An Efficient Synthesis of α-Ketoamides via 2-Acyl-5-aminooxazoles by Reacting Acyl Chlorides and α-Isocyanoacetamides

Riccardo Mossetti,[a] Tracey Pirali,[a,*] Gian Cesare Tron,[a] and Jieping Zhu[b]

a) Dipartimento di Scienze Chimiche, Alimentari, Farmaceutiche e Farmacologiche, Università degli Studi del Piemonte Orientale "A. Avogadro", Via Bovio 6, 28100 Novara, Italy.

b) Institut de Chimie des Substances Naturelles, CNRS, 91198 Gif-sur-Yvette Cedex, France

Contents :

Experimental section

Commercially available reagents and solvents were used without further purification. Dichloromethane was dried by distillation from P_2O_5 and stored on activated molecular sieves (4 Å). When needed, the reactions were performed in oven-dried glassware under a positive pressure of dry nitrogen.

Melting points were determined in open glass capillary with a Stuart scientific SMP3 apparatus and are uncorrected. All the compounds were checked by IR (FT-IR THERMO-NICOLET AVATAR), ^{1}H and ^{13}C APT (JEOL ECP 300 MHz), and mass spectrometry (Thermo Finningan LCQ-deca XP-*plus*) equipped with an ESI source and an ion trap detector. Chemical shifts are reported in part per million (ppm). Column chromatography was performed on silica gel (Merck Kieselgel 70-230 mesh ASTM) using the indicated eluants. Thin layer chromatography (TLC) was carried out on 5 x 20 cm plates with a layer thickness of 0.25 mm (Merck Silica gel 60 F_{254}). When necessary they were developed with $KMnO_4$.

Elemental Analysis (C, H, N) of all the new compounds are within ± 0.4 % of the calculated values unless otherwise noted.

Acyl chloride **1e** was prepared according to the literature.[1]

α-Isocyanoacetamides (**2 a-g**)

α-Isocyanoacetamides (**2 a-g**) were prepared according to literature procedure.[2] The methylisocyanoacetate is reacted with the amine to give the α-isocyanoacetamide **2 b, d, e, g**; the subsequent alkylation, in the presence of cesium hydroxide, gives the α-sustituted α-isocyanoacetamide **2 a, c, f**.[3] Experimental data for compounds **2 a**,[3] **6b**,[2] **6c**[4] have already been reported.

2d

The product precipitates during the reaction and it is filtered off, washed three times with cold diethyl ether, and dried under vacuum overnight to give a brown solid (85%). ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.38-7.22 (m, 5-H), 6.91 (br s, 1-H), 4.44 (d, J =5.8 *J*, 2-H), 4.12 (s, 2-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 161.3, 161.0, 135.8, 127.7, 126.8, 126.7, 44.1, 42.7; *m/z* 175 $(M+H)^+$.

2e

The product precipitates during the reaction and it is filtered off, washed three times with cold diethyl ether, and dried under vacuum overnight to give a brown solid (91%). ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.39-7.20 (m, 5-H), 4.56 (s, 2-H), 4.33 (s, 2-H), 2.86 (s, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 161.3, 135.0, 128.2, 127.7, 127.1, 125.1, 50.6, 43.5, 33.2; *m/z* 189 $(M+H)^+$.

2f

The crude of the alkylation reaction is purified by column cromatography using PE/EtOAc 7:3 as eluant to give a yellow oil (76%). ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.40-7.11 (m, 5-H), 4.63-4.47 (m, 3-H), 2.98 (s, 3-H), 1.60 (d, *J* = 6.6 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 165.1, 158.1, 135.6, 134.8, 127.6, 125.7, 51.2, 49.2, 34.3, 18.1; *m/z* 203 $(M+H)^+$.

2g

The crude material is purified by column cromatography using PE/EtOAc 7:3 as eluant to give a brown solid (98%). ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 6.54 (br s, 1-H), 4.12 (s, 2-H), 3.28 (q, *J* = 6.8 Hz, 2-H), 1.50 (quint, *J* = 6.8 Hz, 2-H), 1.32 (sest, *J* = 7.9 Hz, 2-H), 0.90 (t, *J* = 7.4 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 161.1, 160.8, 44.1, 38.6, 30.1, 18.8, 12.5; *m/z* 141 $(M+H)^+$.

General procedure for the preparation of 2-acyl-5-aminooxazoles 5 (a-l):

To a solution of α-isocyanoacetamide (1 eq) in dry dichloromethane, triethylamine (1 eq) is added under nitrogen atmosphere. A solution of acyl chloride (1 eq) in dry dichloromethane is added dropwise in a period of ten minutes and the reaction is stirred at room temperature for 1 hour. The reaction is diluted with dichloromethane and washed with Na_2CO_3 sat. aq. (x 1). The organic phase is dried over sodium sulphate and evaporated. The crude material is then purified by column chromatography by using petroleum ether/EtOAc as eluant to give the 2-acyl-5-aminooxazole.

5a, **1-[5-(4-morpholinyl)-4-(phenylmethyl)-2-oxazolyl]-1-hexanone**

The crude material is purified by column chromatography, using petroleum ether/EtOAc 9:1 as eluant to give a white solid (75%); IR (neat) 1658, 1605, 1530, 1475, 1280 cm^{-1}; ^{1}H-NMR (300 MHz, $CDCl_3$) δ 7.32-7.14 (m, 5-H), 3.94 (s, 1-H), 3.70-3.63 (m, 4-H), 3.22-3.17 (m, 4-H), 2.93 (t, *J* = 7.4 Hz, 2-H), 1.70 (quint, *J* = 7.4 Hz, 2-H), 1.38-1.28 (m, 4-H), 0.88 (t, *J* = 6.9 Hz, 3-H); ^{13}C-NMR (75 MHz, $CDCl_3$) δ 187.0, 154.4, 150.3, 138.9, 128.6, 128.2, 126.5, 120.5, 66.3, 48.6, 38.0, 32.7, 31.4, 24.1, 22.5, 14.0; Mp = 91-92 °C.

5b, **1-[5-(4-morpholinyl)-4-(phenylmethyl)-2-oxazolyl]-3-phenyl-1-propanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a yellow solid (50%); IR (neat) 1658, 1610, 1548, 1492, 1105 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.30-7.15 (m, 10-H), 3.95 (s, 2-H), 3.68 (br t, 4-H), 3.30 (t, *J* = 7.3 Hz, 2-H), 3.23 (br t, 4-H), 3.04 (t, *J* = 7.3 Hz, 2-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 185.2, 149.5, 149.2, 140.3, 138.3, 128.1, 128.0, 127.9, 127.6, 126.0, 125.6, 120.0, 65.8, 48.0, 39.1, 32.2, 29.6.; Mp = 98-99 °C.

5c, **1-[5-(4-morpholinyl)-4-(phenylmethyl)-2-oxazolyl]-1-propanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a colorless oil (73%); IR (neat) 1658, 1610, 1498, 1483, 1110 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.32-7.12 (m, 5-H), 3.93 (s, 2-H), 3.68-3.62 (m, 4-H), 3.22-3.16 (m, 4-H), 2.95 (quart, *J* = 7.4 Hz, 2-H), 1.17 (t, *J* = 7.4 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 187.0, 153.8, 149.6, 138.3, 128.1, 127.6, 126.0, 120.1, 65.8, 48.1, 32.1, 30.8, 7.7.

5d, **1-[5-(methyl2-propynylamino)-4-(phenylmethyl)-2-oxazolyl]-1-hexanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a yellow solid (73%); IR (neat) 3305, 1670, 1610, 1535, 1500, 980 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.28-7.12 (m, 5-H), 3.91 (s, 2-H), 3.79 (d, *J* = 2.5 Hz, 2-H), 2.88 (s, 3-H), 2.83 (t, *J* = 7.4 Hz, 2-H), 2.23 (t, *J* = 2.5 Hz, 1-H), 1.61 (quint, *J* = 7.4 Hz, 2-H), 1.25-1.18 (m, 4-H), 0.81-0.77 (br t, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 186.4, 154.0, 149.7, 139.1, 128.3, 127.8, 126.1, 119.3, 77.8, 73.5, 42.3, 37.6, 37.5, 32.2, 31.1, 23.8, 22.1, 13.6.; Mp = 77-78 °C.

5e, **1-[4-methyl-5-[methyl(phenylmethyl)amino]-2-oxazolyl]-3-phenyl-1-propanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a yellow solid (70%); IR (neat) 1670, 1604, 1540, 1502, 984 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.39-7.13 (m, 10-H), 4.46 (s, 1-H), 3.27 (m, 2-H), 3.05 (m, 2-H), 2.97 (s, 3-H), 2.23 (s, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 184.1, 154.7, 148.3, 140.7, 136.3, 128.4, 128.1, 128.0, 127.4, 127.2, 125.6, 114.7, 55.9, 38.9, 37.0, 29.9, 12.5; Mp = 89-90 °C.

5f, **1-[5-[methyl(phenylmethyl)amino]-2-oxazolyl]-1-propanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a yellow solid (55%); IR (neat) 1672, 1600, 1532, 1483, 1075 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.33-7.14 (m, 5-H), 6.09 (s, 1-H), 4.46 (s, 2-H), 2.99-2.84 (m, 5-H), 1.17 (t, *J*

= 7.4 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 186.2, 159.1, 135.7, 128.7, 128.5, 127.8, 127.6, 102.4, 54.9, 35.9, 30.9, 8.5; Mp = 70-71 °C.

5g, **3-cyclopentyl-1-[5-[(phenylmethyl)amino]-2-oxazolyl]-1-propanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a yellow solid (76%). IR (neat) 3282, 1661, 1601, 1521, 1483, 1070 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.33-7.23 (m, 5-H), 6.08 (s, 1-H), 5.88 (t, *J* = 6.0, 1-H), 4.39 (d, *J* = 6.0, 2-H), 2.89 (t, *J* = 7.7 Hz, 2-H), 1.80-1.43 (m, 11-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 186.2, 157.8, 149.3, 136.8, 128.3, 127.3, 126.8, 102.4, 47.4, 39.3, 36.5, 32.0, 30.4, 29.2, 24.7; Mp = 87-88 °C.

5h, **1-[5-[(phenylmethyl)amino]-2-oxazolyl]-1-hexanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a yellow solid (73%); IR (neat) 3280, 1659, 1608, 1532, 1469, 1069 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.34-7.22 (m, 5-H), 6.07 (s, 1-H), 5.98 (br t, 1-H), 4.38 (d, *J* = 6.0 Hz, 2-H), 2.86 (t, *J* = 7.4 Hz, 2-H), 1.65 (quint, *J* = 7.4 Hz, 2-H), 1.36-1.23 (m, 4-H), 0.86 (t, *J* = 6.9 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 186.1, 157.9, 149.3, 136.8, 128.2, 127.3, 126.8, 102.4, 47.4, 37.1, 30.9, 23.9, 21.9, 13.4; Mp = 95-96 °C.

5i, **1-[5-(2-propynylamino)-2-oxazolyl]-1-hexanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a yellow solid (71%); IR (neat) 3307, 3281, 1660, 1602, 1546, 1495, 1105 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 6.25 (s, 1-H), 6.08 (br t, 1-H), 3.98 (br d, 2-H), 2.85 (t, *J* = 7.4 Hz, 2-H), 2.23 (s, 1-H), 1.63 (br quint, *J* = 7.1 Hz, 2-H), 1.30-1.15 (m, 4-H), 0.83 (br t, 3-H); ^{13}C-

NMR (75 MHz, 25°C, $CDCl_3$) δ 186.9, 157.5, 150.2, 103.6, 77.4, 72.2, 37.5, 33.2, 31.2, 24.2, 22.2, 13.7; Mp = 70-71 °C.

5j, **1-[5-(2-propynylamino)-2-oxazolyl]-1-propanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a yellow solid (51%); IR (neat) 1661, 1601, 1521, 1483, 1070 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 6.29 (s, 1-H), 5.31 (br t, 1-H), 4.00 (dd, *J* = 6.0 Hz, 2.5 Hz, 2-H), 2.95 (quart, *J* = 7.4 Hz, 2-H), 2.29 (t, *J* = 2.5 Hz, 1-H), 1.19 (t, *J* = 7.4 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 186.9, 156.6, 149.8, 103.4, 72.2, 33.1, 30.6, 29.2, 7.8; Mp = 99-100 °C.

5k, **3-cyclopentyl-1-[5-(pentylamino)-2-oxazolyl]-1-propanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a yellow solid (83%); IR (neat) 3315, 1678, 1608, 1520, 1302, 1109 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 6.08 (s, 1-H), 5.41 (br t, 1-H), 3.15 (quart, *J* = 6.7 Hz, 2-H), 2.87 (t, *J* = 7.4 Hz, 2-H), 1.8-1.0 (m, 15-H), 0.88 (t, *J* = 7.4 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 185.8, 158.2, 149.1, 101.5, 43.2, 39.3, 36.3, 32.0, 30.8, 29.1, 24.6, 19.4, 13.1; Mp = 70-71 °C.

5l, **1-[5-(butylamino)-2-oxazolyl]-1-hexanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a yellow solid (71%); IR (neat) 3284, 1671, 1602, 1558, 1482,1100 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 6.06 (s, 1-H), 5.52 (br t, 1-H), 3.14 (quart, *J* = 6.6 Hz, 2-H), 2.83 (t, *J* = 7.4 Hz, 2-H), 1.68-1.50 (m, 4-H), 1.38-1.14 (m, 6-H), 0.90-0.72 (m, 6-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 185.7, 158.4, 149.2, 101.6, 43.3, 37.0, 31.0, 30.9, 24.1, 22.0, 19.5, 13.4, 13.2; Mp = 89-90 °C.

5m, **hexanoic acid, (*Z*)-1-[5-(4-morpholinyl)-4-(phenylmethyl)-2-oxazolyl]-1-hexenyl ester**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a light yellow oil (5%); IR (neat) 3282, 1660, 1600, 1558, 1355, 1052 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.28-7.12 (m, 5-H), 6.19 (t, *J* = 7.7 Hz, 1-H), 3.78 (s, 2-H), 3.65 (m, 4-H), 2.91 (m, 4-H), 2.53 (t, J = 7.4 Hz, 2-H), 2.11 (q, J = 7.4 Hz, 2-H), 1.73 (quint, J = 7.1 Hz, 2-H), 1.39-1.30 (m, 8-H), 0.89 (m, 6-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 169.4, 151.7 (2C), 139.1, 135.8, 128.6, 128.4, 126.1 (2C), 123.1, 67.1, 48.5, 34.0, 31.9, 31.3, 30.8, 25.4, 24.7, 22.2 (2C), 13.9 (2C).

7, **1-[5-(benzylamino)-1,3-oxazol-2-yl]-2-phenyl-1-butanone**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a yellow oil (40%). ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.41-7.15 (m, 5-H), 6.10 (s, 1-H), 6.00 (br t, 1-H), 4.68 (t, *J* = 7.7 Hz, 1-H), 4.36 (d, *J* = 5.8 Hz, 2-H), 2.13 (m, 1-H), 1.84 (m, 1-H), 0.88 (t, *J* = 7.4 Hz, 2-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 186.6, 159.4, 150.5, 139.8, 137.9, 129.4, 129.2, 128.6, 128.3, 128.1, 127.9, 104.1, 54.5, 48.5, 26.8, 12.8; *m/z* 321 $(M+H)^+$.

General procedure for the preparation of α-ketoamides, 6

To a solution of the 2-acyl-5-aminooxazole **7** in THF, HCl 37 % (100 μL/0.1 mmol) was added dropwise. The reaction was stirred at room temperature for 1 hour. The solvent was evaporated and the reaction was diluted with ethyl acetate and washed with Na_2CO_3 sat. aq. (x 1). The organic phase was dried over sodium sulphate and evaporated. The crude material was then purified by column chromatography by using petroleum ether/EtOAc as eluant to give the α-ketoamide **6**.

6a, ***N*-[2-(4-morpholinyl)-2-oxo-1-(phenylmethyl)ethyl]-2-oxo-heptanamide**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a yellow amorphous solid (61%). IR (neat) 3218, 1680, 1648, 1258, 898, 730 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 7.71 (d, *J* = 8.3 Hz, 1-H), 7.35-7.14 (m, 5-H), 5.03 (q, *J* = 8.3 Hz, 1-H), 3.58 (d, *J* = 10.4 Hz, 2-H), 3.50-3.31 (m, 4-H), 3.08-2.96 (m, 2-H), 2.95-2.78 (m, 4-H), 1.65-1.50 (br s, 2-H), 1.38-1.18 (br s, 4-H), 0.89 (br t, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 198.2, 169.0, 159.6, 135.8, 129.6, 128.8, 127.5, 66.0, 49.6, 46.0, 42.4, 39.9, 36.8, 31.2, 22.9, 13.9; *m/z* 383 $(M+Na)^+$.

6b, ***N*-[2-(4-morpholinyl)-2-oxo-1-(phenylmethyl)ethyl]-α-oxo-benzenebutanamide**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a light yellow oil (55%). IR (neat) 3228, 1682, 1655, 1265, 895, 732, 703 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.66 (d, *J* = 8.5 Hz, 1-H), 7.27-7.08 (m, 10-H), 4.96 (quart, *J* = 6.3 Hz, 1-H), 3.55-3.46 (m, 2-H), 3.45-3.28 (m, 4-H), 3.19-3.12 (m, 2-H), 2.97-2.91 (m, 2-H), 2.89-2.74 (m, 4-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 196.7, 168.6, 158.9, 140.0, 135.2, 129.2, 128.4, 128.1, 128.0, 127.1, 125.9, 66.0, 49.2, 45.6, 39.5, 38.1, 28.7; *m/z* 395 $(M+H)^+$.

6c, ***N*-[2-(4-morpholinyl)-2-oxo-1-(phenylmethyl)ethyl]-2-oxo-butanamide**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a white amorphous solid (68%). IR (neat) 3229, 1677, 1652, 1256, 890, 710 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 7.71 (d, *J* = 8.2 Hz, 1-H), 7.34-7.18 (m, 5-H), 5.03 (quart, *J* = 7.4 Hz, 1-H), 3.57 (br d, *J* = 7.4 Hz, 2-H), 3.49-3.35 (m, 4-H), 3.04-2.83 (m, 6-H), 1.24 (t, *J* = 7.2 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 198.1, 168.6, 159.0, 135.2, 129.1, 128.4, 127.0, 66.0, 49.1, 45.6, 41.9, 30.0, 6.7; *m/z* 319 $(M+H)^+$.

6d, α-[(1,2-dioxoheptyl)amino]-*N*-methyl-*N*-(2-propynyl)-benzenepropanamide

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a white solid (55%). IR (KBr) 1683, 1647, 1265, 1092, 895, 734 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 7.70 (d, *J* = 8.5 Hz, 1-H), 7.25-7.11 (m, 5-H), 5.07-4.95 (m, 1-H), 4.10 (dd, *J* = 17.3/2.5 Hz, 1-H), 3.98 (dd, *J* = 17.3 /2.5 Hz, 1-H), 2.98 (t, *J* = 7.4 Hz, 2-H), 2.81-2.72 (m, 2-H), 2.69 (s, 3-H), 2.19 (t, *J* = 2.5 Hz, 1-H), 1.53 (quint, *J* = 7.4 Hz, 2-H), 1.30-1.17 (m, 4-H), 0.83 (t, *J* = 7.2 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 197.8, 169.9, 159.2, 135.3, 129.1, 128.3, 126.9, 77.4, 72.1, 50.1, 39.1, 36.4, 36.3, 33.7, 30.9, 22.6, 22.0, 13.6; *m/z* 365 $(M+Na)^+$; Mp = 58 °C.

6e, *N*-[1-methyl-2-[methyl(phenylmethyl)amino]-2-oxoethyl]-α-oxo-benzenebutanamide

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a yellow oil (65%). IR (neat) 1681, 1643, 1496, 1453, 1107, 733, 698 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 7.95 (d, *J* = 7.7 Hz, 1-H), 7.30-7.04 (m, 10-H), 4.96-4.82 (m, 1-H), 4.68 (d, *J* = 14.6 Hz, 1-H), 4.52 (d, *J* = 14.6 Hz, 1-H), 3.29-3.17 (m, 2-H), 2.98-2.90 (m, 5-H), 1.41 (d, *J* = 6.6 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 196.8, 171.1, 158.8, 140.0, 136.0, 128.3, 128.2, 128.1, 128.0, 127.5, 125.8, 50.8, 45.0, 38.0, 34.0, 28.7, 17.9; *m/z* 375 $(M+Na)^+$.

