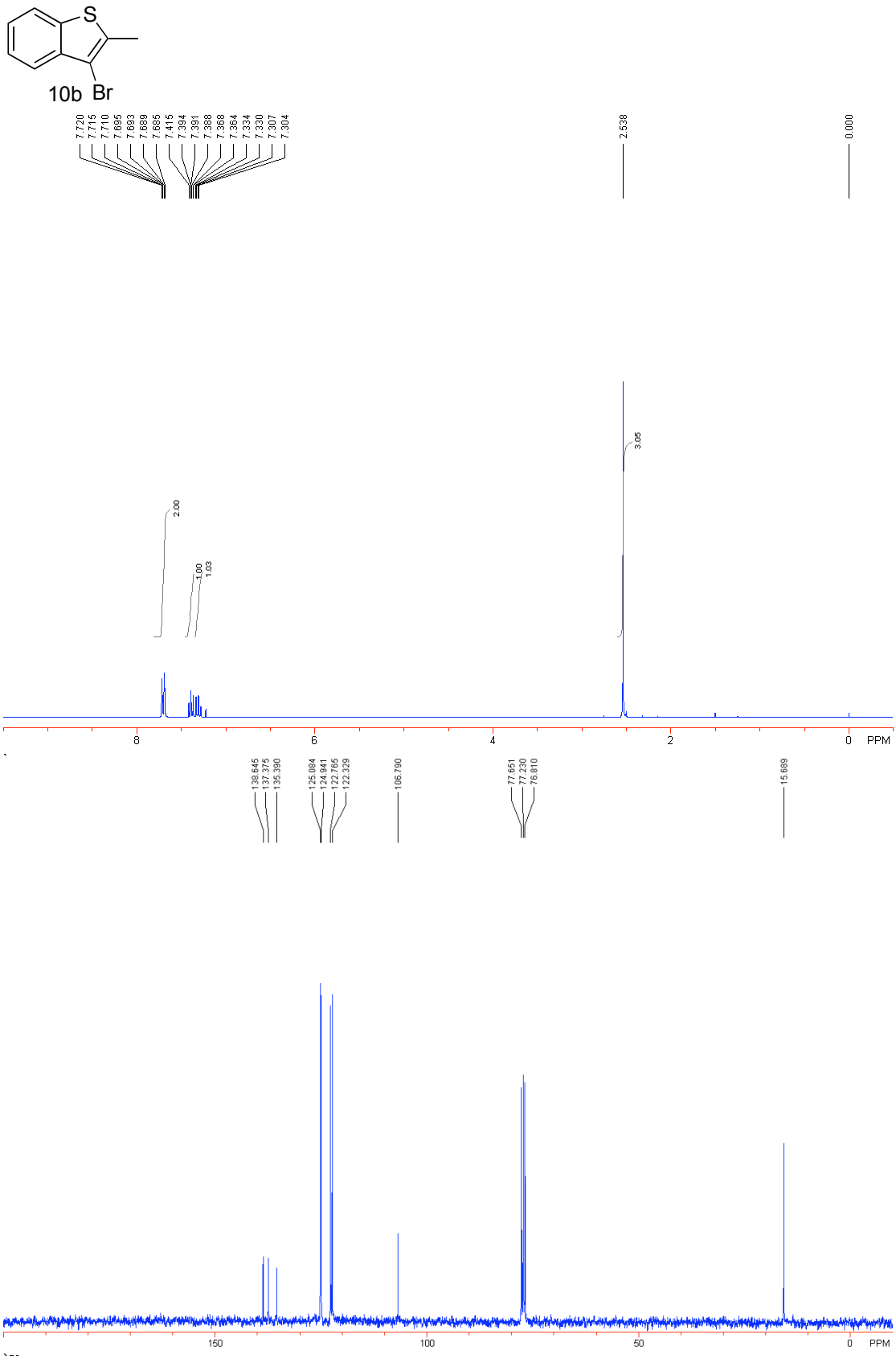
PPM


S
10b Br
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7.693
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7.685
7.415
7.394
7.391
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7.368
7.364
7.334
7.330
7.307
7.304
2.538
0.000
2.00
1.00
1.03
3.05
8
6
4
2
0
PPM
138.645
137.375
135.390
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77.651
77.230
76.810
15.689
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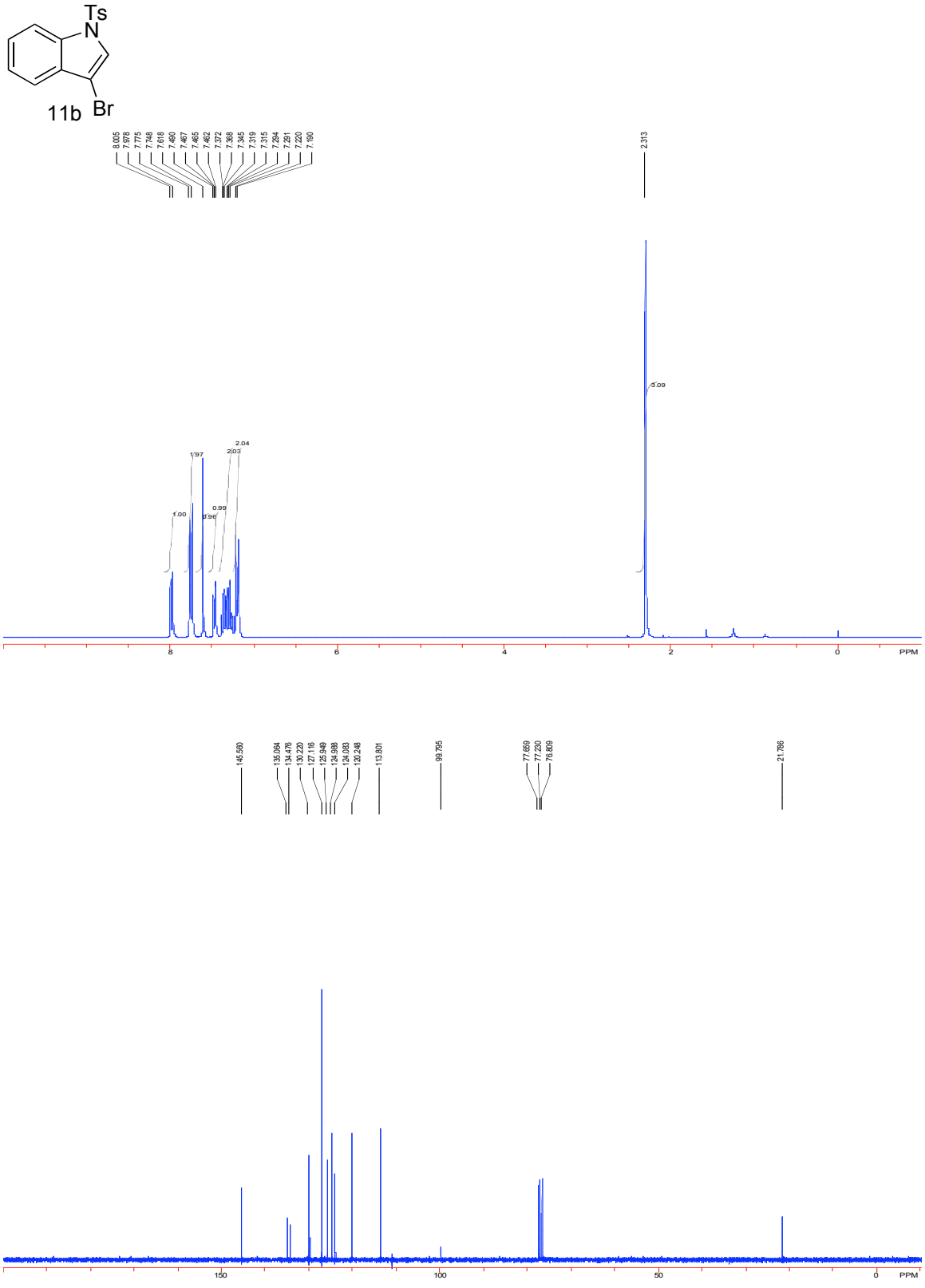
100
50
0
PPM