6f, *N*-[2-[methyl(phenylmethyl)amino]-2-oxoethyl]-2-oxo-butanamide

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give an orange oil (65%). IR (neat) 1684, 1648, 1496, 1453, 1114, 734, 700 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$, referred to the main rotamer) δ 7.90 (br s, 1-H), 7.38-7.10 (m, 5-H), 4.59 (s, 1-H), 4.10 (br d, 2-H), 2.98-2.84 (m, 5-H), 1.09 (br t, 3-H); ^{13}C-NMR (75 MHz, 25°C,

$CDCl_3$, referred to the main rotamer) δ 190.1, 168.0, 160.9, 136.9, 129.4, 128.6, 126.9, 52.0, 41.7, 34.2, 31.0, 7.7; *m/z* 263 $(M+H)^+$.

6g, **α-oxo-*N*-[2-oxo-2-[(phenylmethyl)amino]ethyl]-cyclopentanebutanamide**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a yellow solid (67%). IR (KBr) 3246, 2945, 2866, 1723, 1681, 1568, 701 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.73 (br t, 1-H), 7.33-7.16 (m, 5-H), 6.73 (br t, 1-H), 4.40 (d, *J* = 5.8 Hz, 2-H), 3.96 (d, *J* = 5.8 Hz, 2-H), 2.82 (t, *J* = 7.4 Hz, 2-H), 1.79-1.64 (m, 2-H), 1.63-1.43 (m, 7-H), 1.15-0.97 (m, 2-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 197.7, 167.3, 160.3, 137.2, 128.3, 127.3, 127.2, 43.2, 42.4, 39.1, 35.7, 32.0, 28.8, 24.7; *m/z* 315 $(M-H)^-$; Mp = 114-115 °C.

6h, **2-oxo-*N*-[2-oxo-2-[(phenylmethyl)amino]ethyl]-heptanamide**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a brown solid (67%). IR (KBr) 3323, 2926, 2859, 1725, 1651, 1232, 741 ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.76 (br t, 1-H), 7.32-7.17 (m, 5-H), 6.78 (br t, 1-H), 4.40 (d, *J* = 5.8 Hz, 2-H), 3.96 (d, *J* = 5.8 Hz, 2-H), 2.78 (t, *J* = 7.4 Hz, 2-H), 1.55 (quint, *J* = 6.9 Hz, 2-H), 1.36-1.18 (m, 4-H), 0.87 (t, *J* = 6.3 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 197.6, 167.3, 160.2, 137.2, 128.3, 127.3, 127.2, 43.2, 42.3, 36.3, 30.7, 22.3, 21.9, 13.4; *m/z* 289 $(M-H)^-$; Mp = 113-114 °C.

6i, **2-oxo-*N*-[2-oxo-2-(2-propynylamino)ethyl]-heptanamide**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a white solid (51%). IR (KBr) 1725, 1655, 1236, 1089, 892, 631 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.76 (s, 1-H), 6.77 (s, 1-H), 4.00 (quart, J = 5.22/2.5 Hz, 2-H), 3.96 (d, *J* = 5.77 Hz, 2-H), 2.88 (t, *J* = 7.4 Hz, 2-H), 2.18 (t, *J* = 2.5 Hz, 1-H), 1.55 (quint, *J* = 7.1 Hz, 2-H),

1.33-1.17 (m, 4-H), 0.82 (t, J = 6.9 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 198.7, 168.4, 161.4, 79.7, 72.5, 43.4, 37.5, 31.8, 29.9, 23.4, 23.0, 14.5; *m/z* 239 $(M+H)^+$; Mp = 135-136 °C.

6j, **2-oxo-*N*-[2-oxo-2-(2-propynylamino)ethyl]-butanamide**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give an amorphous yellow solid (50%). IR (neat) 1725, 1655, 1523, 1264, 738, 699 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $(CD_3)_2CO$) δ 7.98 (s, 1-H), 7.63 (s, 1-H), 3.90 (dd, J = 5.5/2.5 Hz, 2-H), 3.84 (d, J = 6.0 Hz, 2-H), 2.79 (quart, J = 7.4 Hz, 2-H), 2.55 (t, J = 2.5 Hz, 1-H), 0.94 (t, J = 7.1 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $(CD_3)_2CO$) δ 199.1, 168.2, 161.2, 80.7, 71.8, 42.4, 33.0, 24.0, 7.0; *m/z* 197 $(M+H)^+$.

6k, ***N*-[2-(butylamino)-2-oxoethyl]-α-oxo-cyclopentanebutanamide**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 7:3 as eluant to give a yellow solid (70%). IR (KBr) 2360, 1733, 1628, 1453, 1178, 749, 698 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.79 (br t, 1-H), 6.44 (br t, 1-H), 3.94 (d, J = 5.8 Hz, 2-H), 3.22 (quart, J = 6.7 Hz, 2-H), 2.87 (t, J = 7.4 Hz, 2-H), 1.79-1.64 (m, 2-H), 1.63-1.16 (m, 11-H), 1.14-0.96 (m, 2-H), 0.87 (t, J = 7.2 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 197.8, 167.2, 160.3, 42.4, 39.1, 39.0, 35.7, 32.0, 31.0, 28.9, 24.7, 19.6, 13.2; *m/z* 281 $(M-H)^-$; Mp = 81-82 °C.

6l, ***N*-[2-(butylamino)-2-oxoethyl]-2-oxo-heptanamide**

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 95:5 as eluant to give a white solid (51%). IR (KBr) 1670, 1265, 1089, 895, 734, 704 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.74 (br t, 1-H), 6.29 (br t, 1-H), 3.94 (d, J = 5.5 Hz, 2-H), 3.23 (quart, J = 6.5 Hz, 2-H), 2.86 (t, J = 7.1 Hz, 2-H), 1.57 (quint, J = 7.1 Hz, 2-H), 1.45 (quint, J = 7.2 Hz, 2-

H), 1.39-1.15 (m, 12-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 197.7, 167.2, 160.3, 42.5, 39.1, 36.4, 31.1, 29.3, 22.4, 22.0, 19.6, 13.7, 13.3; *m/z* 255 $(M-H)^-$; Mp = 99-100 °C.

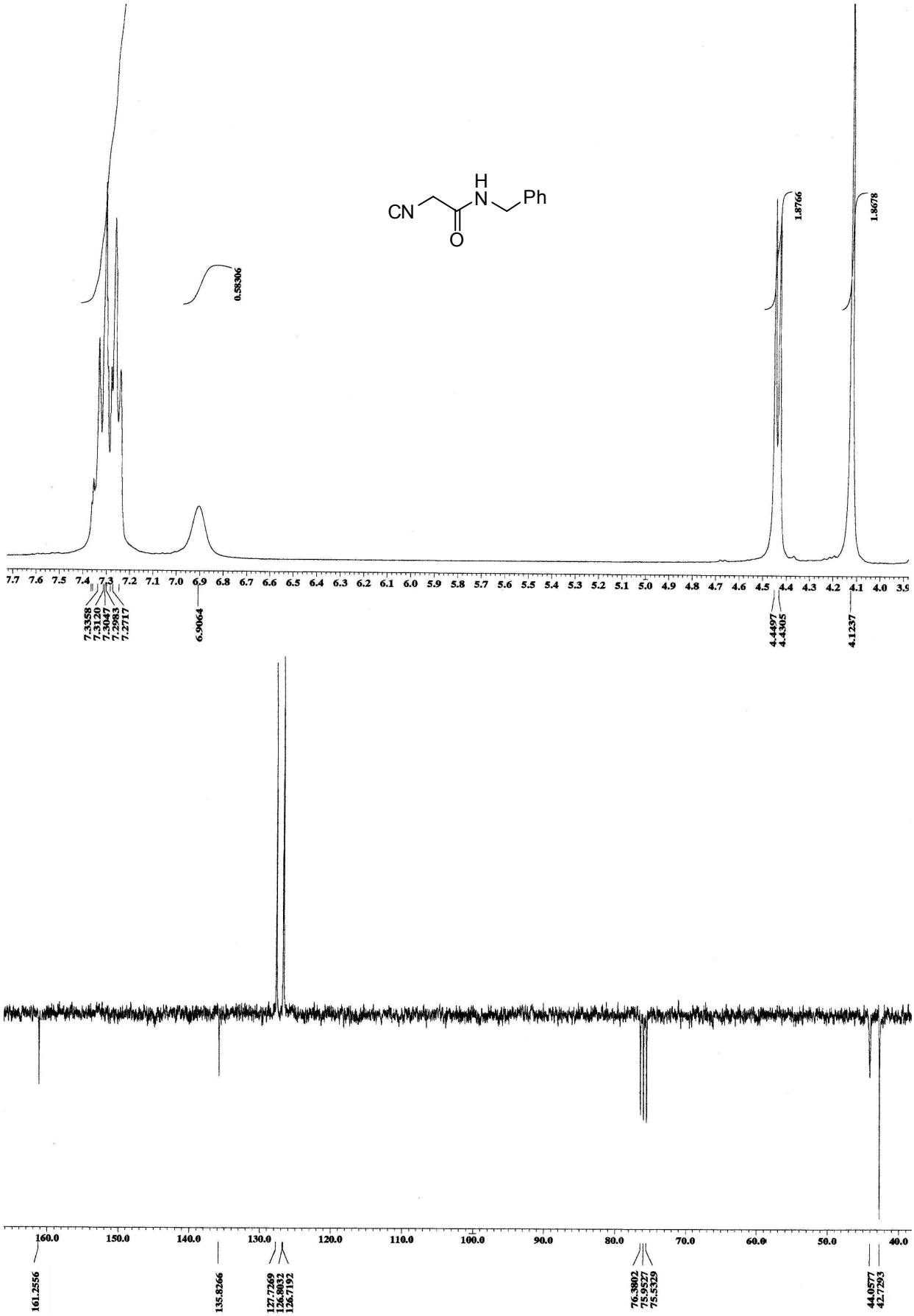
6m, β-ethyl-α-oxo-*N*-[2-oxo-2-[(phenylmethyl)amino]ethyl]- benzenepropanamide

The crude material was purified by column chromatography, by using petroleum ether/EtOAc 9:1 as eluant to give a yellow oil (71%). IR (KBr) 3307, 2927, 1716, 1664, 1522, 1260, 698 cm^{-1}; ^{1}H-NMR (300 MHz, 25°C, $CDCl_3$) δ 7.57 (br s, 1-H), 7.35-7.14 (m, 10-H), 6.18 (br s, 1-H), 4.58 (t, *J* = 7.4 Hz, 1-H), 4.38 (d, *J* = 5.8 Hz, 2-H), 3.85 (dd, *J* = 16.2 Hz, 5.2 Hz, 1-H), 3.77 (dd, *J* = 16.2 Hz, 5.8 Hz, 1-H), 2.11-1.97 (m, 1-H), 1.86-1.70 (m, 1-H), 0.84 (t, *J* = 7.1 Hz, 3-H); ^{13}C-NMR (75 MHz, 25°C, $CDCl_3$) δ 197.1, 168.2, 161.1, 138.2, 137.4, 129.7, 129.6, 129.5, 128.7, 128.5, 128.2, 53.3, 44.4, 43.7, 25.8, 12.7; *m/z* 339 $(M+H)^+$.

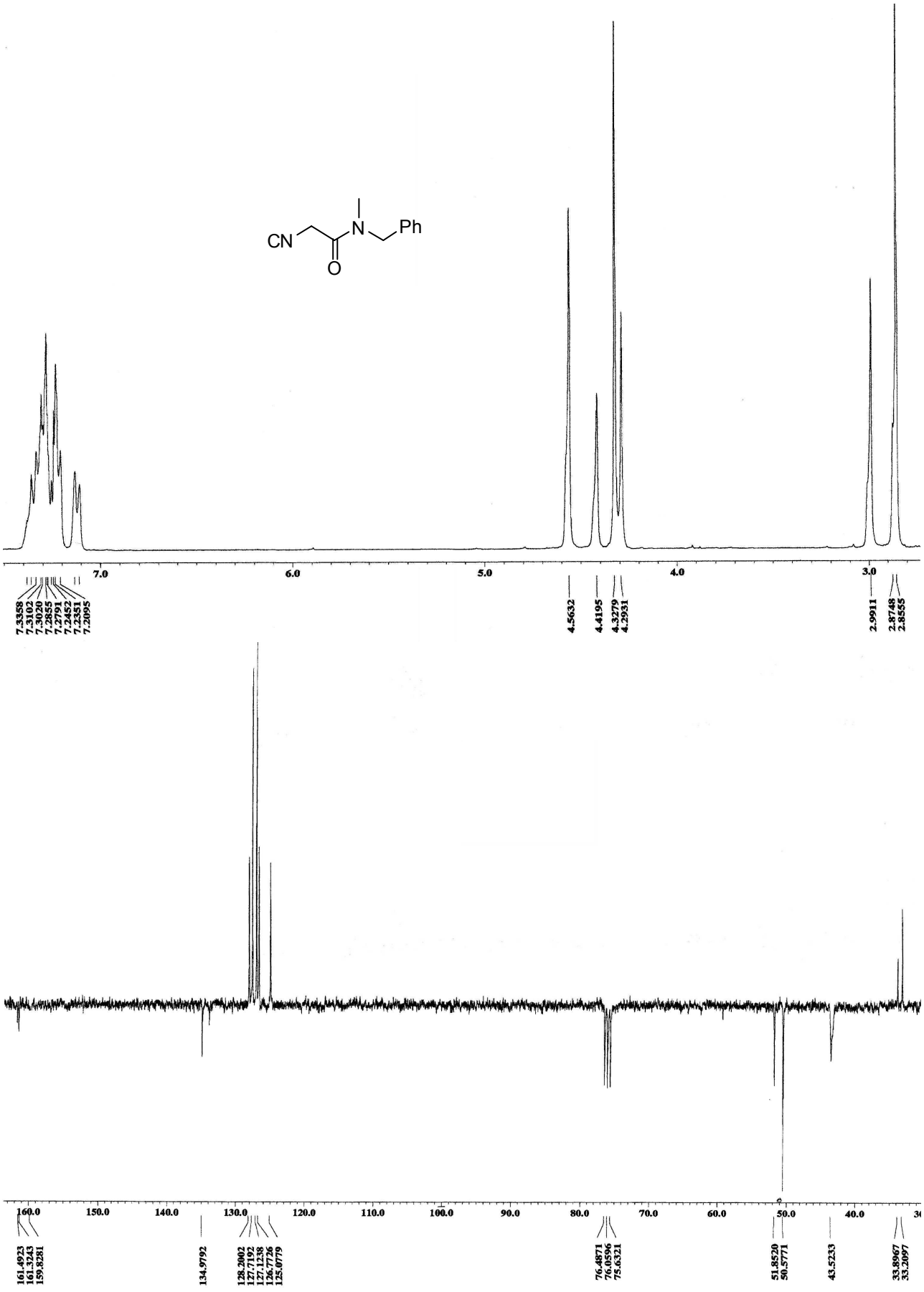
References

1) Cardellina, J. H., II; Barnekow, D. E. *J. Org. Chem.* **1988**, *53*, 882-4.
2) Dömling, A.; Beck, B.; Fuchs, T.; Yazback, A. *J. Comb. Chem.* **2006**, *8*, 872-880.
3) Housseman, C.; Zhu, J. *Synlett* **2006**, *11*, 1777-1779.
4) Pirali, T.; Tron, G. C.; Zhu, J. *Org. Lett.* **2006**, *8*, 4145-4148.

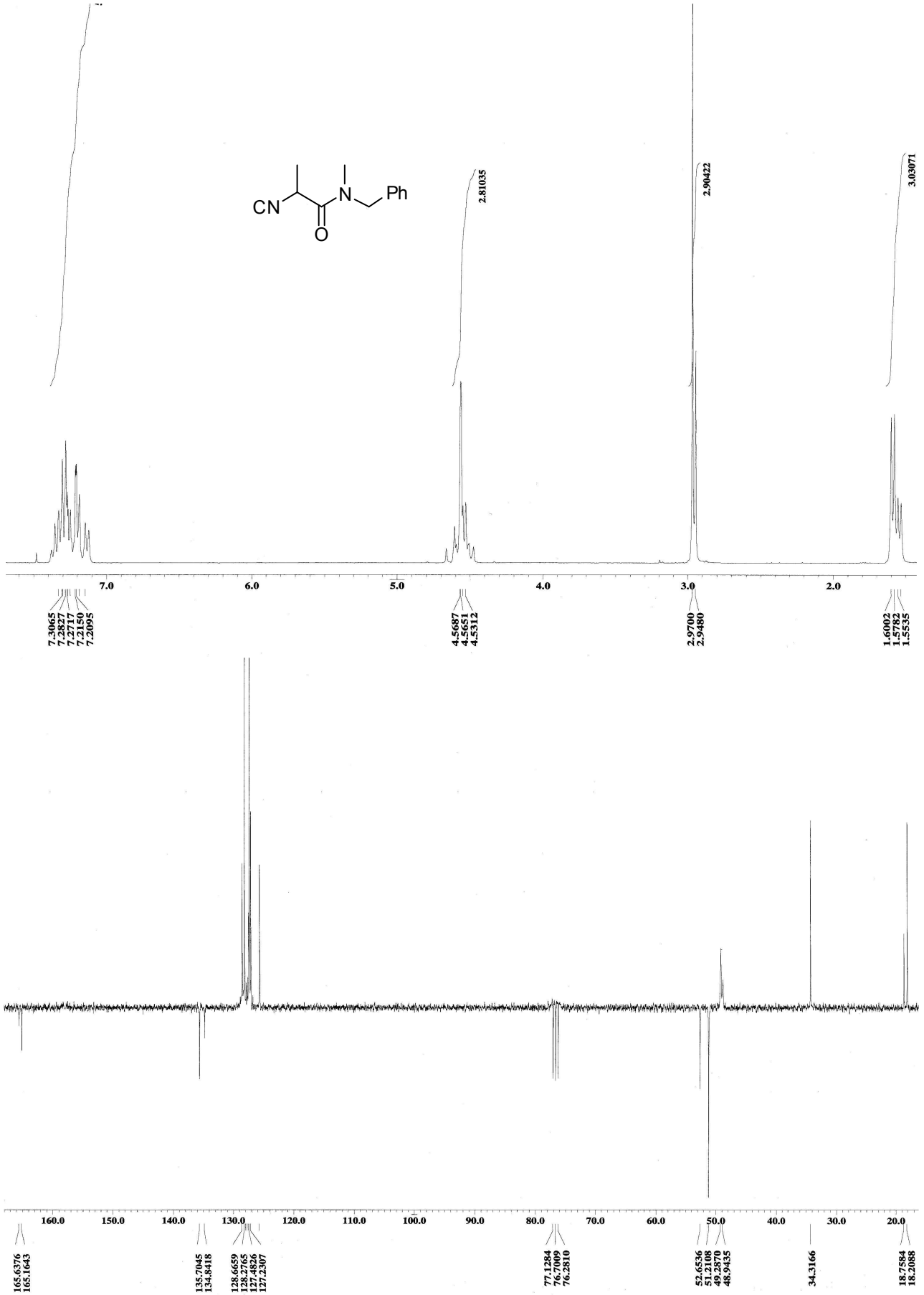
2d


CN
H
N
Ph
O
0.58306
1.8766
1.8678
7.3358
7.3120
7.3047
7.2983
7.2717
6.9064
4.4497
4.4305
4.1237
161.2556
135.8266
127.7269
126.8032
126.7192
76.3802
75.9527
75.5329
44.0577
42.7293

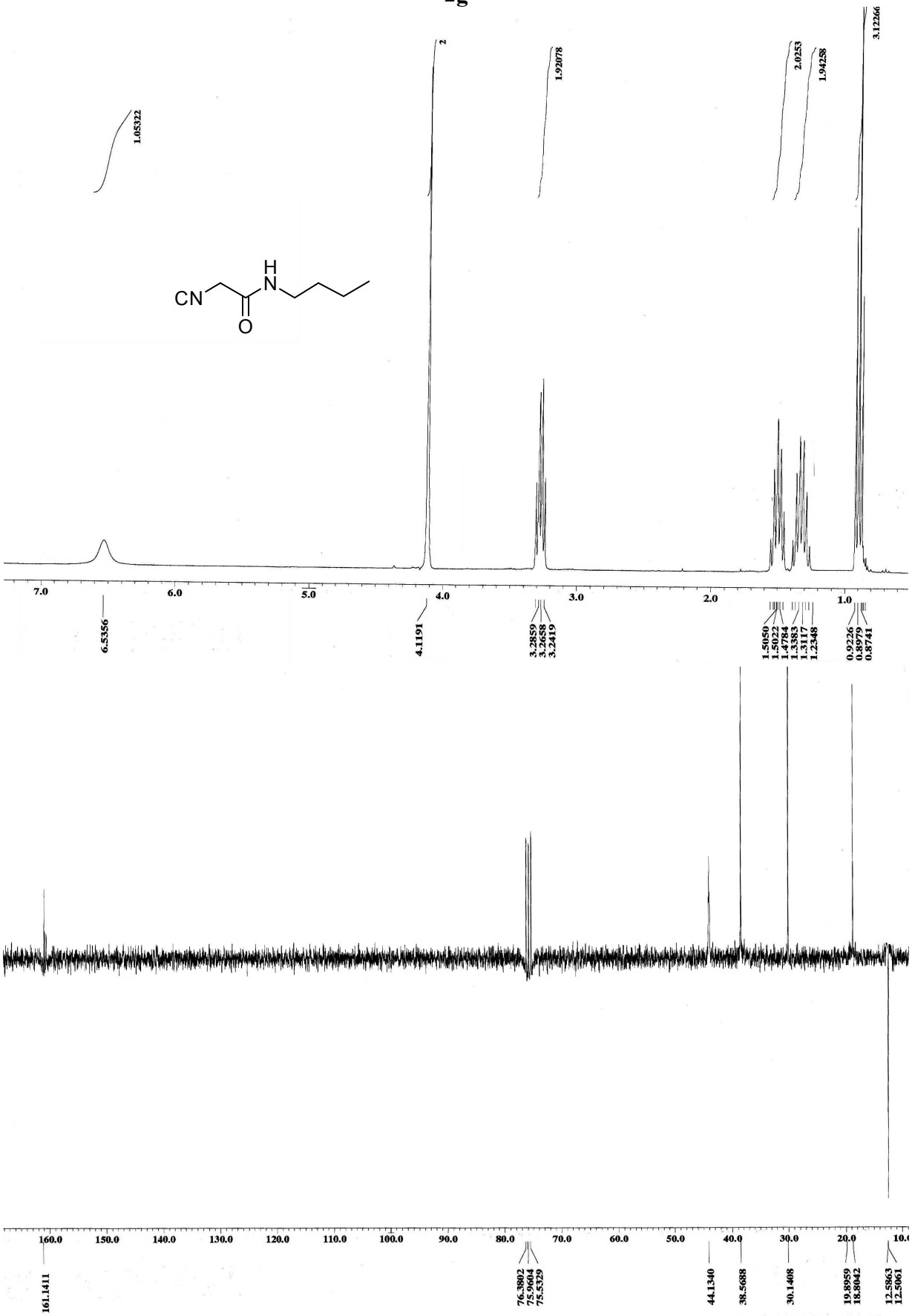
2e


CN
N
Ph
O
7.3358
7.3102
7.3020
7.2855
7.2791
7.2452
7.2351
7.2095
4.5632
4.4195
4.3279
4.2931
2.9911
2.8748
2.8555
161.4923
161.3243
159.8281
134.9792
128.2002
127.7192
127.1238
126.7726
125.0779
76.4871
76.0596
75.6321
51.8520
50.5771
43.5233
33.8967
33.2097

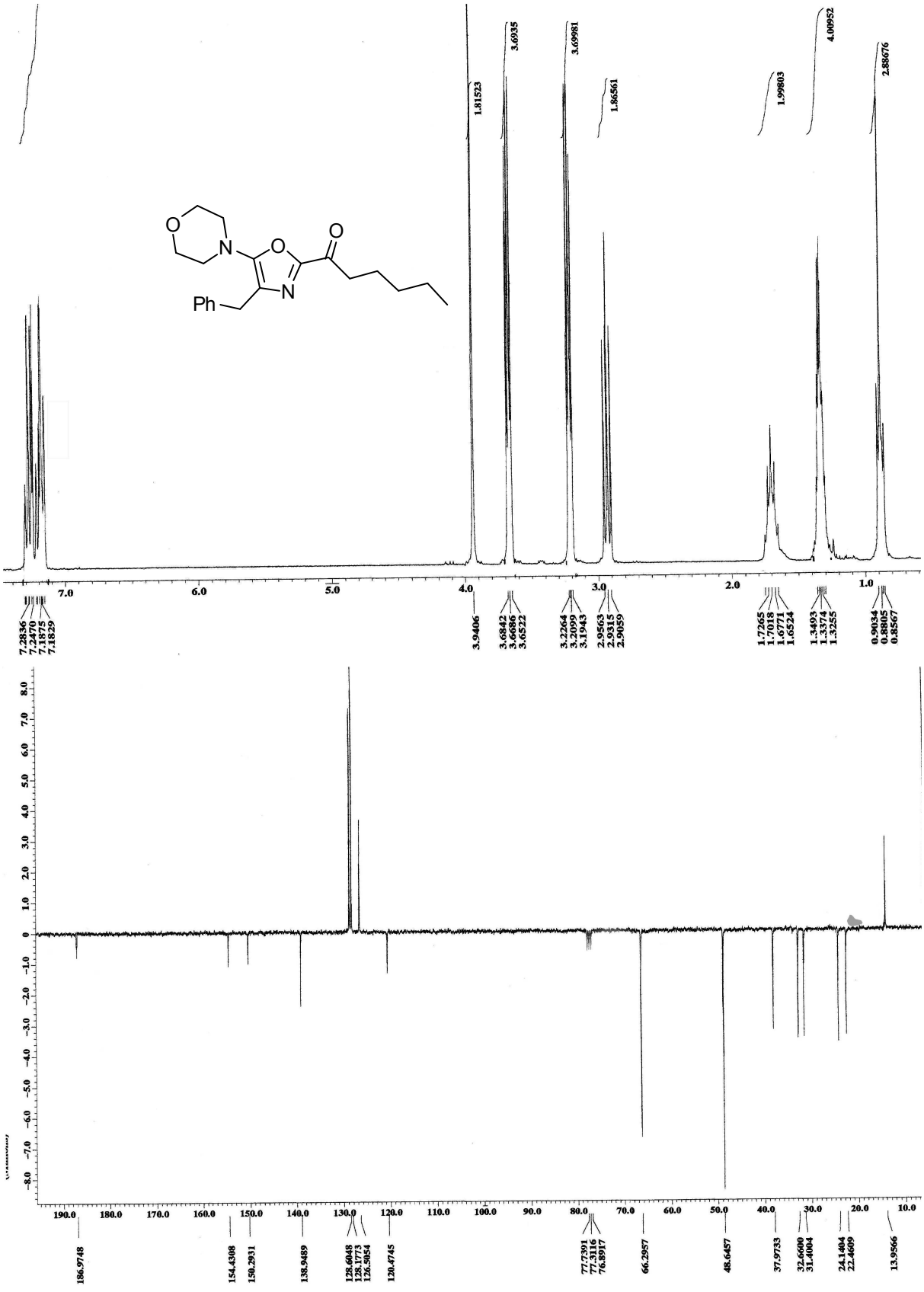
2f


CN
N
Ph
O
2.81035
2.90422
3.03071
7.0
6.0
5.0
4.0
3.0
2.0
7.3065
7.2827
7.2717
7.2150
7.2095
4.5687
4.5651
4.5312
2.9700
2.9480
1.6002
1.5782
1.5535
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
165.6376
165.1643
135.7045
134.8418
128.6659
128.2765
127.4826
127.2307
77.1284
76.7009
76.2810
52.6536
51.2108
49.2870
48.9435
34.3166
18.7584
18.2088

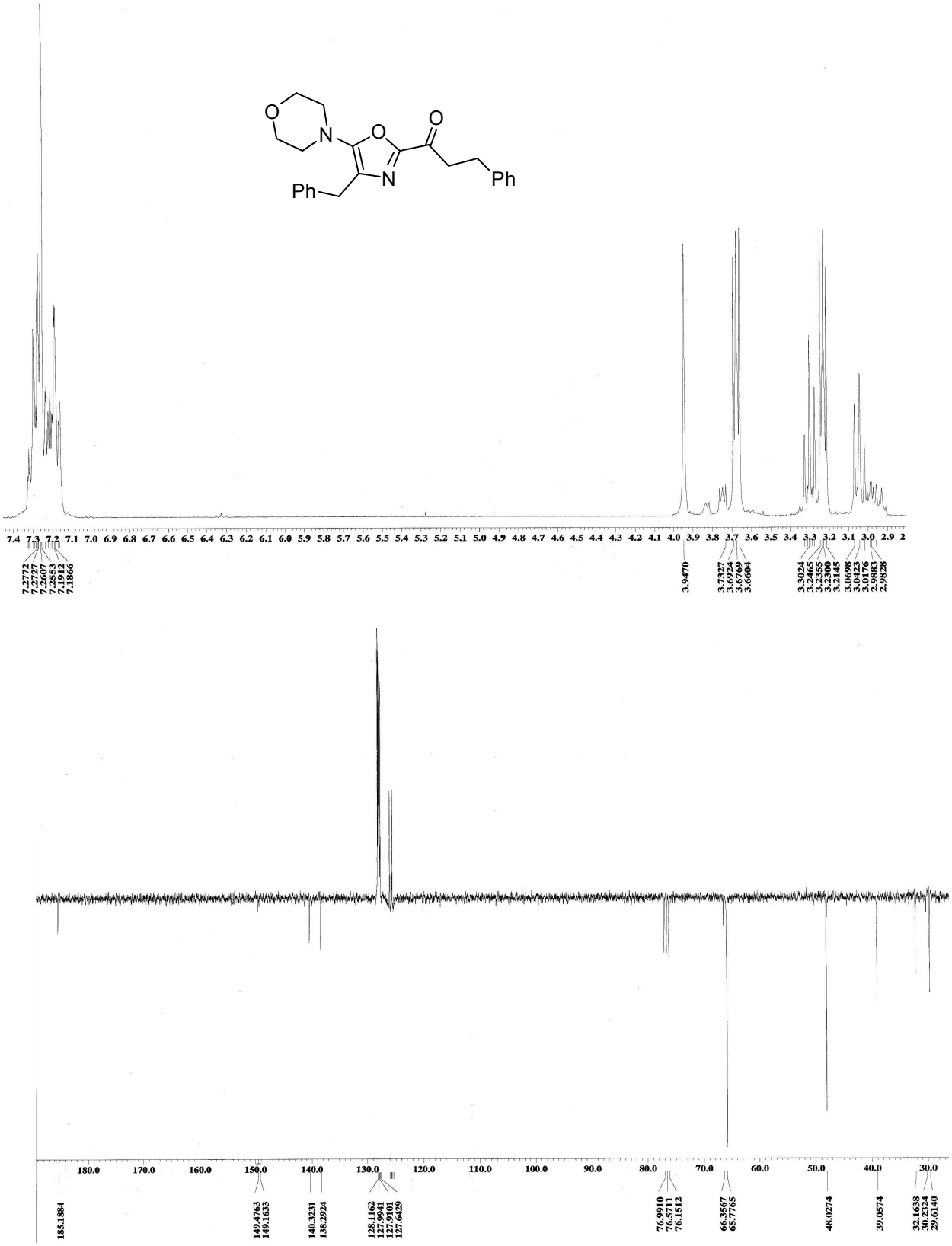
2g


1.05322
1.92078
2.0253
1.94258
3.12266
CN
H
N
O
7.0
6.0
5.0
4.0
3.0
2.0
1.0
6.5356
4.1191
3.2859
3.2658
3.2419
1.5050
1.5022
1.4784
1.3383
1.3117
1.2348
0.9226
0.8979
0.8741
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
161.1411
76.3802
75.9604
75.5329
44.1340
38.5688
30.1408
19.8959
18.8042
12.5863
12.5061

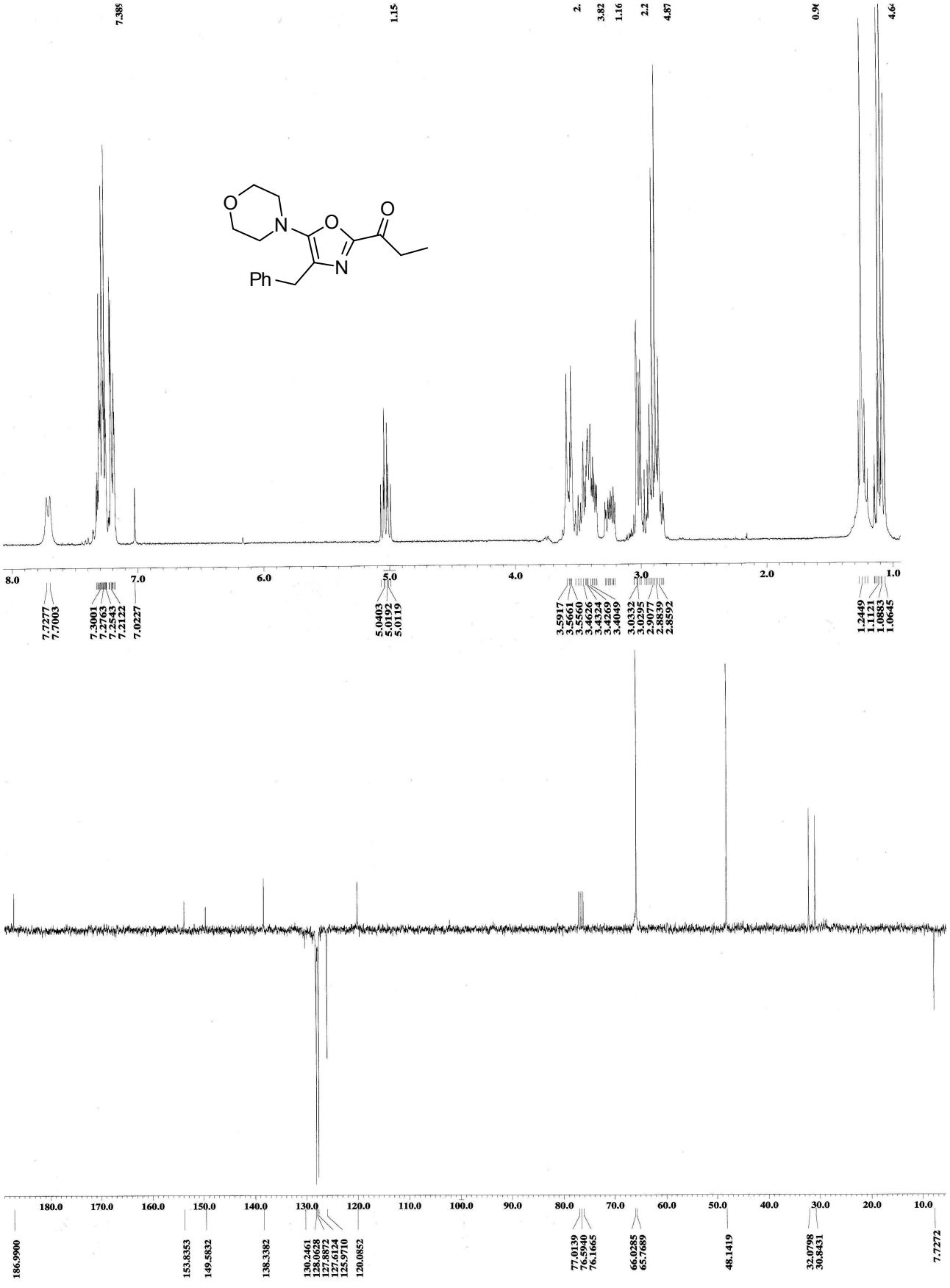
5a


O
N
O
O
N
Ph
1.81523
3.6935
3.69981
1.86561
1.99803
4.00952
2.88676
7.2836
7.2470
7.1875
7.1829
3.9406
3.6842
3.6686
3.6522
3.2264
3.2099
3.1943
2.9563
2.9315
2.9059
1.7265
1.7018
1.6771
1.6524
1.3493
1.3374
1.3255
0.9034
0.8805
0.8567
186.9748
154.4308
150.2931
138.9489
128.6048
128.4773
126.5854
120.4745
77.7391
77.3116
76.8917
66.2957
48.6457
37.9733
32.6600
31.4004
24.1404
22.4609
13.9566

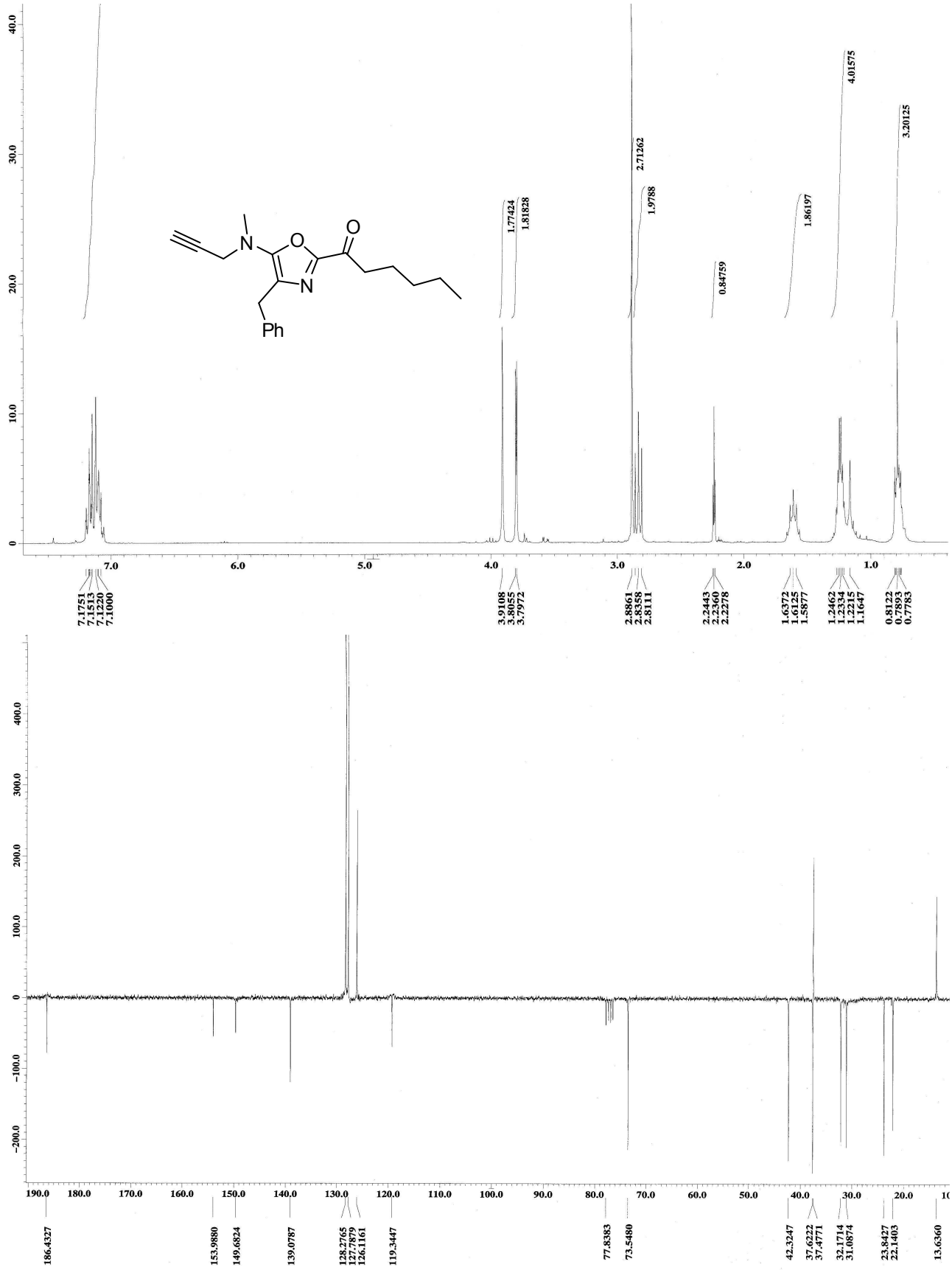
5b


O
N
O
O
N
Ph
Ph
7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6 6.5 6.4 6.3 6.2 6.1 6.0 5.9 5.8 5.7 5.6 5.5 5.4 5.3 5.2 5.1 5.0 4.9 4.8 4.7 4.6 4.5 4.4 4.3 4.2 4.1 4.0 3.9 3.8 3.7 3.6 3.5 3.4 3.3 3.2 3.1 3.0 2.9 2
7.2772
7.2727
7.2607
7.2553
7.1912
7.1866
3.9470
3.7327
3.6934
3.6769
3.6604
3.3024
3.2465
3.2355
3.2300
3.2145
3.0423
3.0176
2.9883
2.9828
180.0 170.0 160.0 150.0 140.0 130.0 120.0 110.0 100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0
185.1884
149.4763
149.1633
140.3231
138.2924
128.1162
127.5941
127.5101
127.4429
76.9910
76.5711
76.1512
66.3567
65.7765
48.0274
39.0574
32.1638
30.2324
29.6140