Ts
N
Br
11b
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7.480
7.467
7.465
7.462
7.372
7.368
7.345
7.319
7.315
7.284
7.281
7.220
7.190
2.313
5.09
2.04
2.03
1.97
1.00
0.96
0.99
8
6
4
2
0
PPM
145.560
135.094
134.476
130.220
127.116
125.949
124.988
124.083
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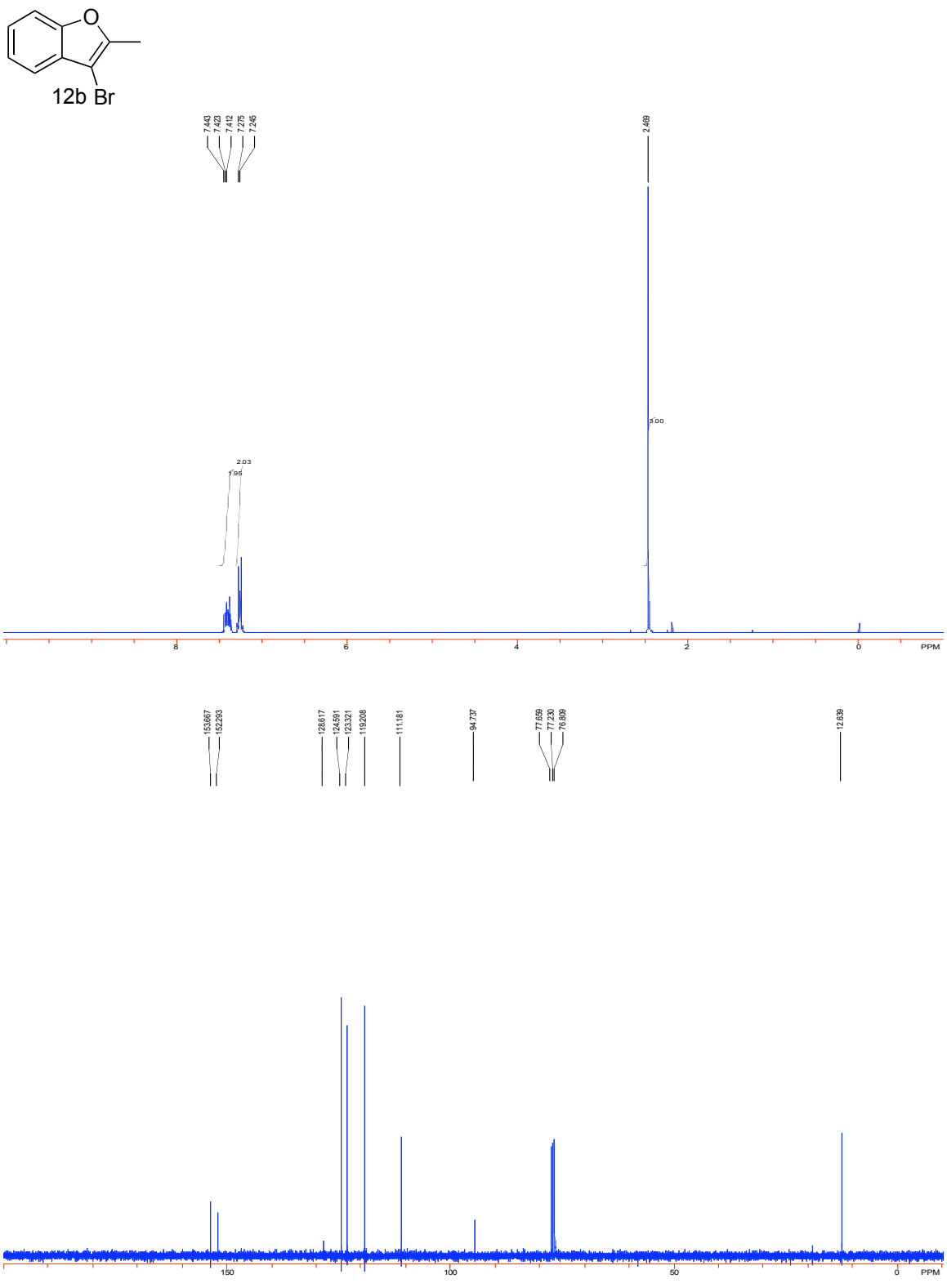
113.801
99.795
77.659
77.220
76.809
21.766
150
100
50
0
PPM


O
12b Br
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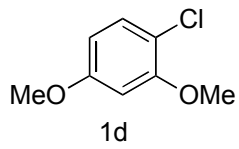
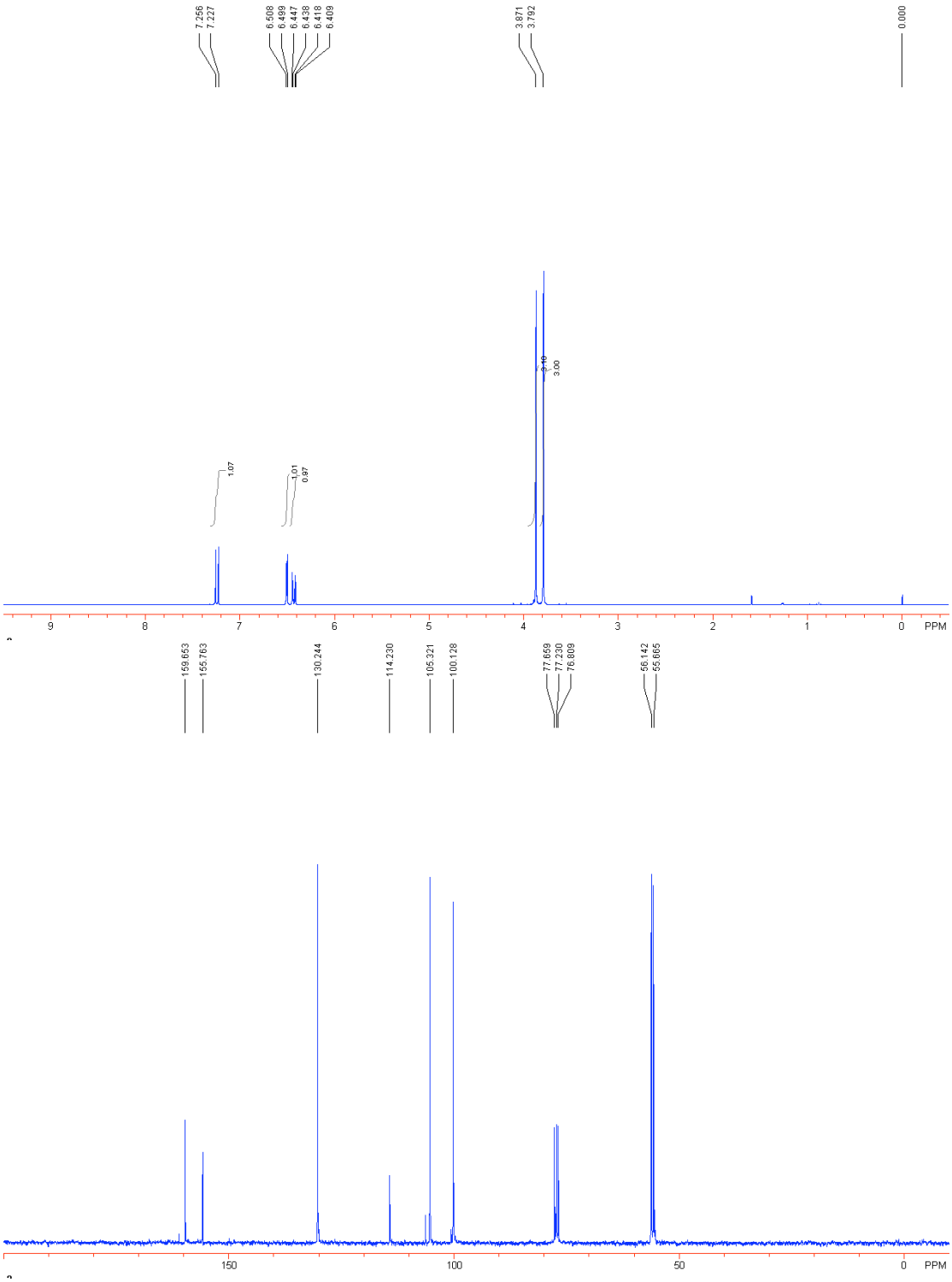
7.423
7.412
7.275
7.245
2.469
3.00
2.03
1.95
8
6
4
2
0
PPM
153.667
152.293
128.617
124.591
123.321
119.208
111.181
94.737
77.669
77.230
76.809
12.639
150
100
50
0
PPM