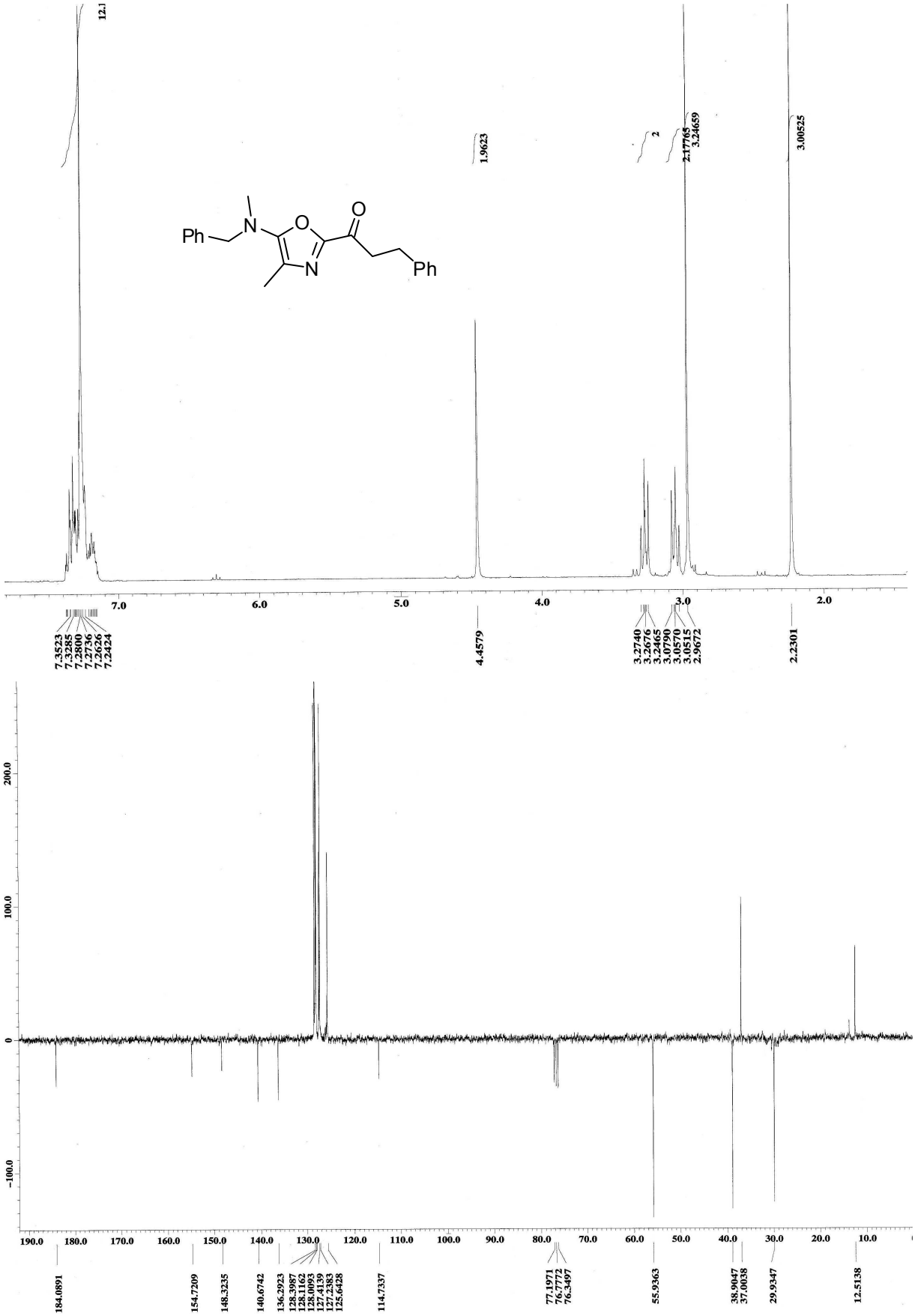
5c


7.385
1.15
2.
3.82
1.16
2.2
4.87
0.96
4.64
O
N
O
O
N
Ph
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.7277
7.7003
7.3001
7.2763
7.2543
7.2122
7.0227
5.0403
5.0192
5.0119
3.5917
3.5661
3.5560
3.4626
3.4324
3.4269
3.4049
3.0332
3.0295
2.9077
2.8839
2.8592
1.2449
1.1121
1.0843
1.0645
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
186.9900
153.8353
149.5832
138.3382
130.2461
128.0628
127.8872
127.6124
125.9710
120.0852
77.0139
76.5940
76.1665
66.0285
65.7689
48.1419
32.0798
30.8431
7.7272

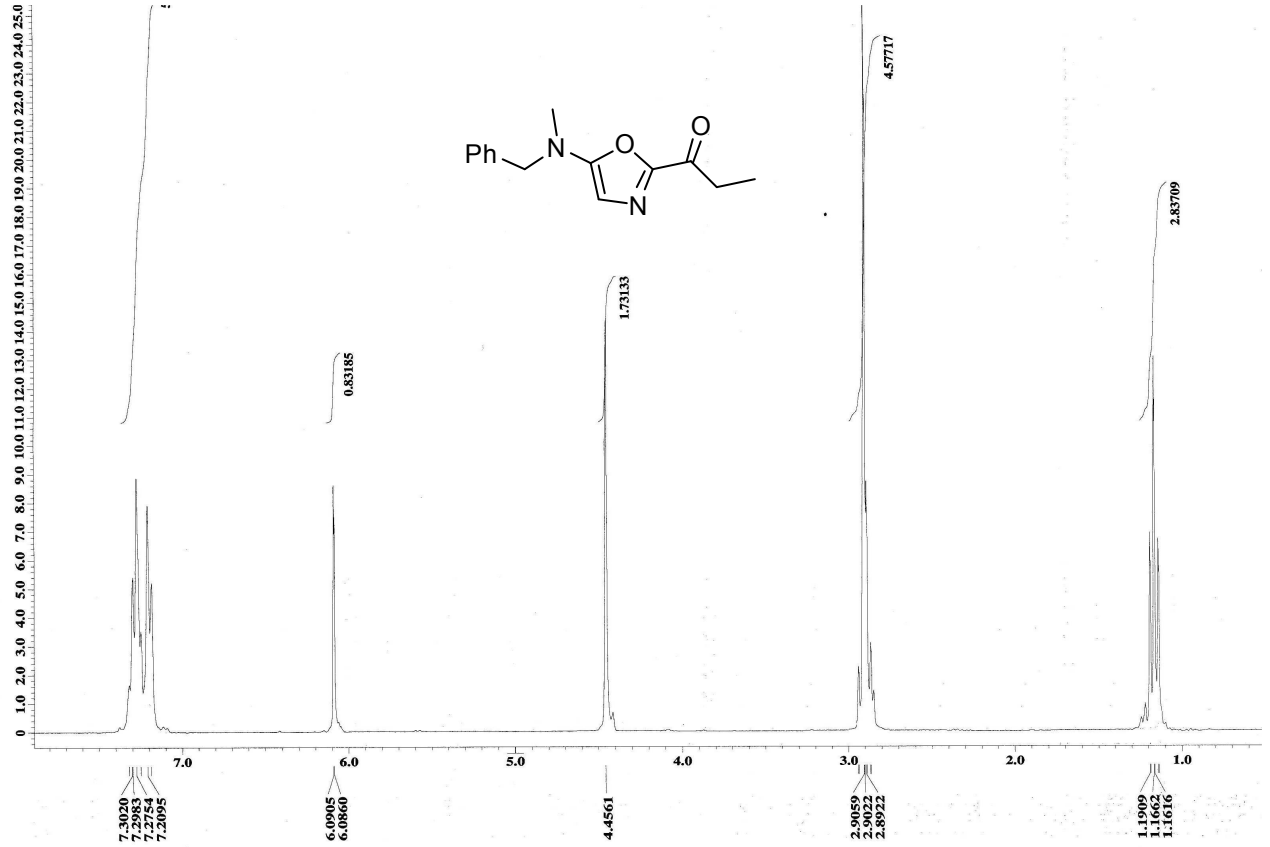
5d

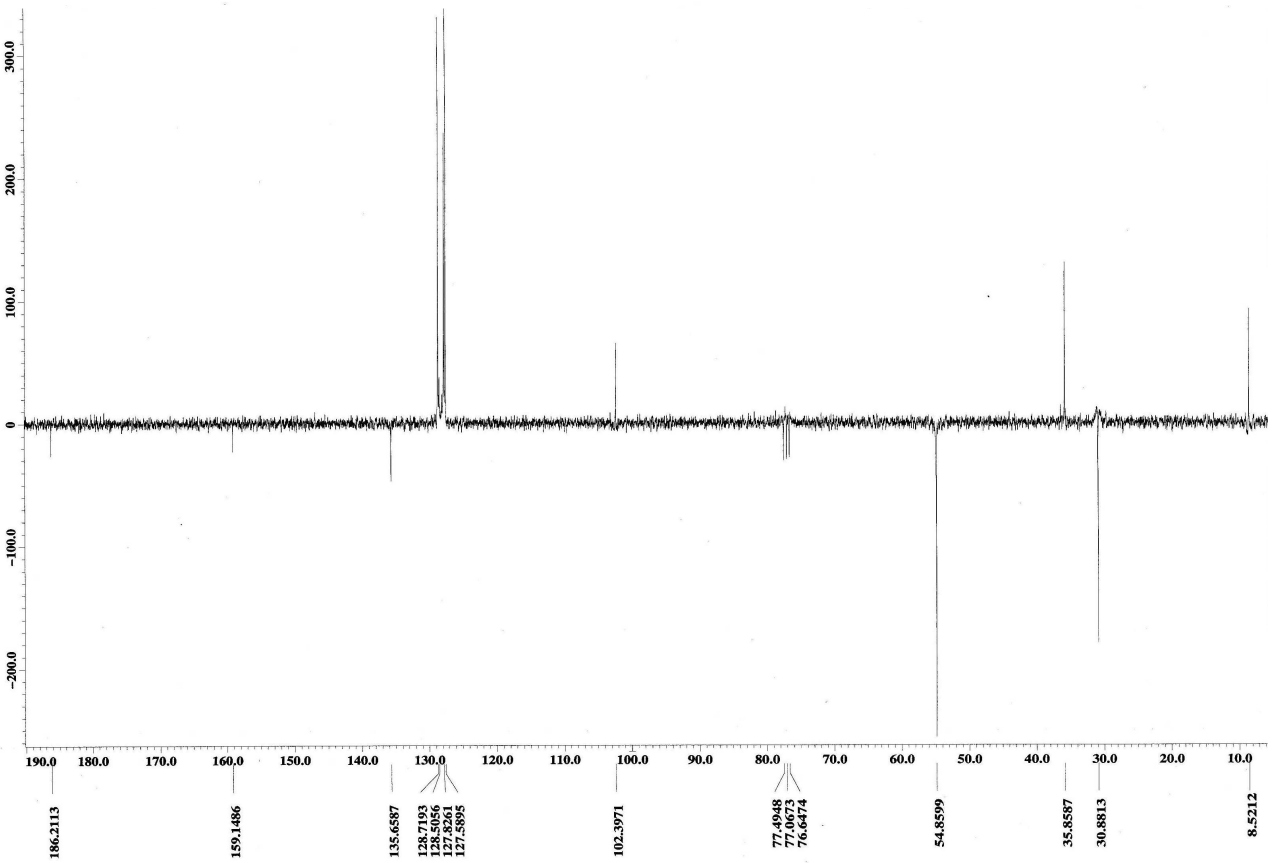

N
O
O
N
Ph
1.77424
1.81828
2.71262
1.9788
0.84759
1.86197
4.01575
3.20125
7.1751
7.1513
7.1220
7.1000
3.9108
3.8055
3.7972
2.8861
2.8358
2.8111
2.2443
2.2340
2.2278
1.6372
1.6125
1.5877
1.2462
1.2334
1.2215
1.1647
0.8122
0.7893
0.7783
186.4327
153.9880
149.6824
139.0787
128.2765
127.7879
126.1161
119.3447
77.8383
73.5480
42.3247
37.6222
37.4771
32.1714
31.0874
23.8427
22.1403
13.6360

5e

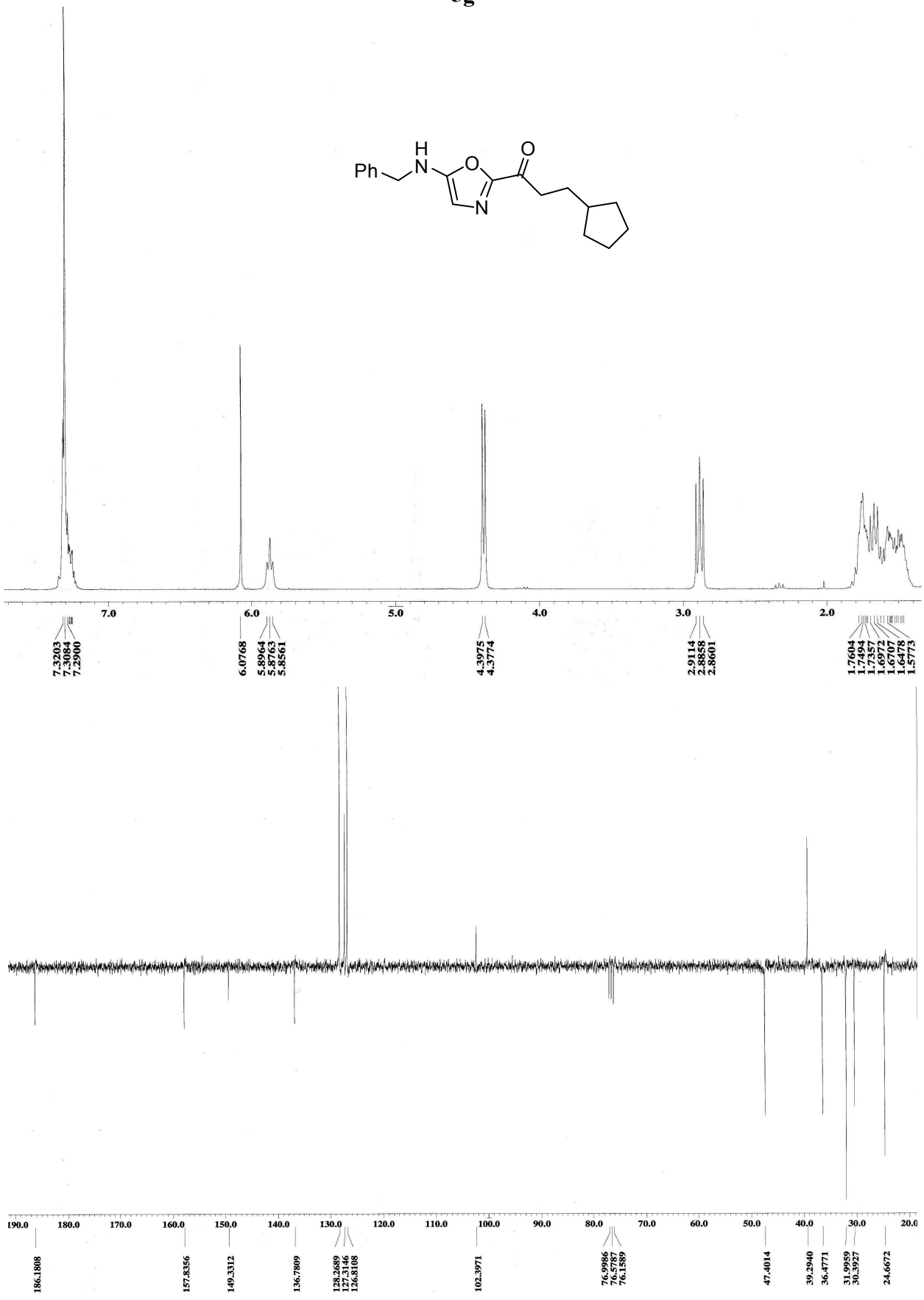

Ph
N
O
O
N
Ph
1.9623
2
2.17765
3.24659
3.00525
7.3523
7.3285
7.2800
7.2736
7.2626
7.2424
4.4579
3.2740
3.2676
3.2465
3.0790
3.0570
3.0515
2.9672
2.2301
184.0891
154.7209
148.3235
140.6742
136.2923
128.3987
128.1140
128.0093
127.4139
127.2383
125.6428
114.7337
77.1971
76.7772
76.3497
55.9363
38.9047
37.0038
29.9347
12.5138

5f

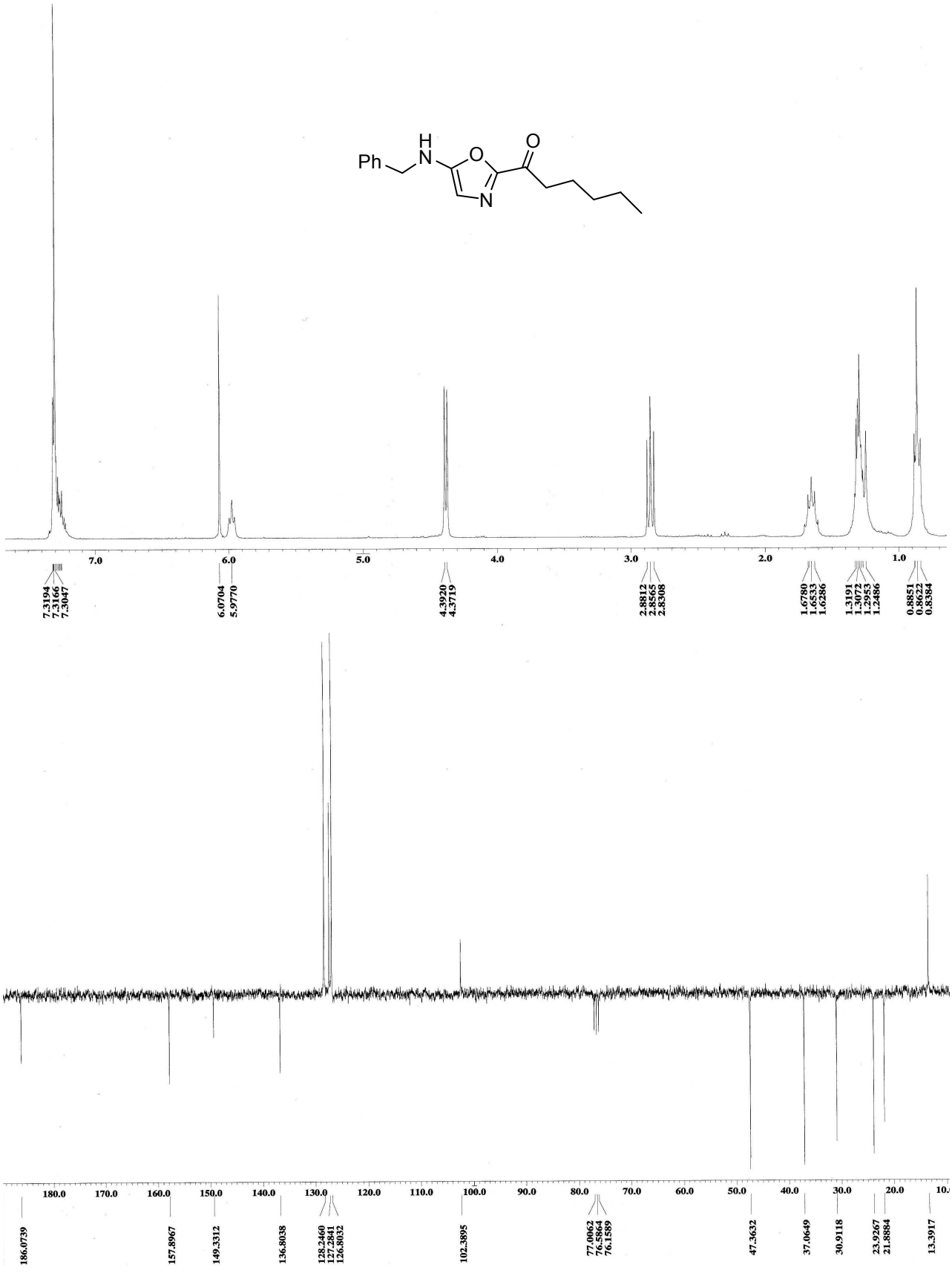

Ph
N
O
O
N
4.57717
2.83709
1.73133
0.83185
7.3020
7.2983
7.2754
7.2095
6.0905
6.0860
4.4561
2.9059
2.9022
2.8922
1.1909
1.1662
1.1616


186.2113
159.1486
135.6587
128.7193
128.5056
127.8261
127.5895
102.3971
77.4948
77.0673
76.6474
54.8599
35.8587
30.8813
8.5212

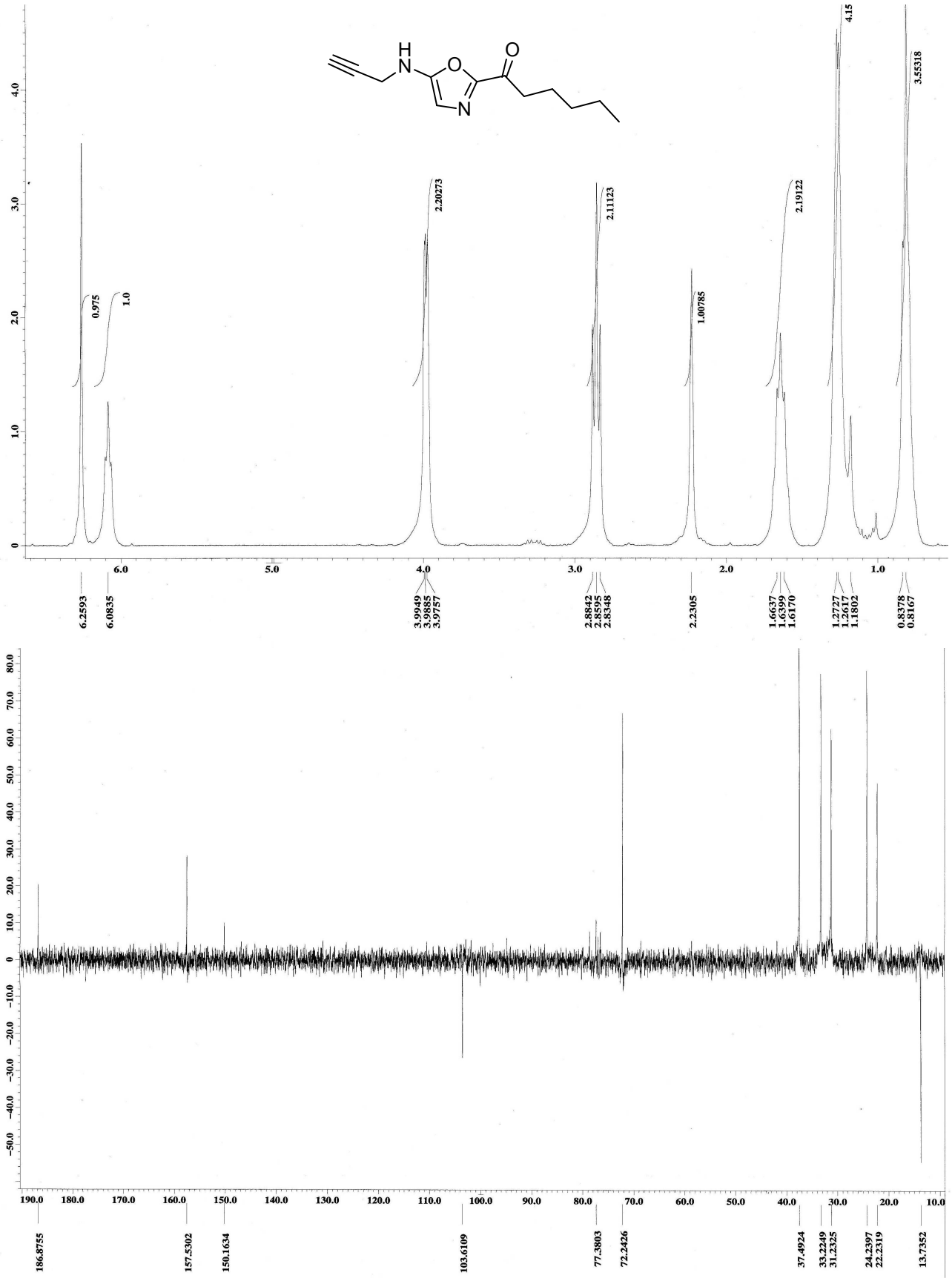
5g


H
N
Ph
O
O
N
7.3203
7.3084
7.2900
6.0768
5.8964
5.8763
5.8561
4.3975
4.3774
2.9114
2.8858
2.8601
1.7604
1.7494
1.7357
1.6972
1.6707
1.6478
1.5773
186.1808
157.8356
149.3312
136.7809
128.2689
127.3146
126.8108
102.3971
76.9986
76.5787
76.1589
47.4014
39.2940
36.4771
31.9959
30.3927
24.6672

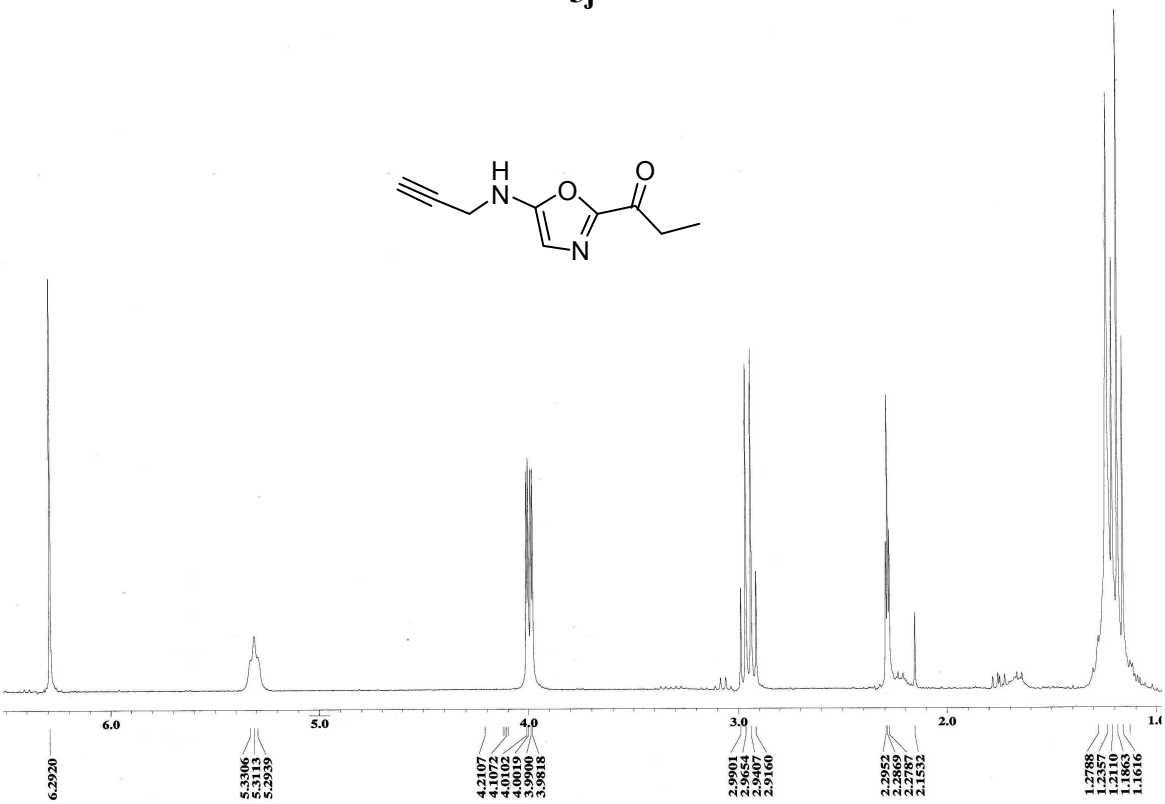
5h

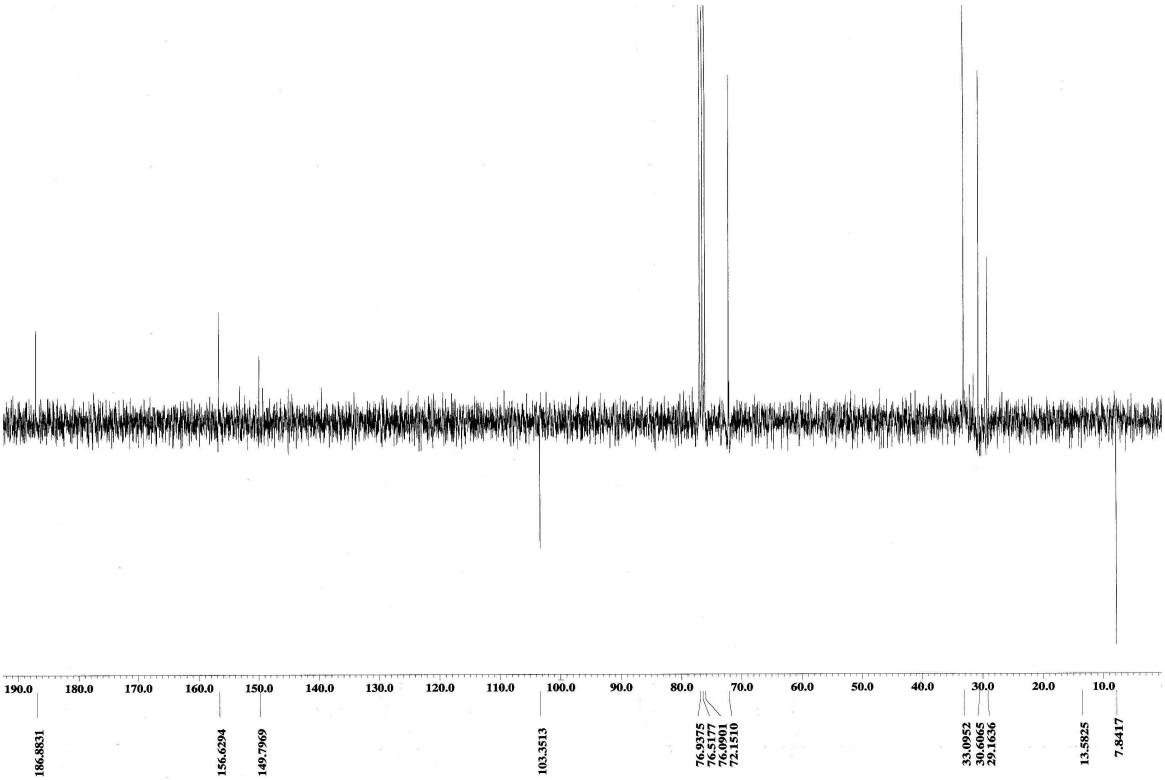

Ph
H
N
O
O
N
7.3194
7.3166
7.3047
6.0704
5.9770
4.3920
4.3719
2.8812
2.8565
2.8308
1.6780
1.6533
1.6286
1.3191
1.3072
1.2953
1.2486
0.8851
0.8622
0.8384
186.0739
157.8967
149.3312
136.8038
128.2460
127.2841
126.8032
102.3895
77.0062
76.5864
76.1589
47.3632
37.0649
30.9118
23.9267
21.8884
13.3917

5i

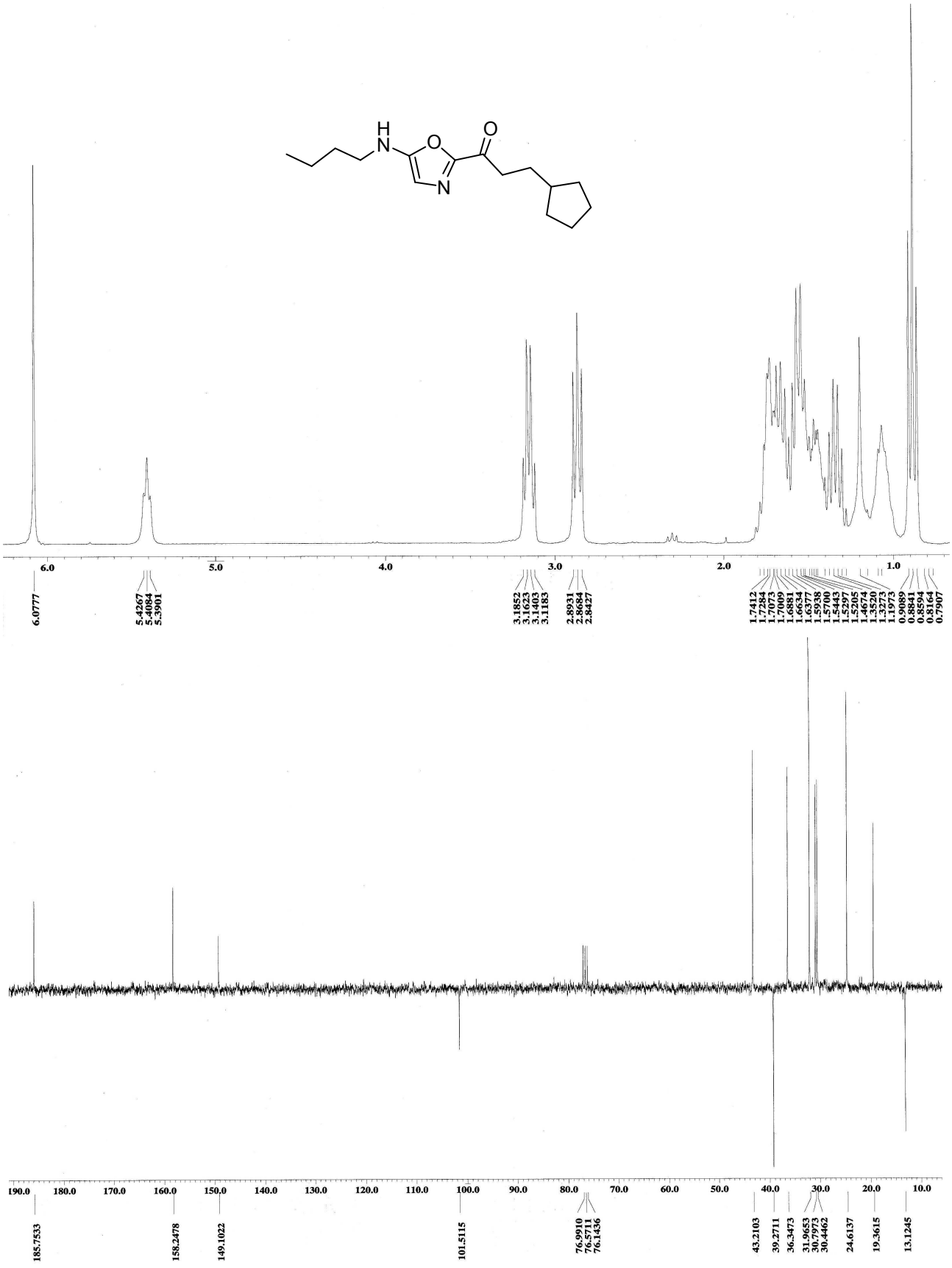

H
N
O
O
N
4.15
3.55318
2.20273
2.11123
2.19122
0.975
1.0
1.00785
6.2593
6.0835
3.9949
3.9885
3.9757
2.8842
2.8595
2.8348
2.2305
1.6637
1.6399
1.6170
1.2727
1.2617
1.1802
0.8378
0.8167
186.8755
157.5302
150.1634
103.6109
77.3803
72.2426
37.4924
33.2249
31.2325
24.2397
22.2319
13.7352

5j

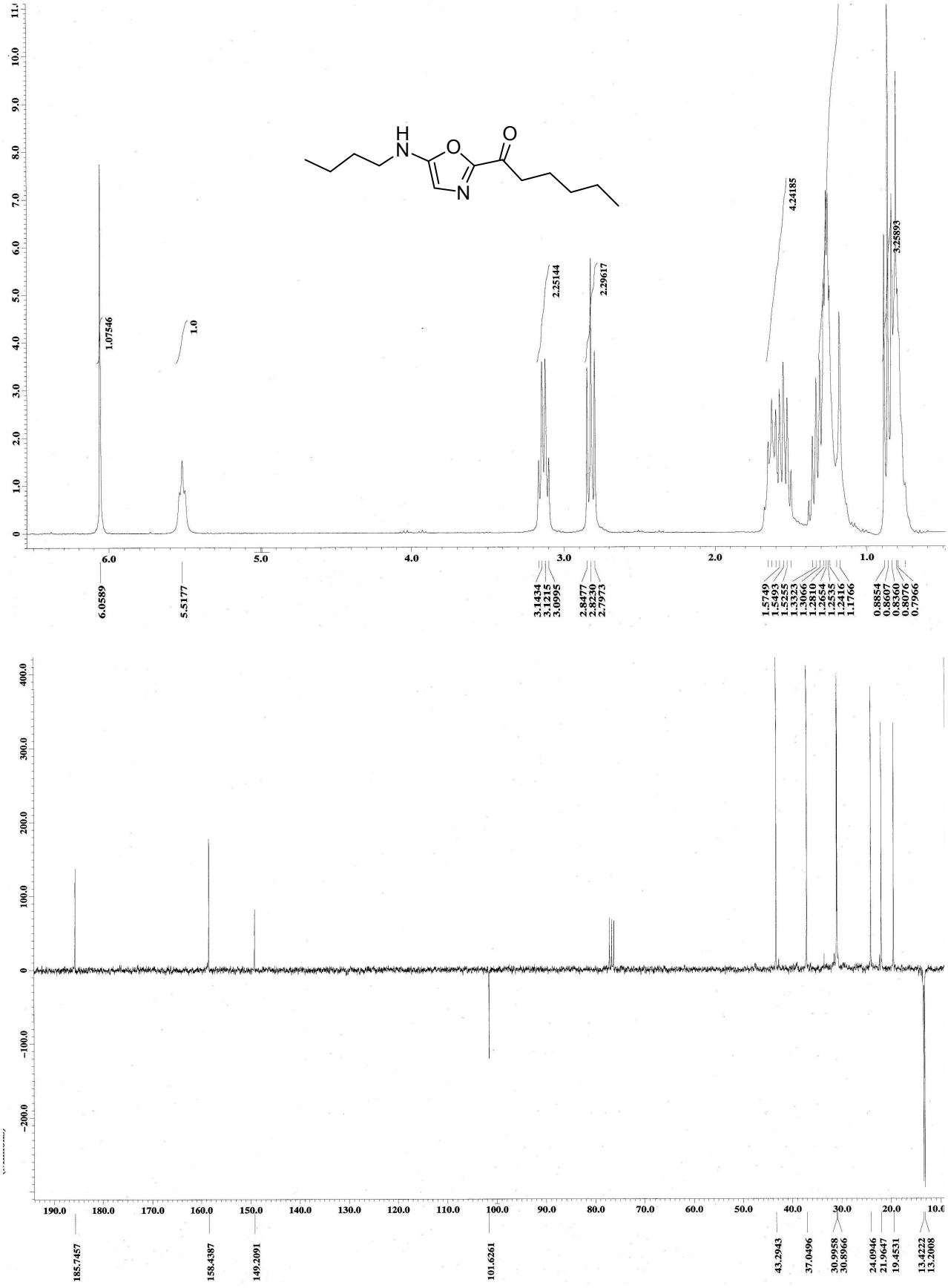

6.0
5.0
4.0
3.0
2.0
6.2920
5.3306
5.3113
5.2939
4.2107
4.1072
4.0102
4.0010
3.9900
3.9818
2.9901
2.9654
2.9407
2.9160
2.2952
2.2869
2.2787
2.1532
1.2788
1.2357
1.2110
1.1863
1.1616


190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
186.8831
156.6294
149.7969
103.3513
76.9375
76.5177
76.0901
72.1510
33.0952
30.6665
29.1656
13.5825
7.8417