Cl
MeO
OMe

1d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6.418
6.409
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3.792
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1.01
0.97
3.10
3.00
9
8
7
6
5
4
3
2
1
0
PPM
159.653
155.763
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77.230
76.809
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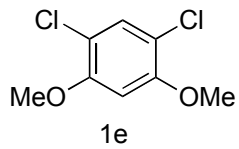
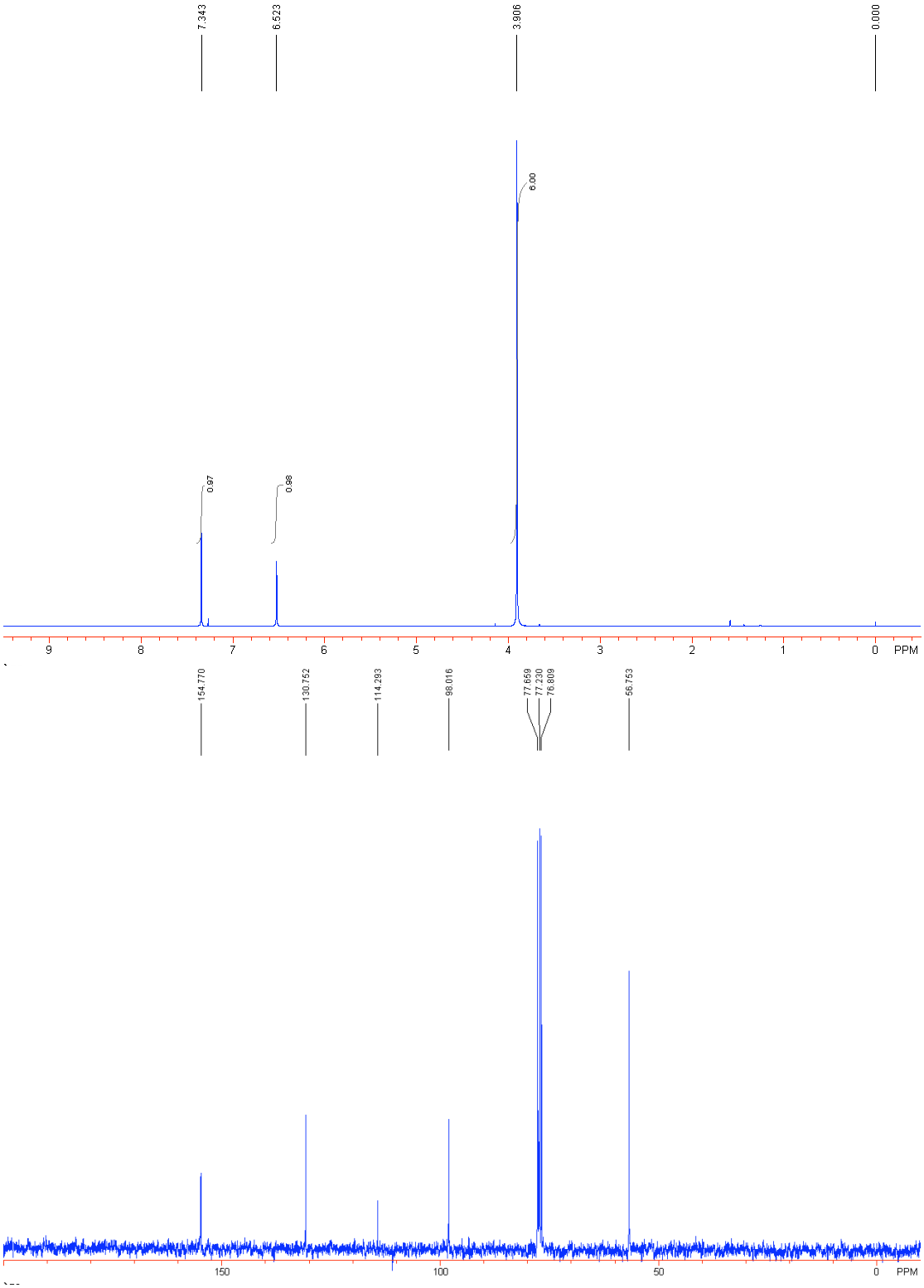

Cl
Cl
MeO
OMe

1e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6.00
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9
8
7
6
5
4
3
2
1
0
PPM
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114.293
98.016
77.659
77.230
76.809
56.753
150
100
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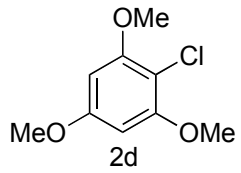
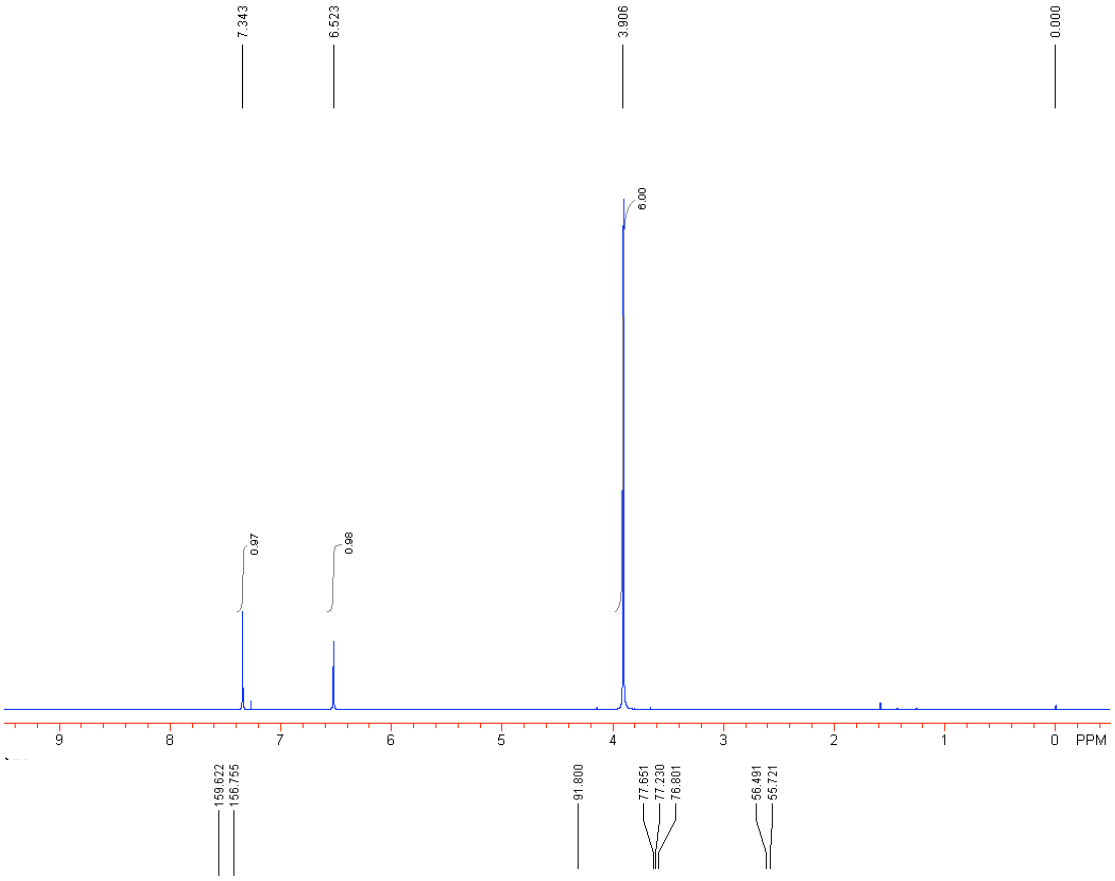
0
PPM