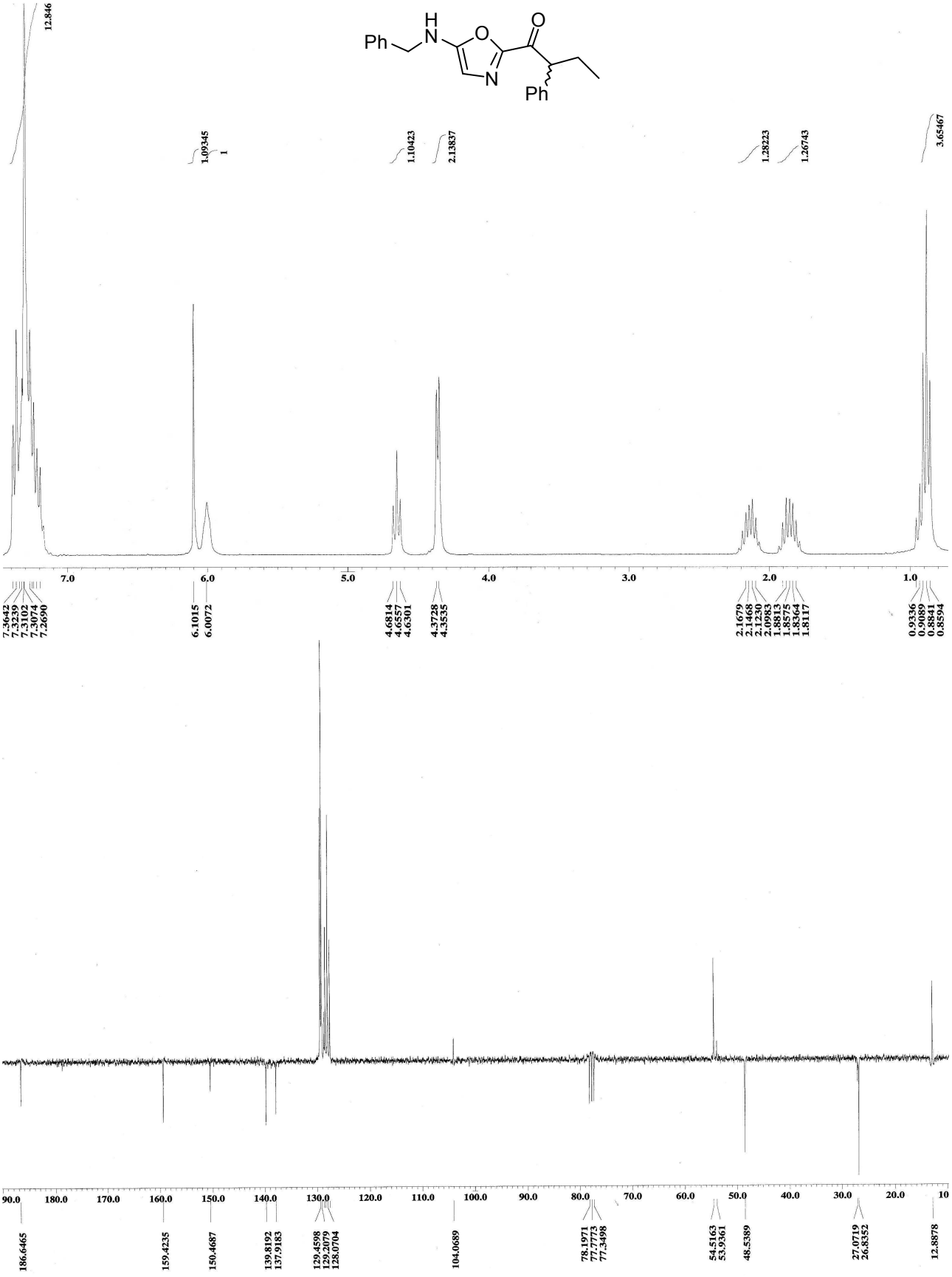
5k


H
N
O
O
N
6.0
5.0
4.0
3.0
2.0
1.0
6.0777
5.4267
5.4084
5.3901
3.1852
3.1623
3.1403
3.1183
2.8931
2.8684
2.8427
1.7412
1.7284
1.7073
1.7009
1.6881
1.6634
1.6377
1.5938
1.5700
1.5443
1.5297
1.5205
1.4674
1.3520
1.3273
1.1973
0.9089
0.8841
0.8594
0.8164
0.7907
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
185.7533
158.2478
149.1022
101.5115
76.9910
76.5711
76.1436
43.2103
39.2711
36.3473
31.9653
30.7973
30.4462
24.6137
19.3615
13.1245

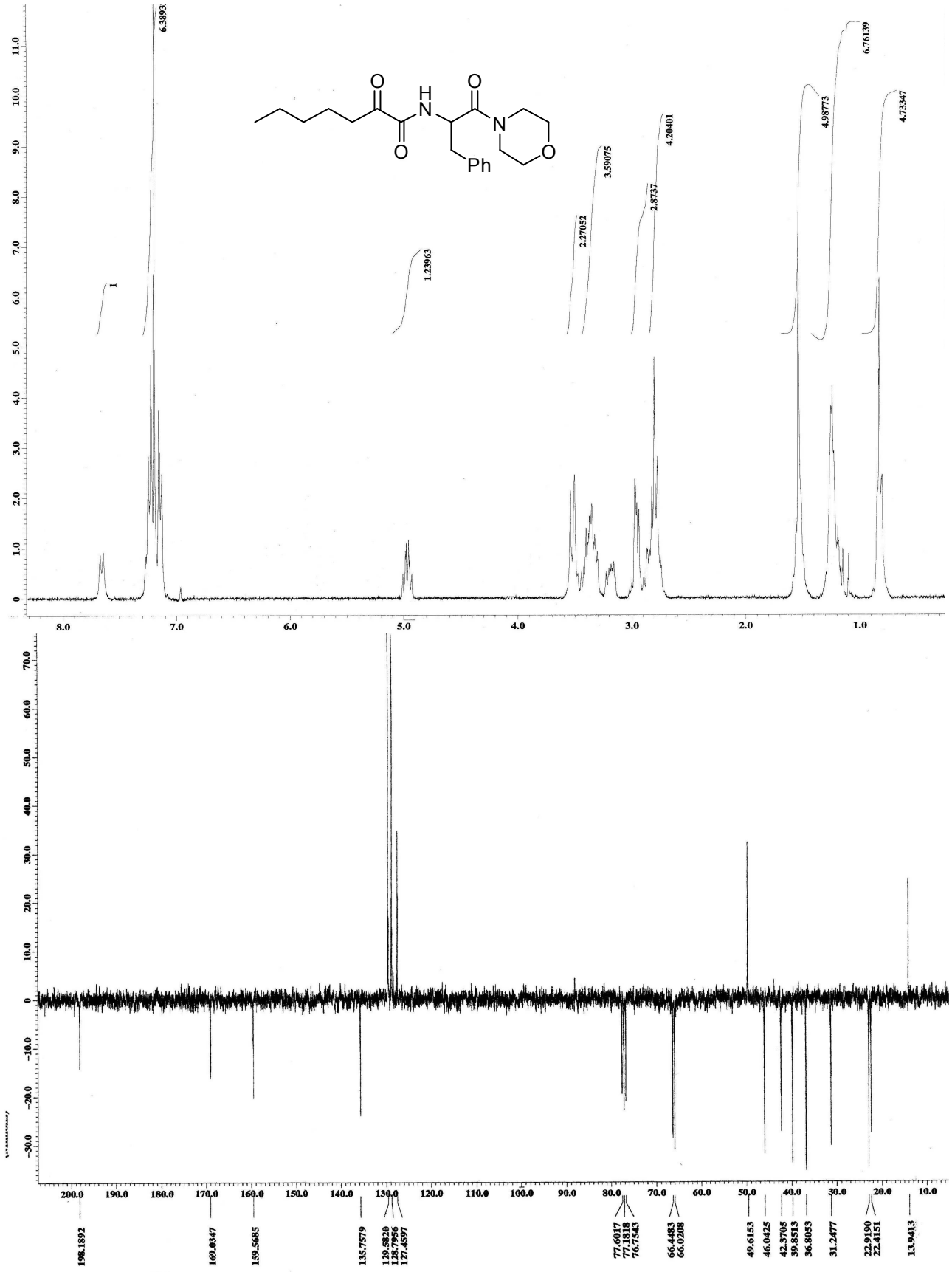
5l


H
N
O
O
N
4.24185
3.25893
2.25144
2.29617
1.07546
1.0
6.0589
5.5177
3.1434
3.1215
3.0995
2.8477
2.8230
2.7973
1.5749
1.5493
1.5255
1.3323
1.3066
1.2810
1.2654
1.2535
1.2416
1.1766
0.8854
0.8607
0.8360
0.8076
0.7966
185.7457
158.4387
149.2091
101.6261
43.2943
37.0496
30.9958
30.8966
24.0946
21.9647
19.4531
13.4222
13.2008

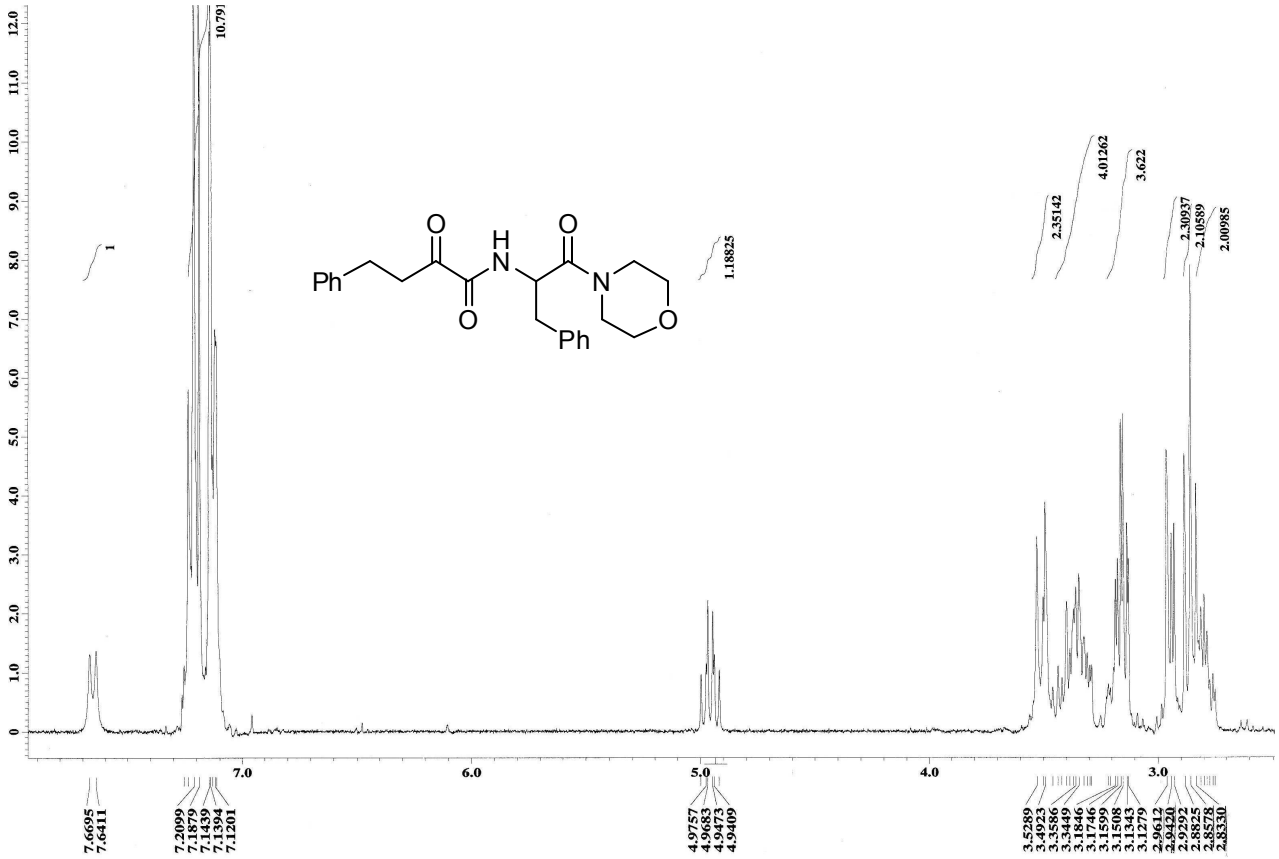
5m

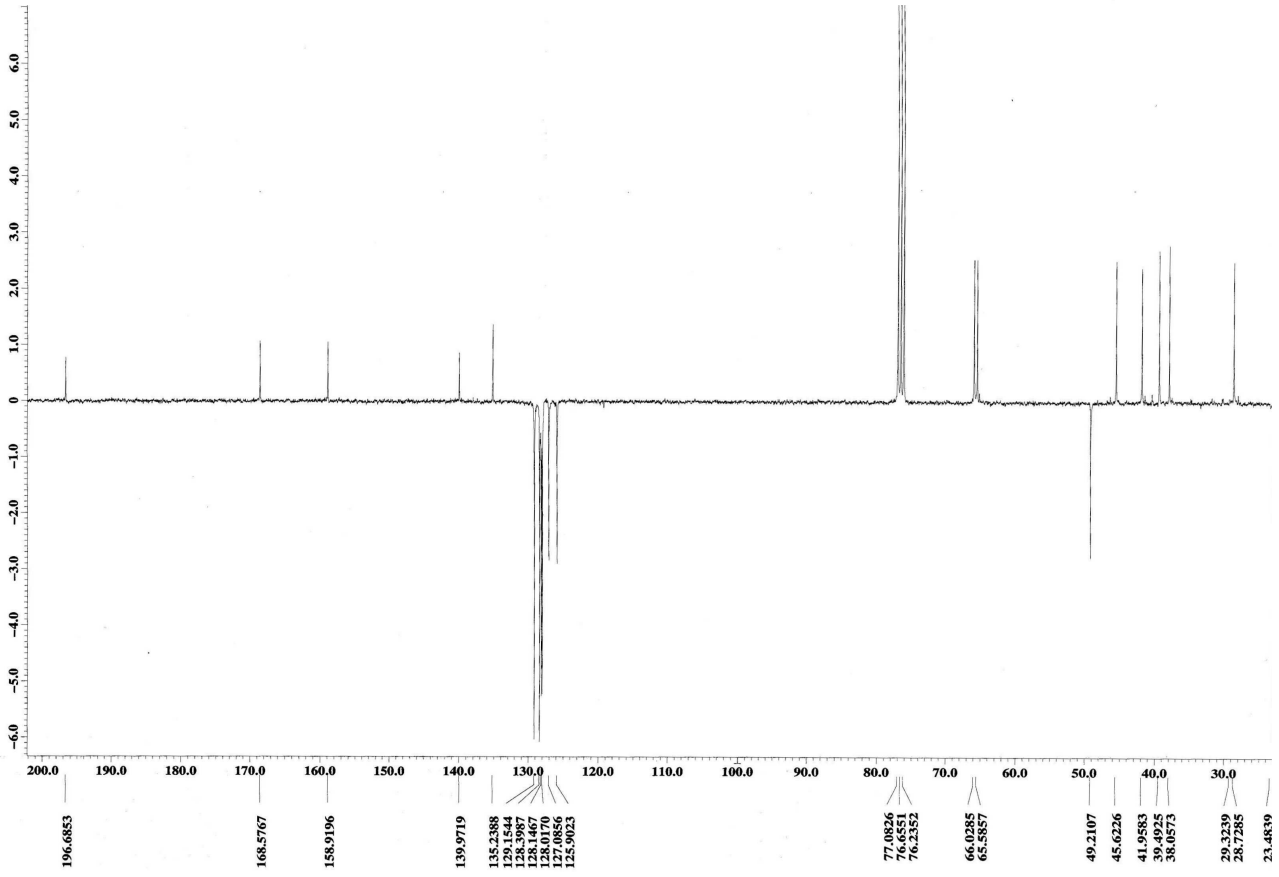

12.846
1.09345
1
1.10423
2.13837
1.28223
1.26743
3.65467
7.3642
7.3239
7.3192
7.3074
7.2690
6.1015
6.0072
4.6814
4.6557
4.6301
4.3728
4.3535
2.1679
2.1468
2.1230
2.0943
1.8813
1.8575
1.8364
1.8117
0.9336
0.9089
0.8841
0.8594
186.6465
159.4235
150.4687
139.8192
137.9183
129.4598
129.2079
128.0704
104.0689
78.1971
77.7773
77.3498
54.5163
53.9361
48.5389
27.0719
26.8352
12.8878

6a

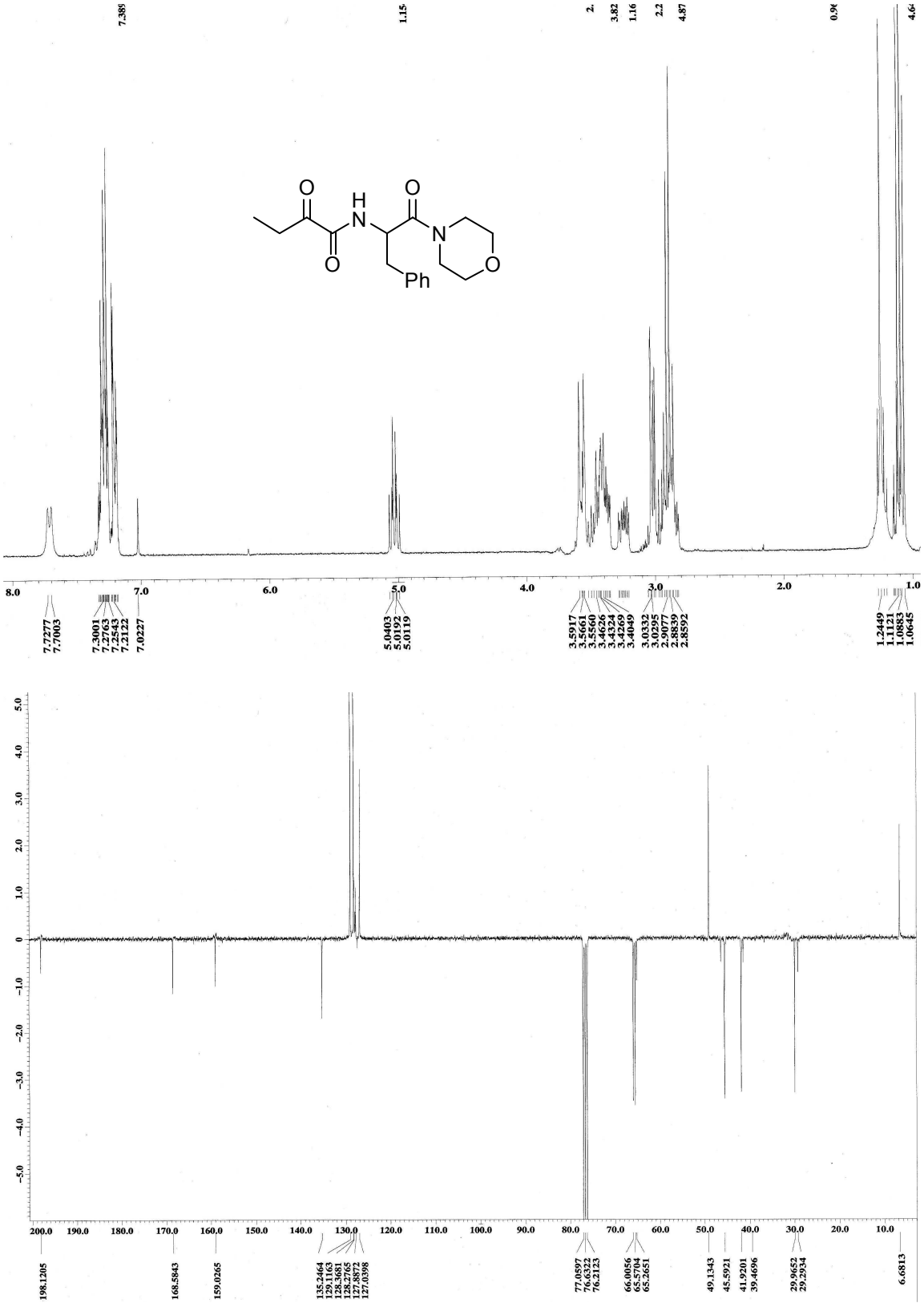

O
H
N
O
O
N
O
Ph
1
6.3893
1.23963
2.27052
3.59075
2.87337
4.20401
4.98773
6.76139
4.73347
198.1892
169.0347
159.5685
135.7579
129.5820
128.7956
127.4597
77.6017
77.1818
76.7543
66.4483
66.0208
49.6153
46.0425
42.3705
39.8513
36.8053
31.2477
22.9190
22.4151
13.9413