OMe
Cl
MeO
OMe

2d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6.523
3.906
0.000
6.00
0.97
0.98
9
8
7
6
5
4
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1
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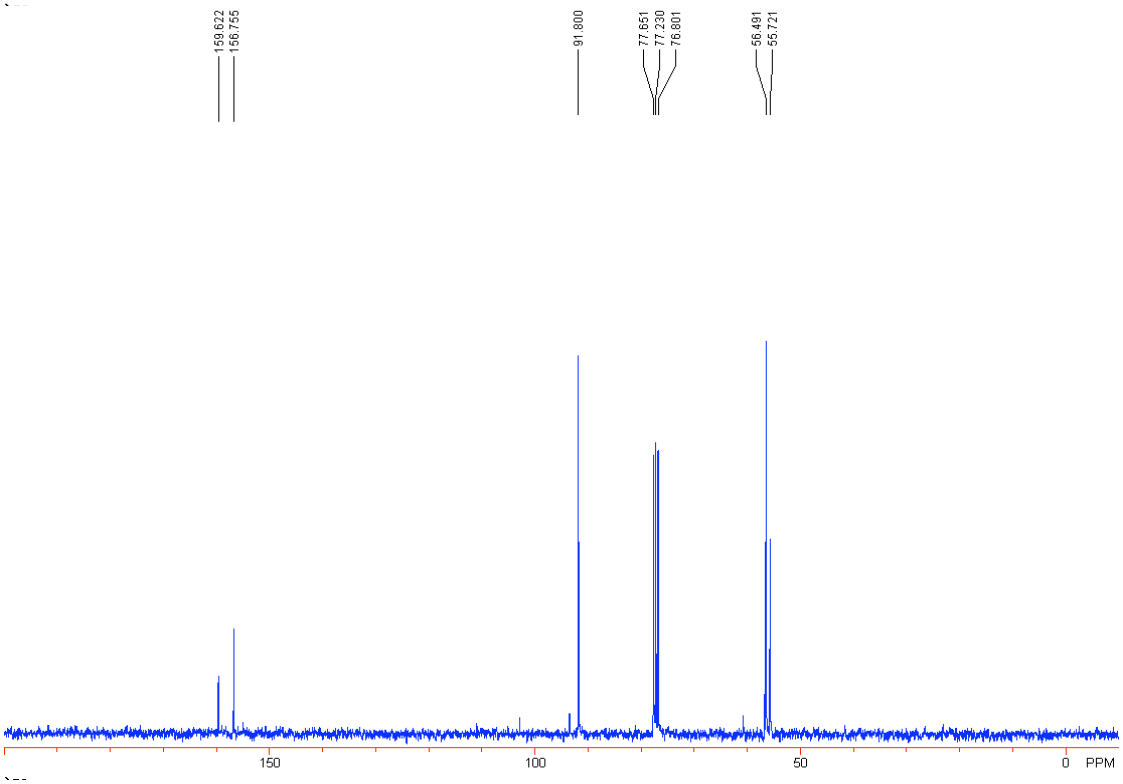
PPM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55.721
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100
50
0
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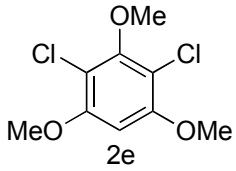
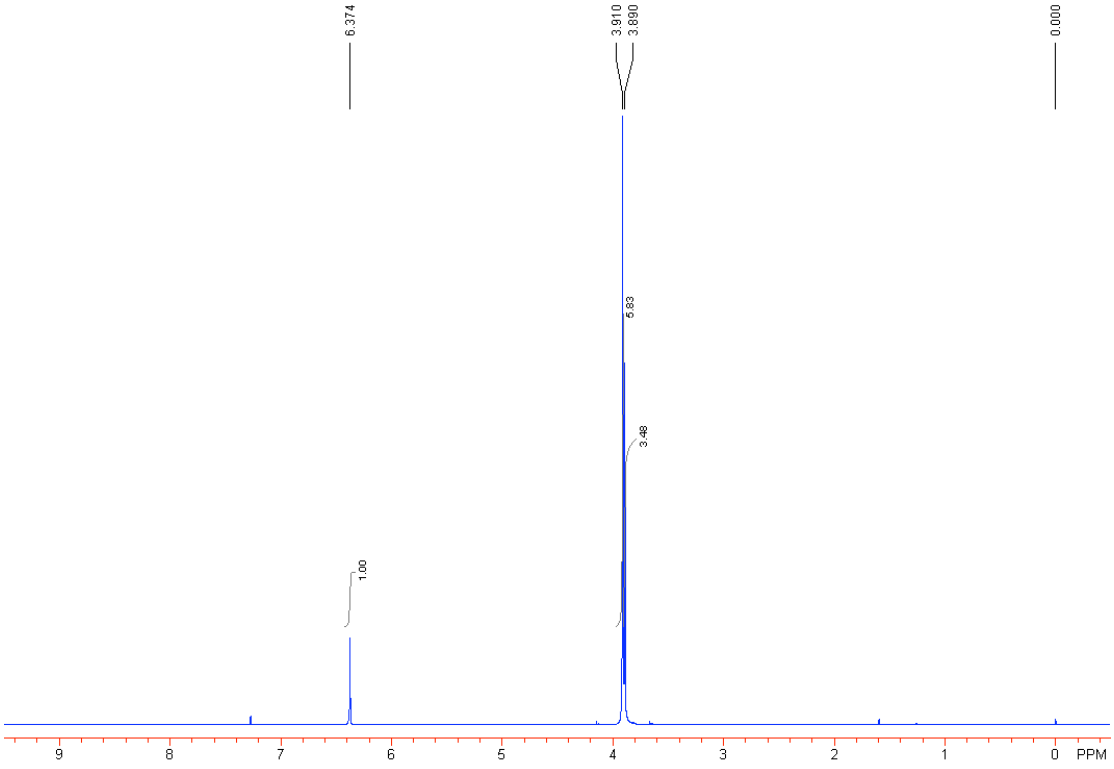

OMe
Cl
Cl
MeO
OMe

2e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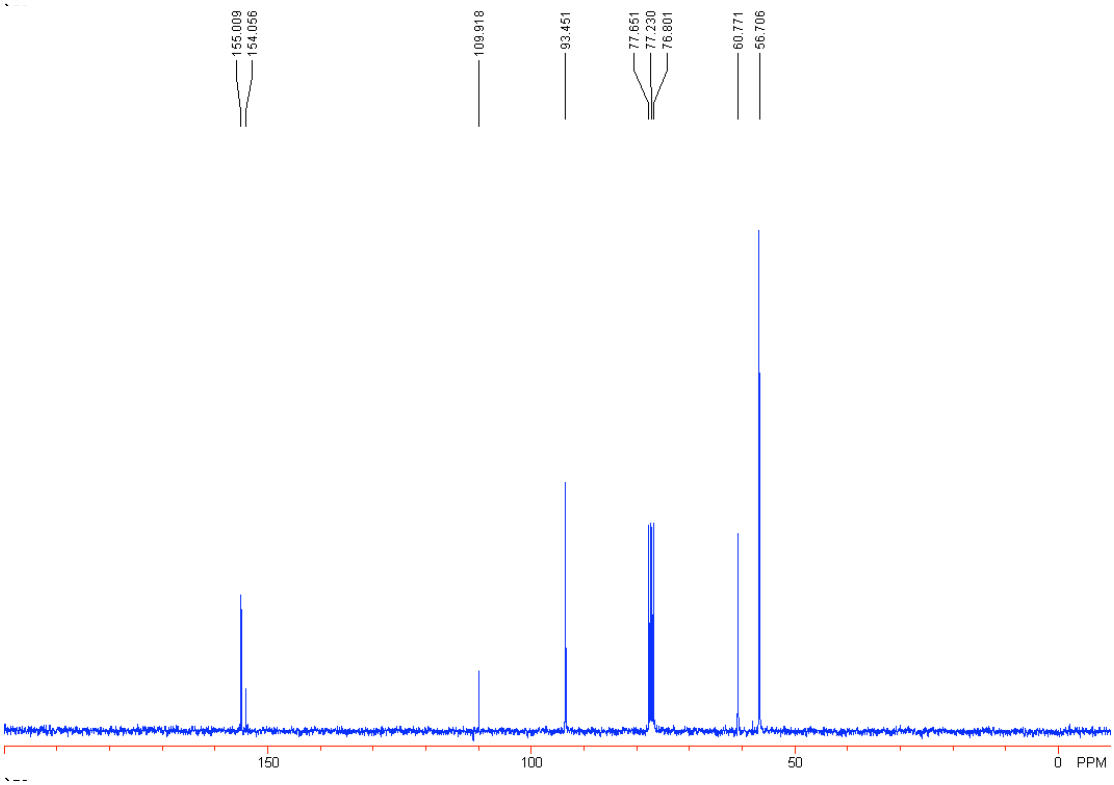
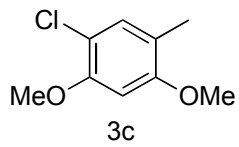
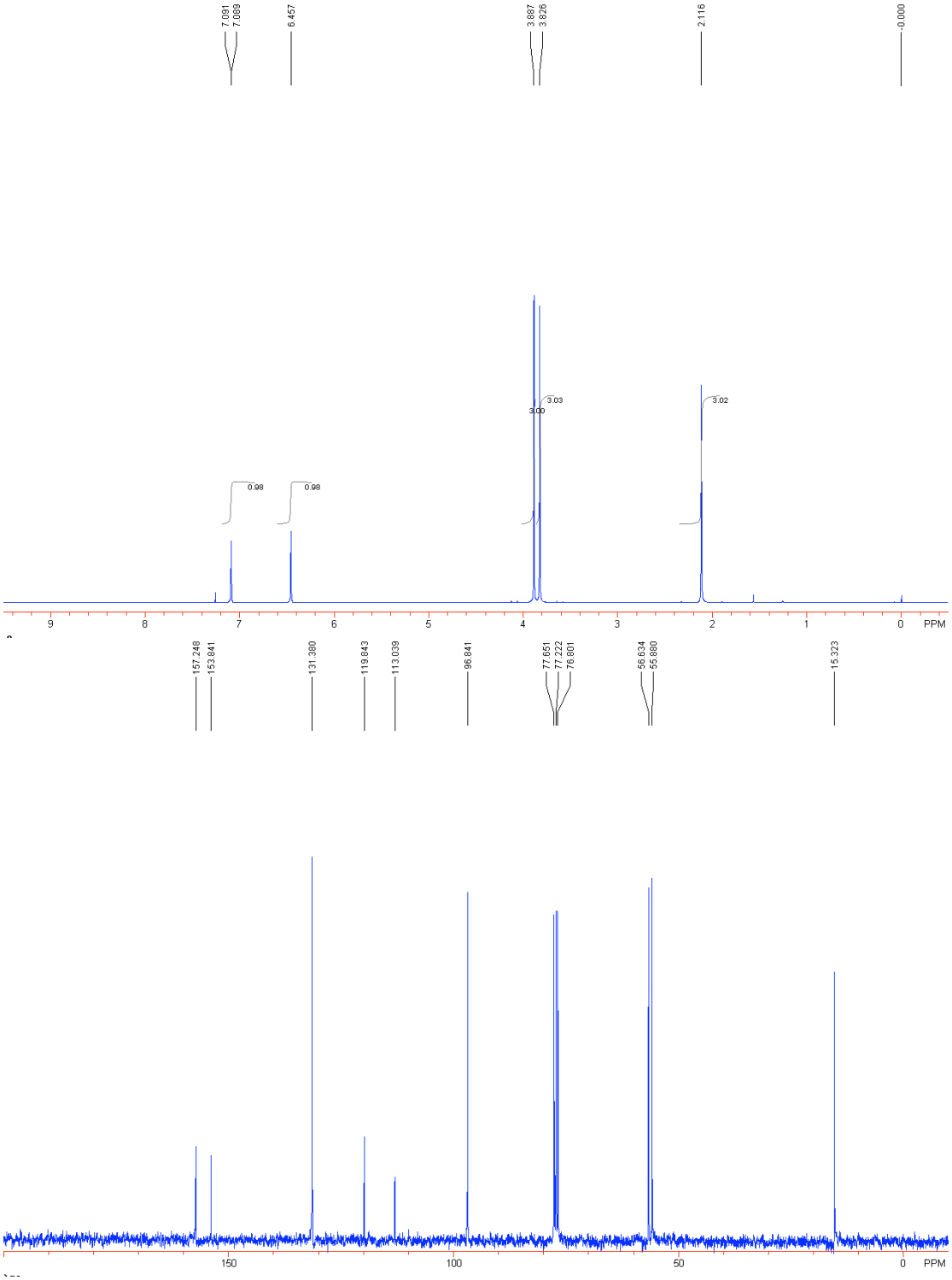
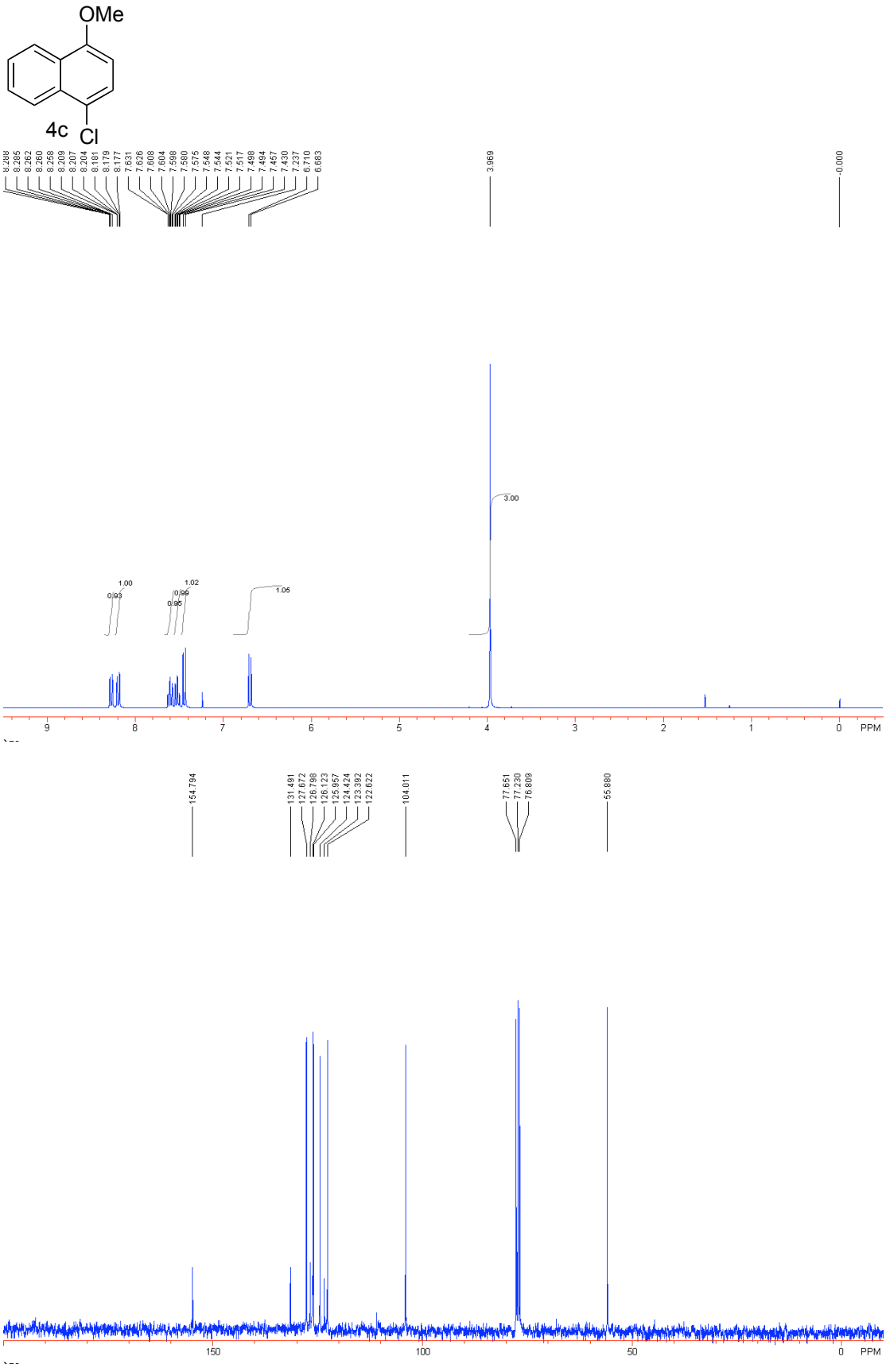
3.910
3.890
0.000
5.83
3.48
1.00
9
8
7
6
5
4
3
2
1
0
PPM