6b

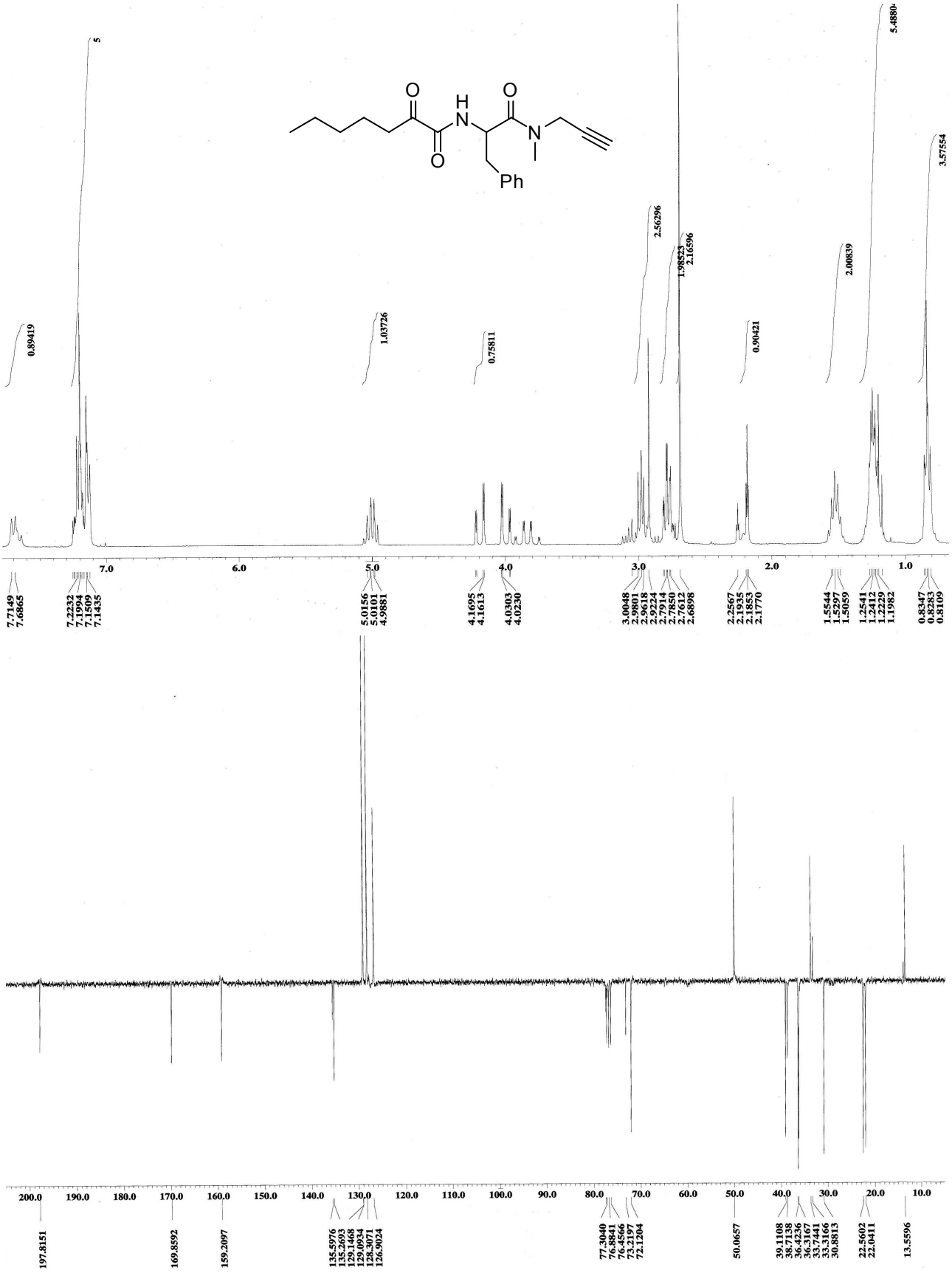

10.791
1
1.18825
2.35142
4.01262
3.622
2.30937
2.10589
2.00985
7.6695
7.6411
7.2099
7.1879
7.1439
7.1304
7.1201
4.9757
4.9683
4.9473
4.9409
3.5289
3.4923
3.3586
3.3449
3.1846
3.1746
3.1599
3.1508
3.1343
3.1279
2.9612
2.9391
2.8825
2.8578
2.8330


196.6853
168.5767
158.9196
139.9719
135.2388
129.1544
128.3987
128.1467
128.0170
127.0856
125.9023
77.0826
76.6551
76.2352
66.0285
65.5857
49.2107
45.6226
41.9583
39.4925
38.0573
29.3239
28.7285
23.4839

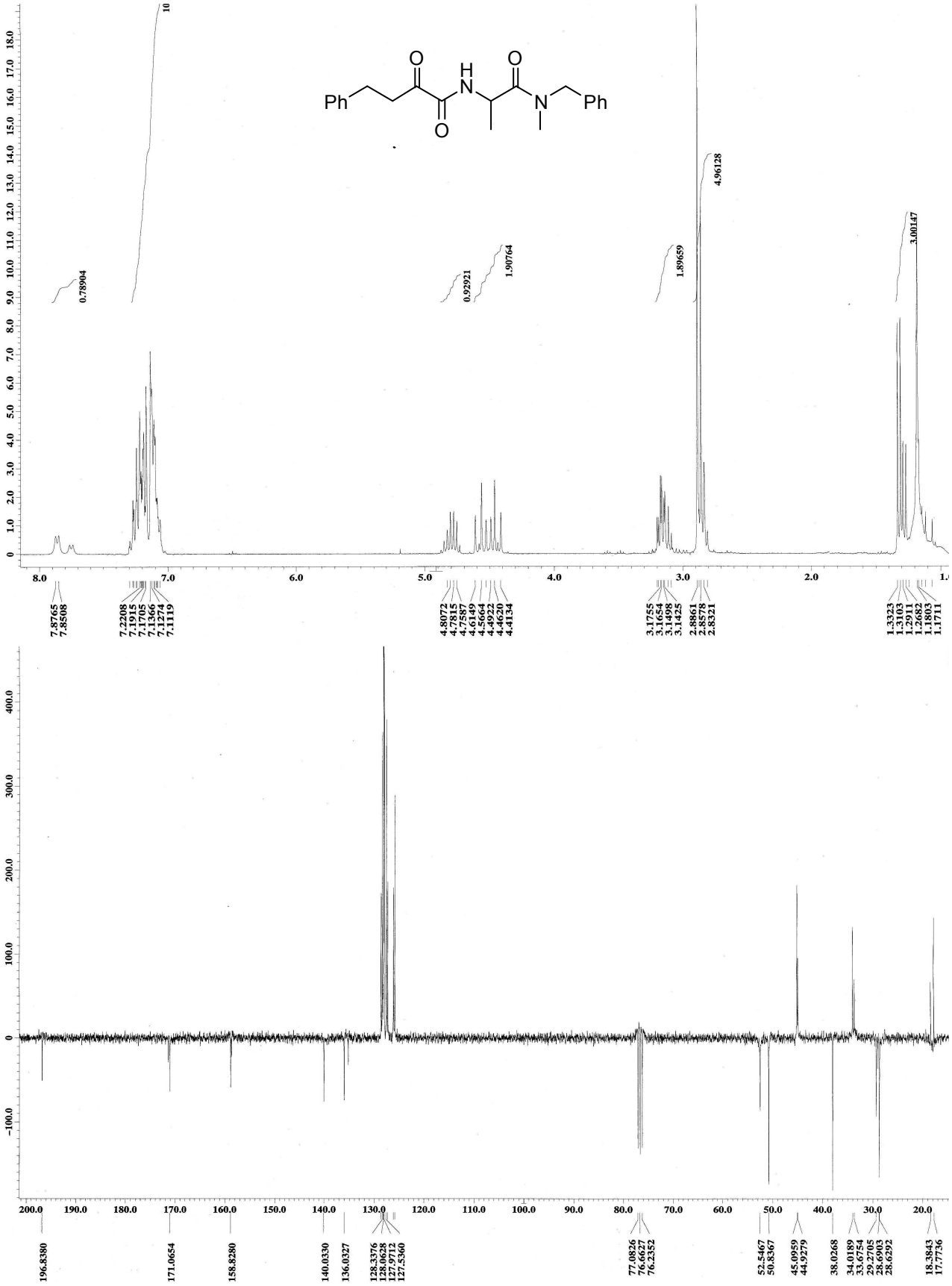
6c


7.388
1.15
2.
3.82
1.16
2.2
4.87
0.94
4.64
O
H
N
O
O
N
O
Ph
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.7277
7.7003
7.3001
7.2763
7.2543
7.2122
7.0227
5.0403
5.0192
5.0119
3.5917
3.5661
3.5560
3.4626
3.4524
3.4264
3.4049
3.0332
3.0295
2.9077
2.8839
2.8592
1.2449
1.1121
1.0883
1.0645
198.1205
168.5843
159.0265
135.2464
129.1163
128.3681
128.2765
127.3872
127.0398
77.0897
76.6322
76.2123
66.0056
65.5704
65.2651
49.1343
45.5921
41.9201
39.4696
29.9652
29.2934
6.6813

6d

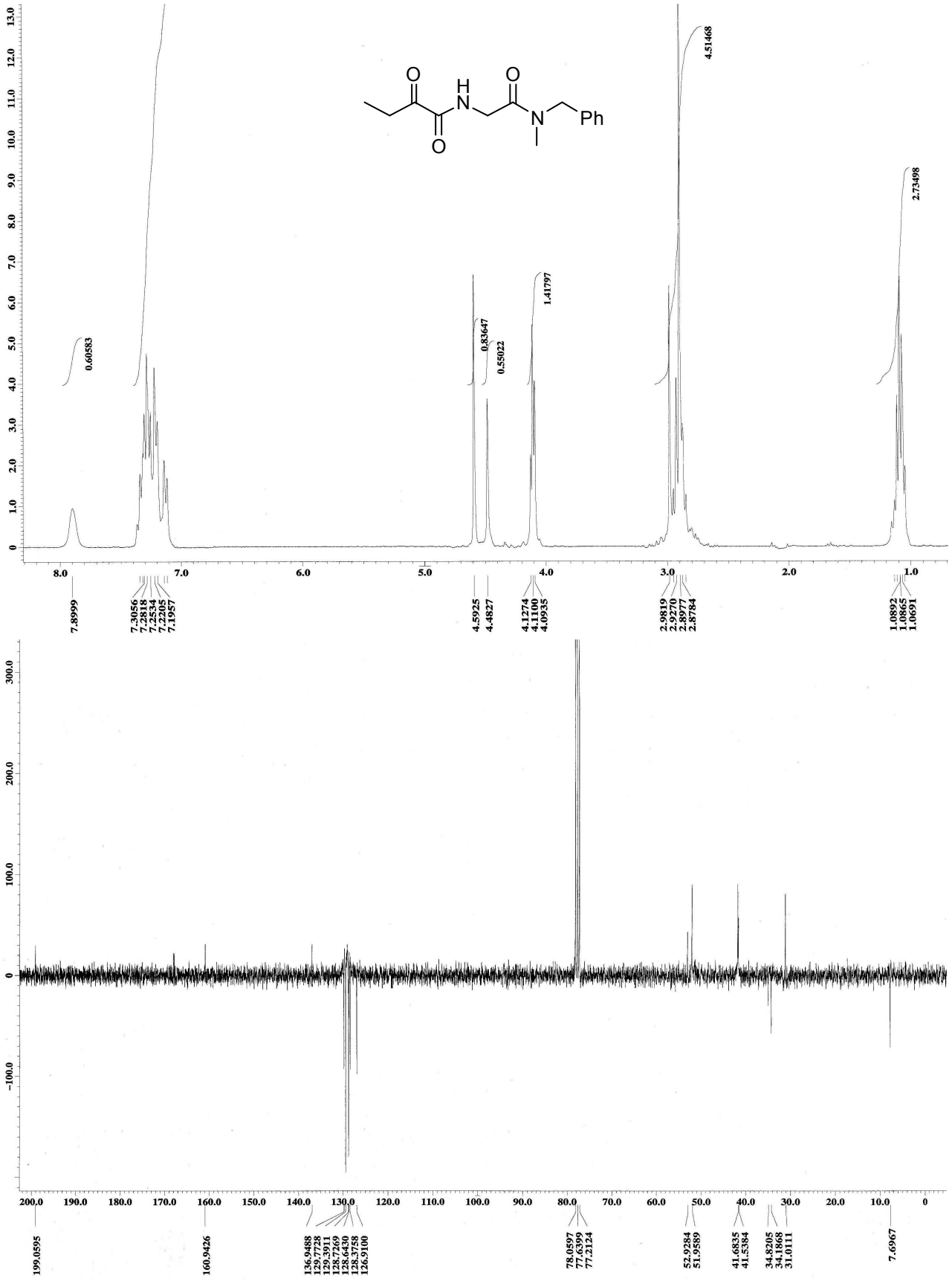

O
H
N
O
N
O
Ph
0.89419
1.03726
0.75811
2.56296
1.98523
2.16596
0.90421
2.00839
5.48804
3.57554
7.7149
7.6865
7.2232
7.1994
7.1509
7.1435
5.0156
5.0101
4.9881
4.1695
4.1613
4.0303
4.0230
3.0048
2.9801
2.9613
2.9224
2.7914
2.7850
2.7612
2.6898
2.2567
2.1935
2.1853
2.1770
1.5544
1.5297
1.5059
1.2541
1.2412
1.2230
1.1982
0.8347
0.8283
0.8109
197.8151
169.8592
159.2097
135.5976
135.2693
129.1468
129.0934
128.3071
126.9024
77.3040
76.8841
76.4566
73.2197
72.1204
50.0657
39.1108
38.7138
36.4236
36.3167
33.7441
33.3166
30.8813
22.5602
22.0411
13.5596

6e

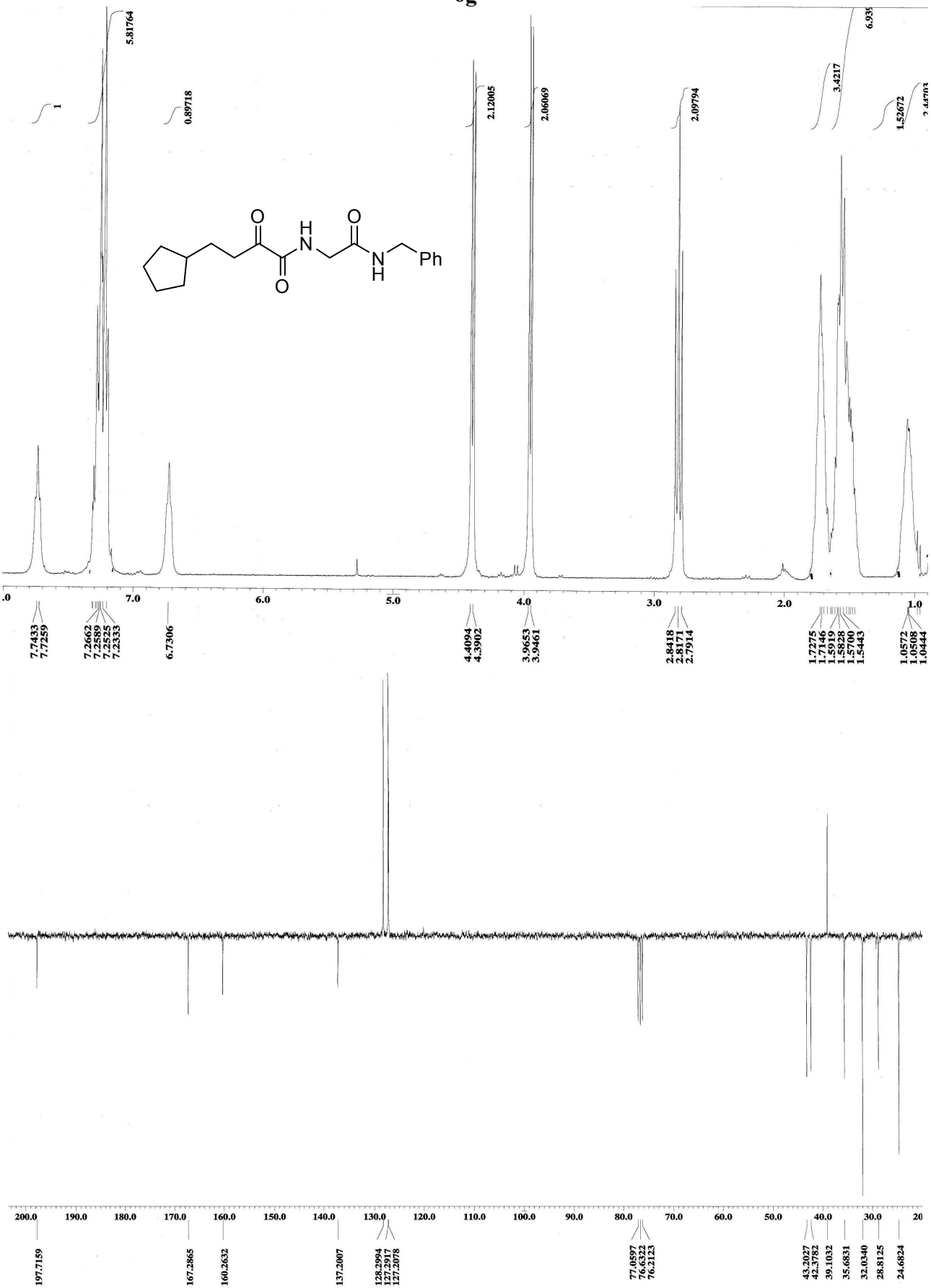

Ph
O
H
N
O
O
N
Ph
10
0.78904
0.92921
1.90764
1.89659
4.96128
3.00147
7.8765
7.8508
7.2208
7.1915
7.1705
7.1365
7.1274
7.1119
4.8072
4.7815
4.7587
4.6149
4.5664
4.4922
4.4620
4.4134
3.1755
3.1654
3.1498
3.1425
2.8861
2.8578
2.8321
1.3323
1.3103
1.2911
1.2682
1.1803
1.1711

196.8380
171.0654
158.8280
140.0330
136.0327
128.3376
128.0628
127.9472
127.5360
77.0826
76.6627
76.2352
52.5467
50.8367
45.0959
44.9279
38.0268
34.0189
33.6754
29.2705
28.6903
28.6292
18.3843
17.7736

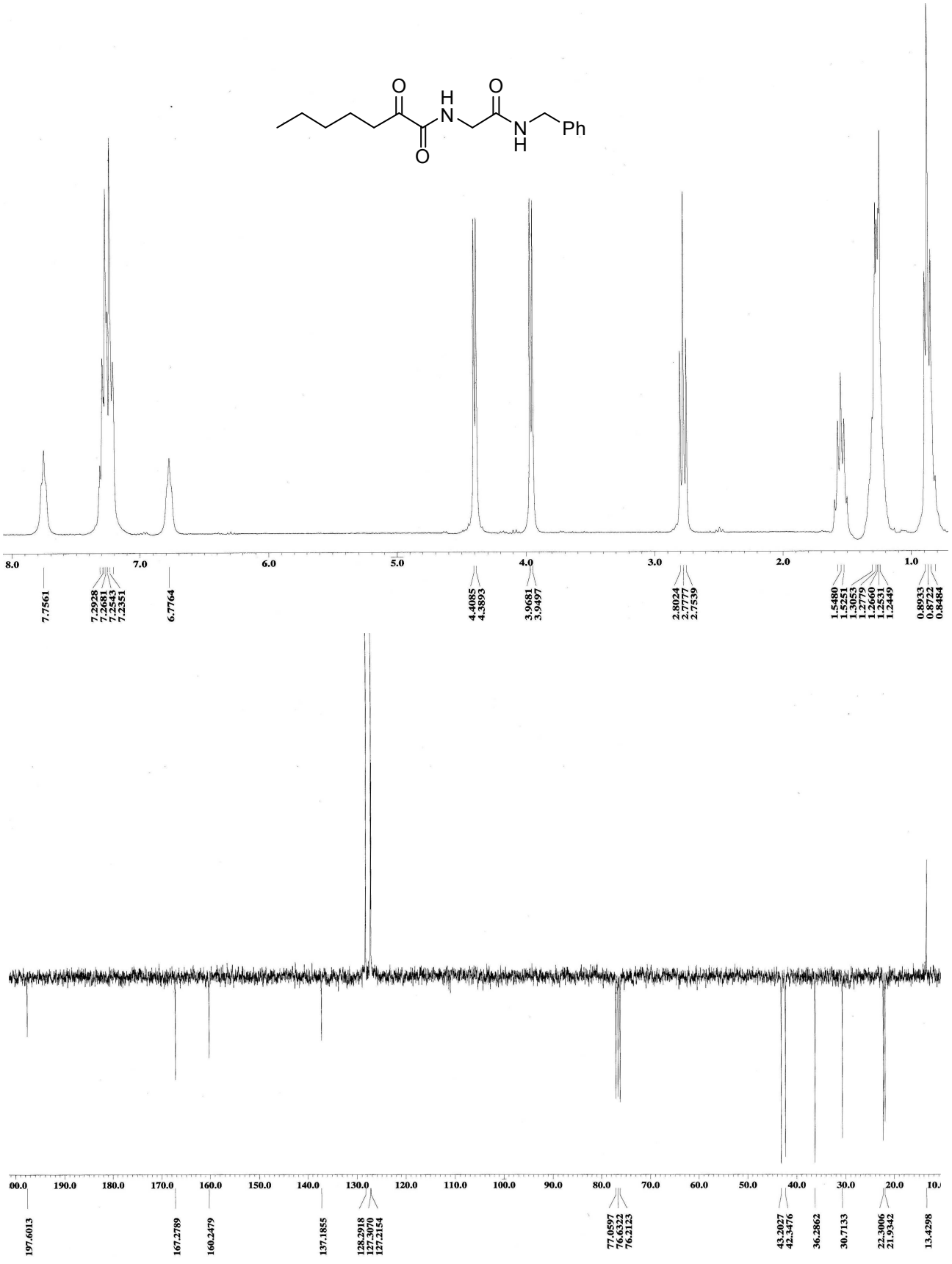
6f


O
H
N
O
O
N
Ph
4.51468
2.73498
1.41797
0.83647
0.55022
0.60583
7.8999
7.3056
7.2818
7.2534
7.2205
7.1957
4.5925
4.4827
4.1274
4.1100
4.0935
2.9819
2.9271
2.8977
2.8784
1.0892
1.0865
1.0691
199.0595
160.9426
136.9488
129.7728
129.3911
128.7269
128.6430
128.3758
126.9100
78.0597
77.6399
77.2124
52.9284
51.9589
41.6835
41.5384
34.8205
34.1868
31.0111
7.6967