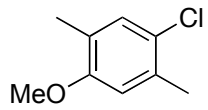

155.009
154.056
109.918
93.451
77.651
77.230
76.801
60.771
56.706
150
100
50
0
PPM


Cl
MeO
OMe

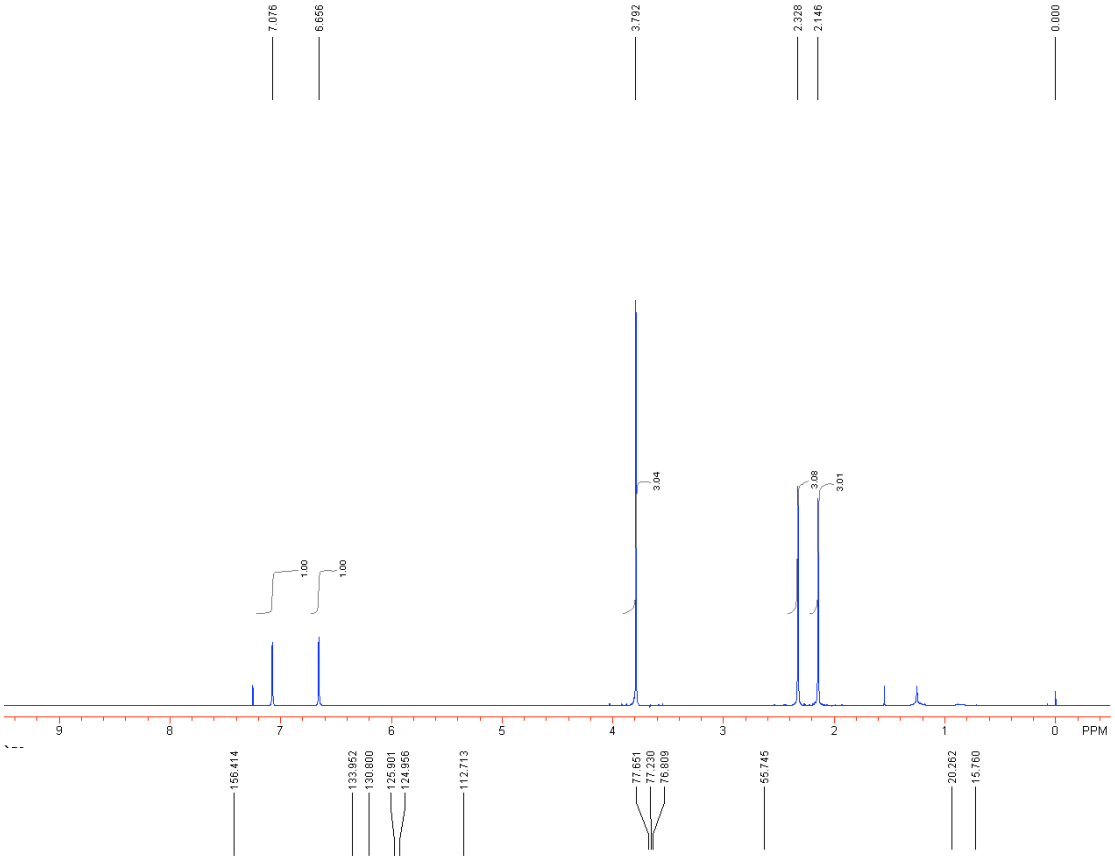
3c


7.091
7.089
6.457
3.887
3.826
2.116
0.000
0.98
0.98
3.03
3.00
3.02
PPM
157.248
153.841
131.380
119.843
113.039
96.841
77.651
77.222
76.801
56.634
55.880
15.323
150
100
50
0
PPM


OMe
4c
Cl
8.288
8.285
8.262
8.260
8.258
8.209
8.207
8.204
8.181
8.179
8.177
7.631
7.626
7.608
7.604
7.598
7.580
7.575
7.548
7.544
7.521
7.517
7.498
7.494
7.457
7.430
7.237
6.710
6.683
3.969
0.000
1.00
0.93
1.02
0.99
0.95
1.05
3.00
9
8
7
6
5
4
3
2
1
0
PPM
154.794
131.491
127.672
126.798
126.123
125.957
124.424
123.392
122.622
104.011
77.651
77.230
76.809
55.880
150
100
50
0
PPM


Cl
MeO

5c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3.792
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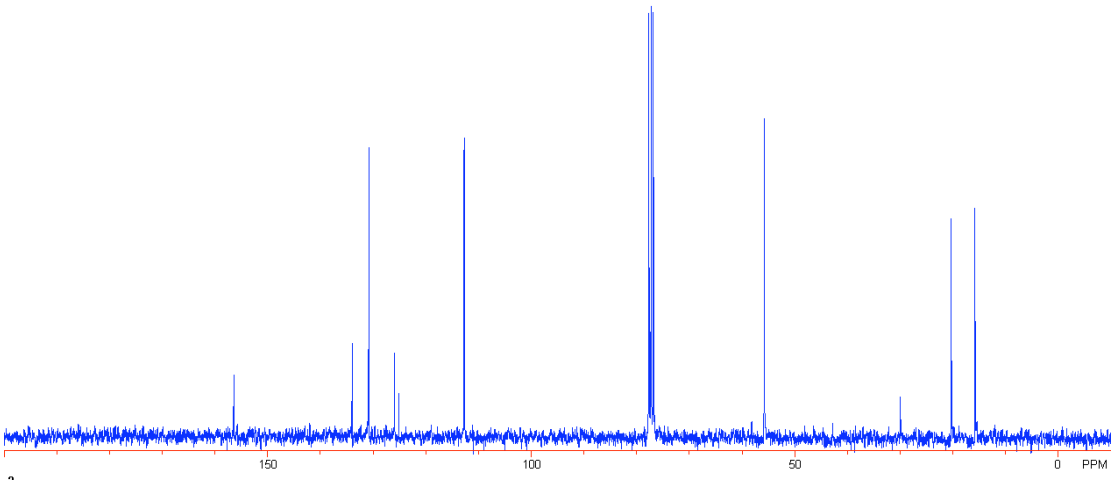
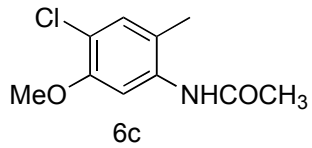
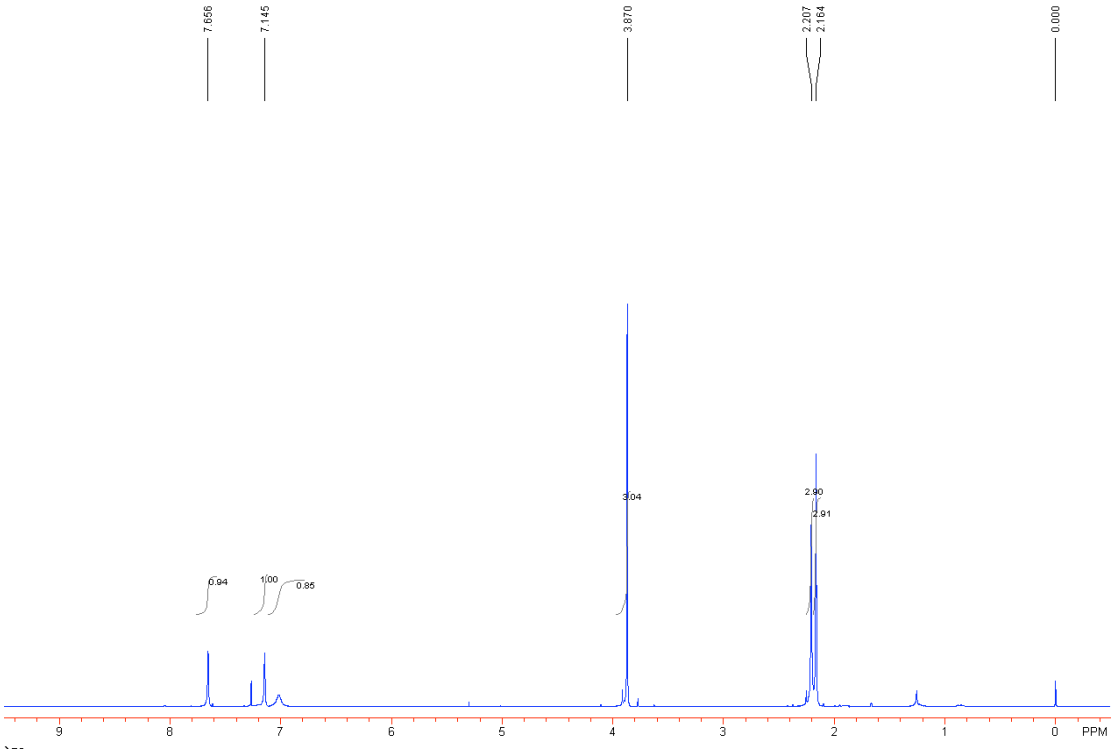
2.146
0.000
1.00
1.00
3.04
3.08
3.01
9
8
7
6
5
4
3
2
1
0
PPM

156.414
133.952
130.800
125.901
124.866
112.713
77.651
77.230
76.809
55.745
20.262
15.760


150
100
50
0
PPM


Cl
MeO
NHCOCH3

6c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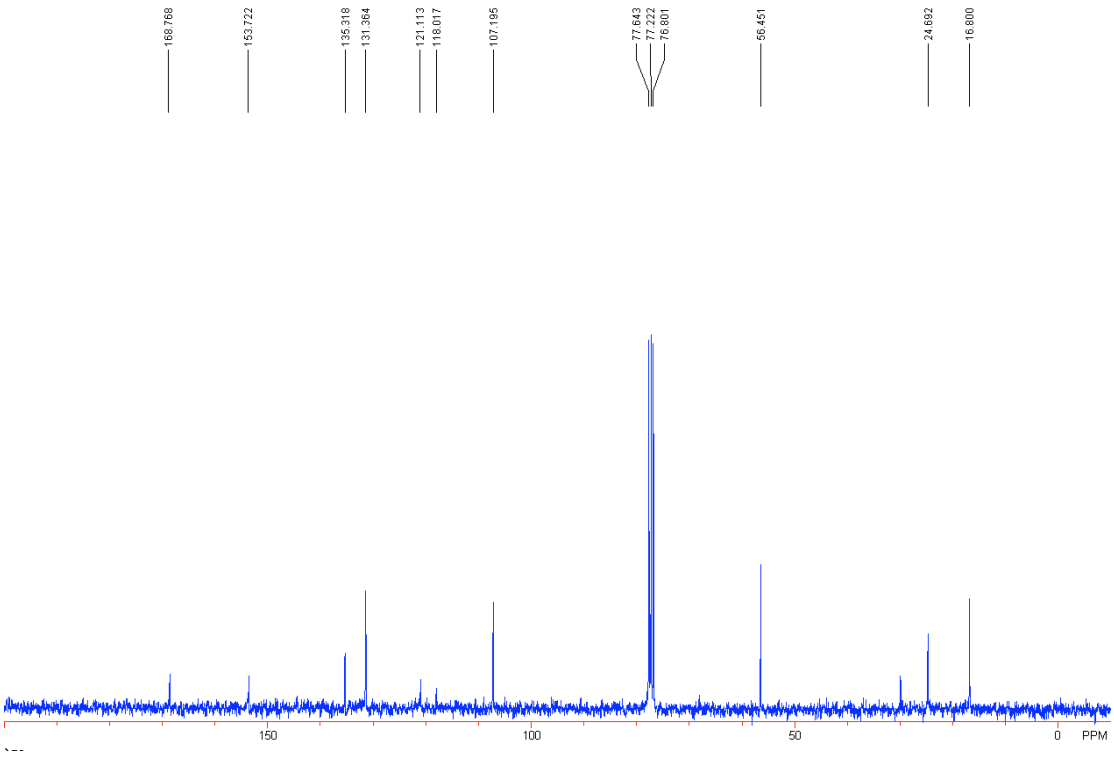
7.145
3.870
2.207
2.164
0.000
3.04
2.90
2.91
0.94
1.00
0.85
9
8
7
6
5
4
3
2
1
0
PPM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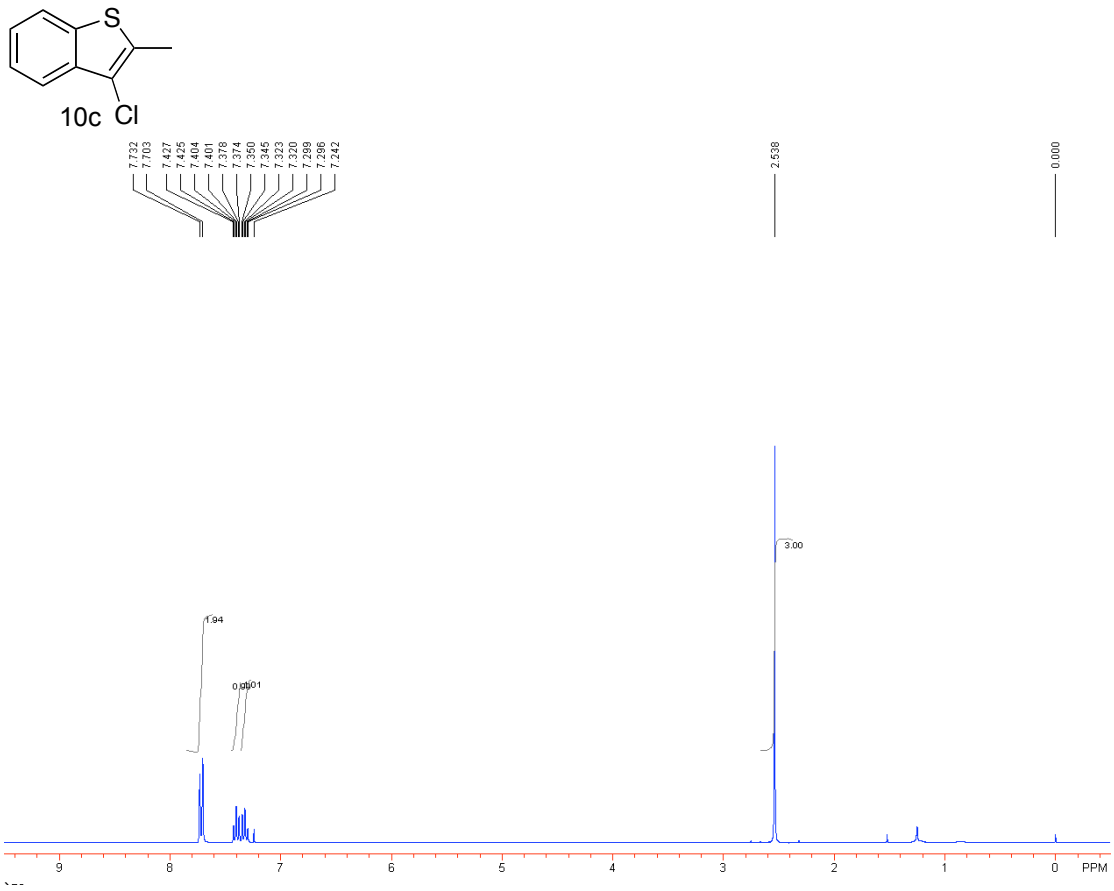
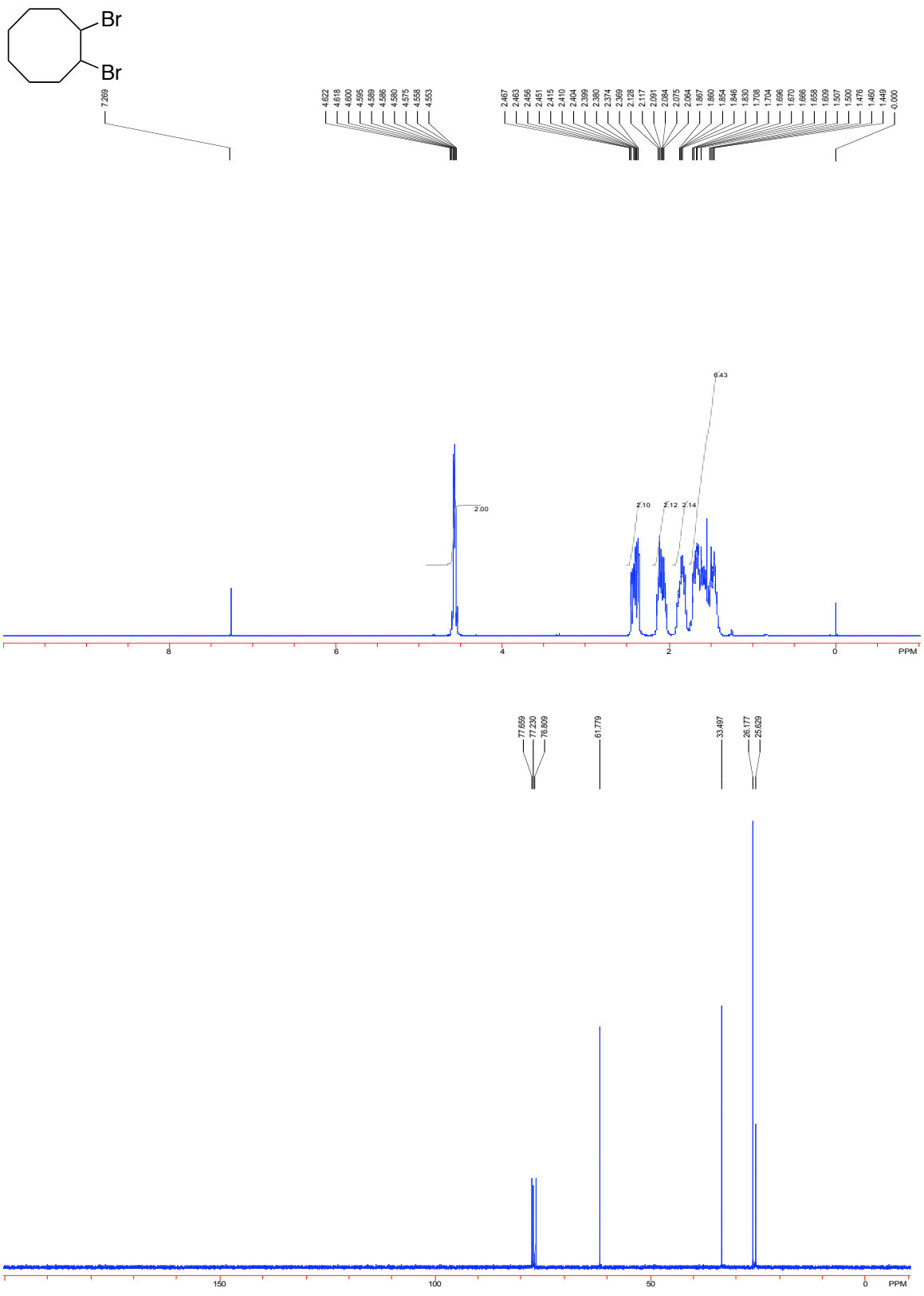
153.722
135.318
131.364
121.113
118.017
107.195
77.643
77.222
76.801
56.451
24.692
16.800
150
100
50
0
PPM


S
Cl
10c
7.732
7.703
7.427
7.425
7.404
7.401
7.378
7.374
7.350
7.345
7.323
7.320
7.299
7.296
7.242
2.538
0.000
3.00
1.94
0.91
PPM
137.215
136.672
133.466
124.940
124.893
122.439
121.487
111.006
77.659
77.230
76.809
13.950
PPM


Br
Br
7.269
4.622
4.618
4.600
4.595
4.589
4.586
4.580
4.575
4.558
4.553
2.467
2.463
2.456
2.451
2.415
2.410
2.404
2.399
2.380
2.374
2.369
2.128
2.117
2.091
2.084
2.075
2.064
1.867
1.860
1.854
1.846
1.830
1.708
1.704
1.696
1.670
1.666
1.658
1.609
1.507
1.500
1.476
1.460
1.449
0.000
6.43
2.00
2.10
2.12
2.14
8
6
4
2
0
PPM
77.659
77.230
76.809
61.779
33.497
26.177
25.629
150
100
50
0
PPM