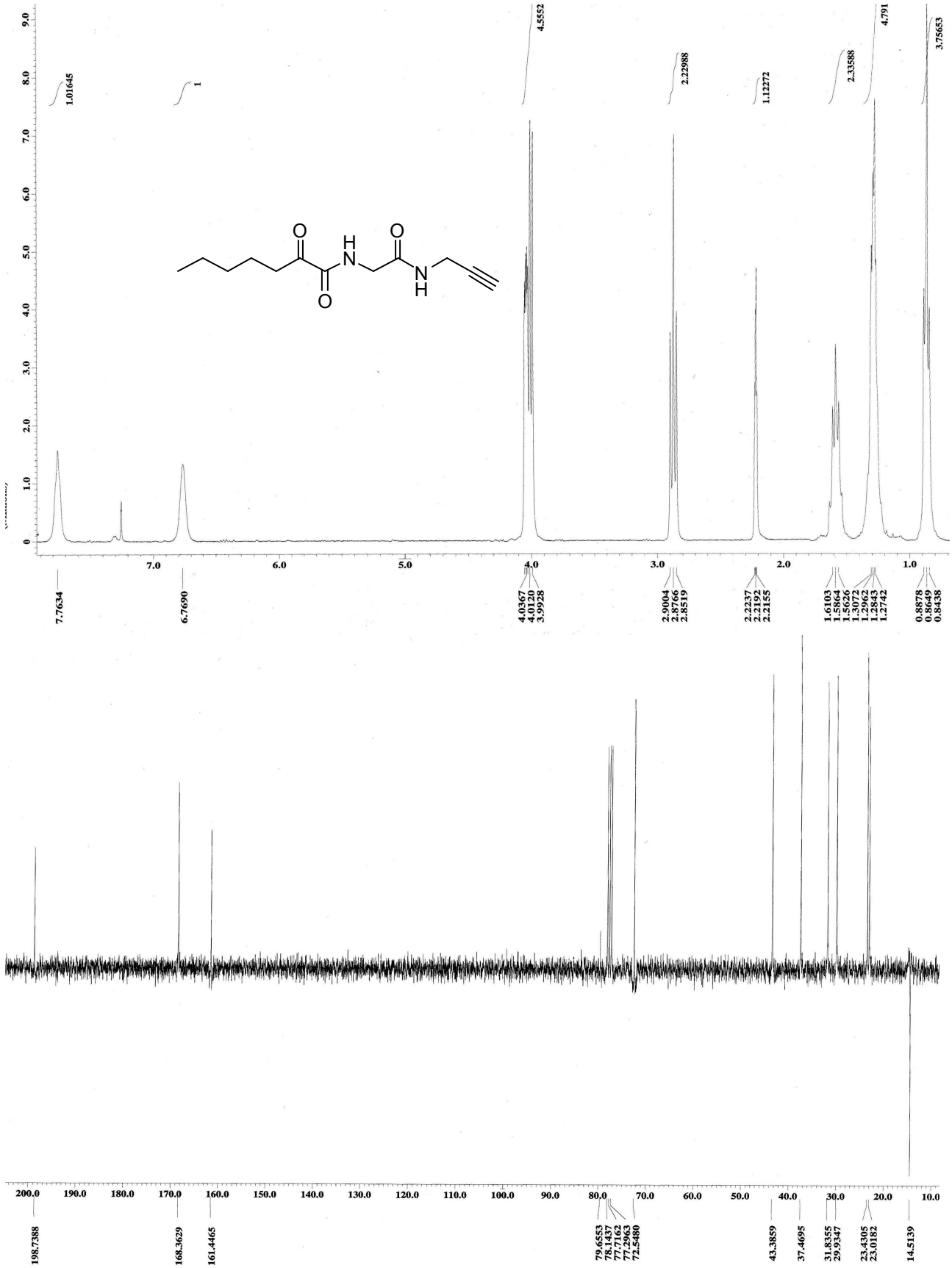
6g


5.81764
0.89718
2.12005
2.06069
2.09794
3.4217
1.52672
7.7433
7.7259
7.2662
7.2589
7.2525
7.2333
6.7306
4.4094
4.3902
3.9653
3.9461
2.8418
2.8171
2.7914
1.7275
1.7146
1.5919
1.5828
1.5700
1.5443
1.0572
1.0508
1.0444
197.7159
167.2865
160.2632
137.2007
128.2994
127.2917
127.2078
77.0597
76.6322
76.2123
43.2027
42.3782
39.1032
35.6831
32.0340
28.8125
24.6824

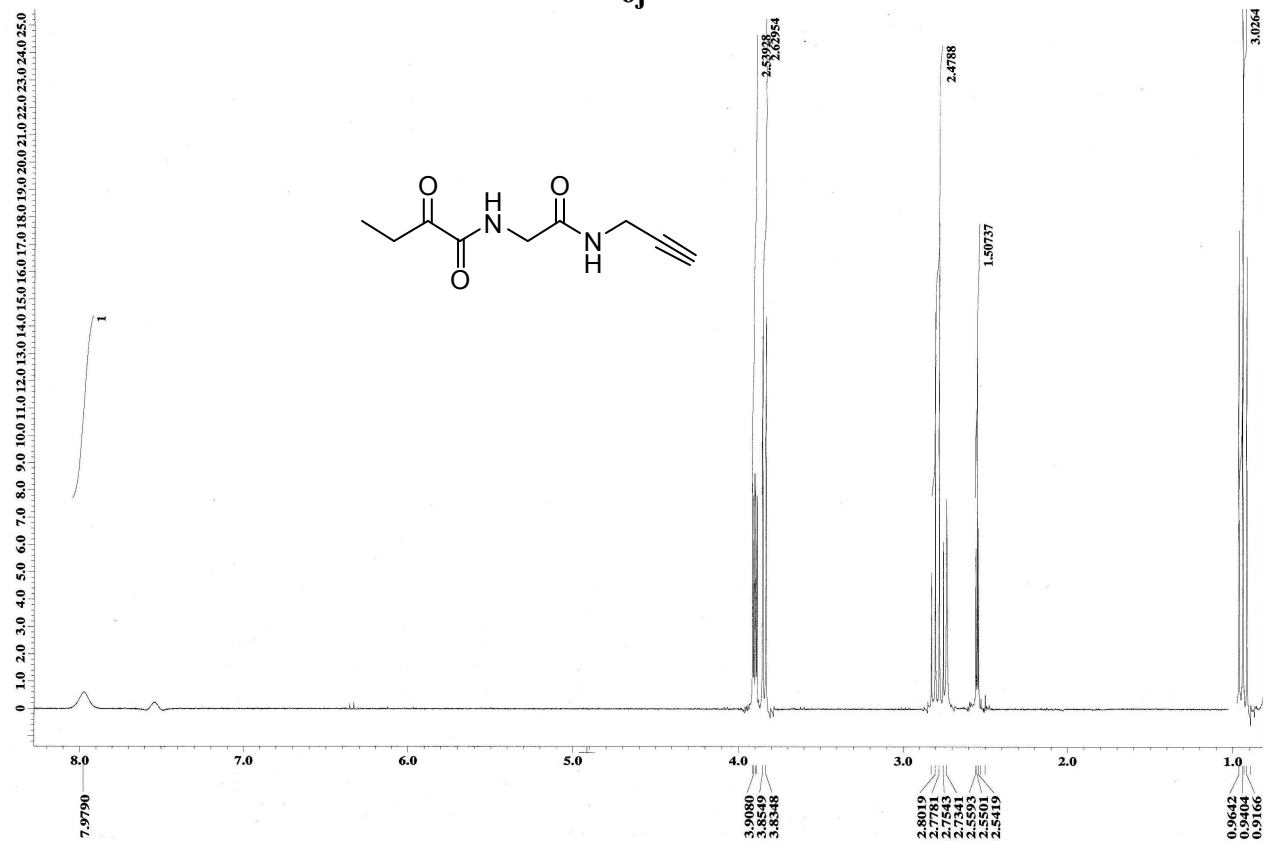
6h

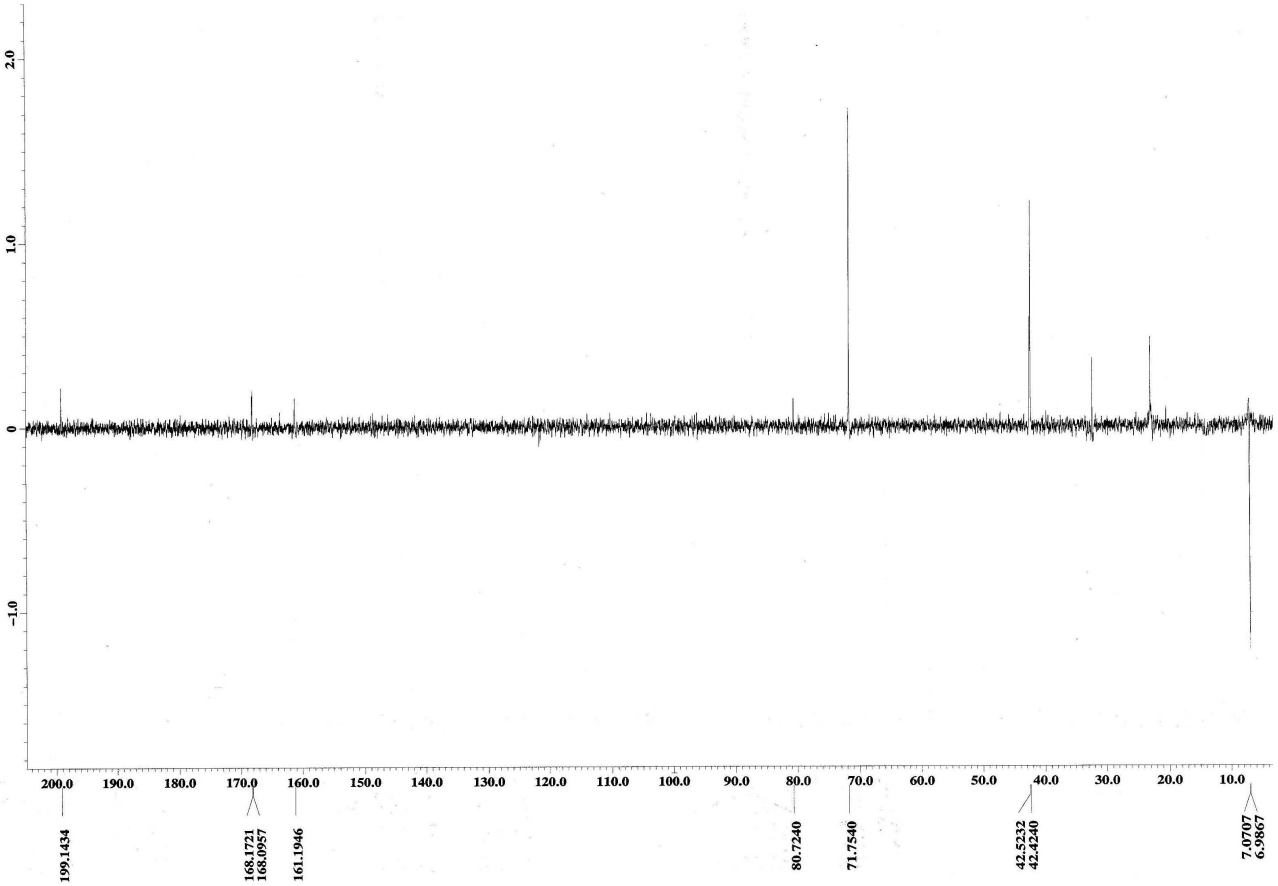

O
H
N
O
N
H
Ph
O
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.7561
7.2928
7.2681
7.2543
7.2351
6.7764
4.4085
4.3893
3.9681
3.9497
2.8024
2.7777
2.7539
1.5480
1.5251
1.3053
1.2779
1.2660
1.2531
1.2449
0.8933
0.8722
0.8484
197.6013
167.2789
160.2479
137.1855
128.2918
127.3070
127.2154
77.0597
76.6322
76.2123
43.2027
42.3476
36.2862
30.7133
22.3006
21.9342
13.4298

6i

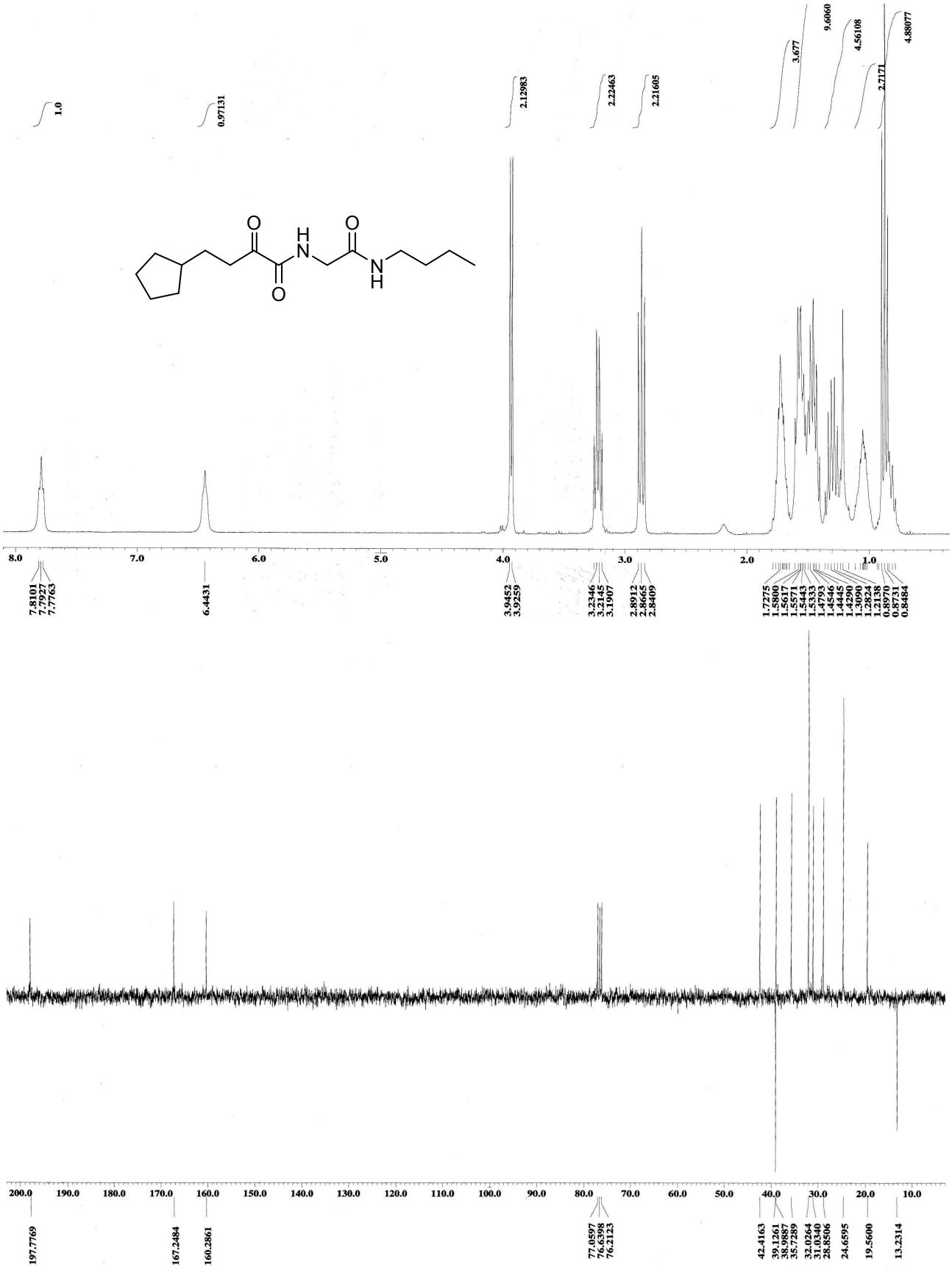

1.01645
1
4.5552
2.22988
1.12272
2.33588
4.791
3.75653
7.7634
6.7690
4.0367
4.0120
3.9928
2.9004
2.8766
2.8519
2.2237
2.2192
2.2155
1.6103
1.5864
1.5626
1.3072
1.2962
1.2843
1.2742
0.8878
0.8649
0.8438
198.7388
168.3629
161.4465
79.6553
78.1437
77.7162
77.2963
72.5480
43.3859
37.4695
31.8355
29.9347
23.4305
23.0182
14.5139

6j

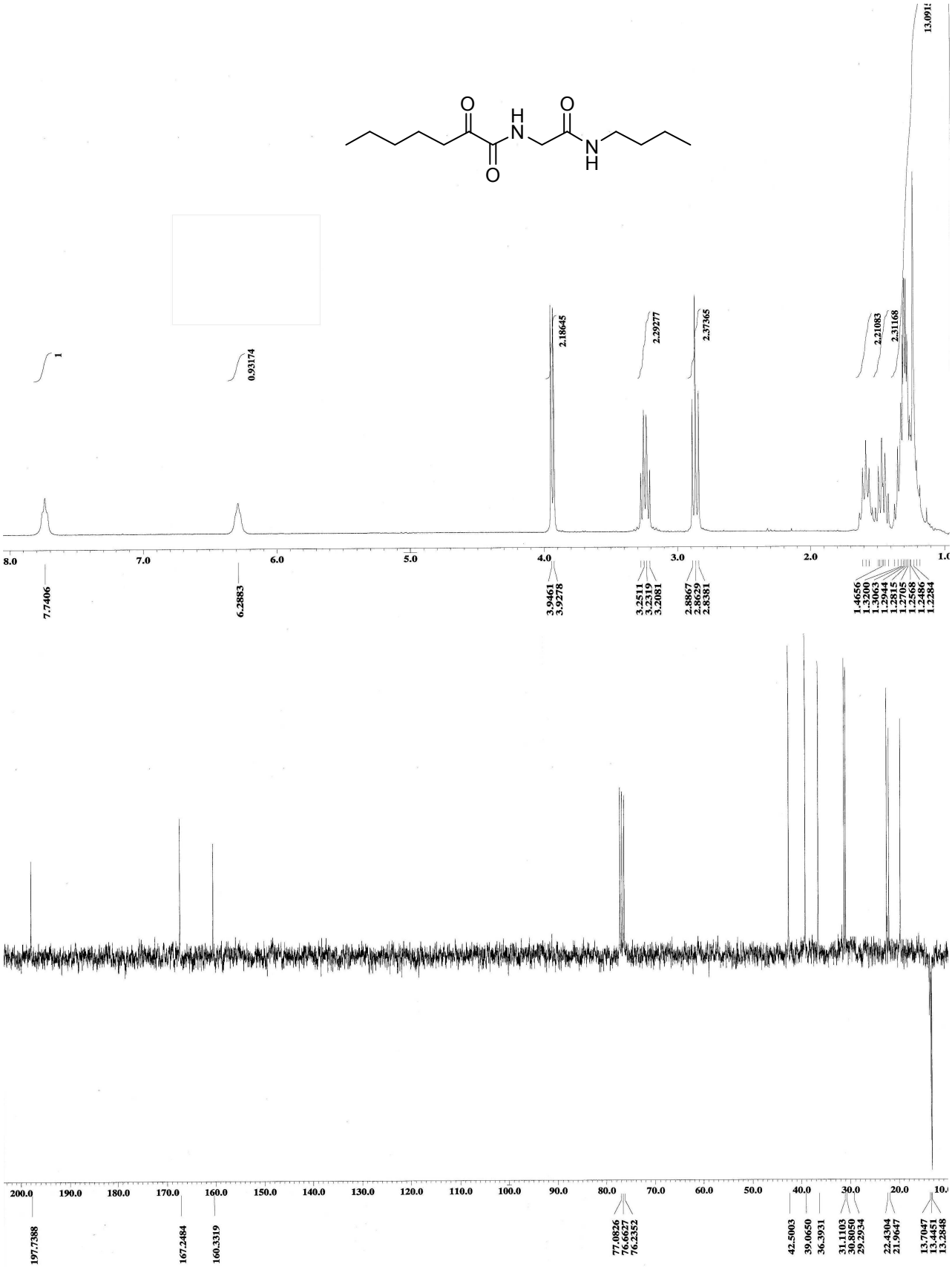

O
H
N
O
O
N
H
2.53935
2.52954
2.4788
1.50737
3.0264
1
7.9790
3.9080
3.8549
3.8348
2.8019
2.7781
2.7543
2.7341
2.5593
2.5501
2.5419
0.9642
0.9404
0.9166


199.1434
168.1721
168.0957
161.1946
80.7240
71.7540
42.5232
42.4240
7.0707
6.9867

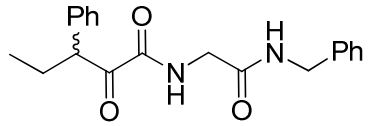
6k

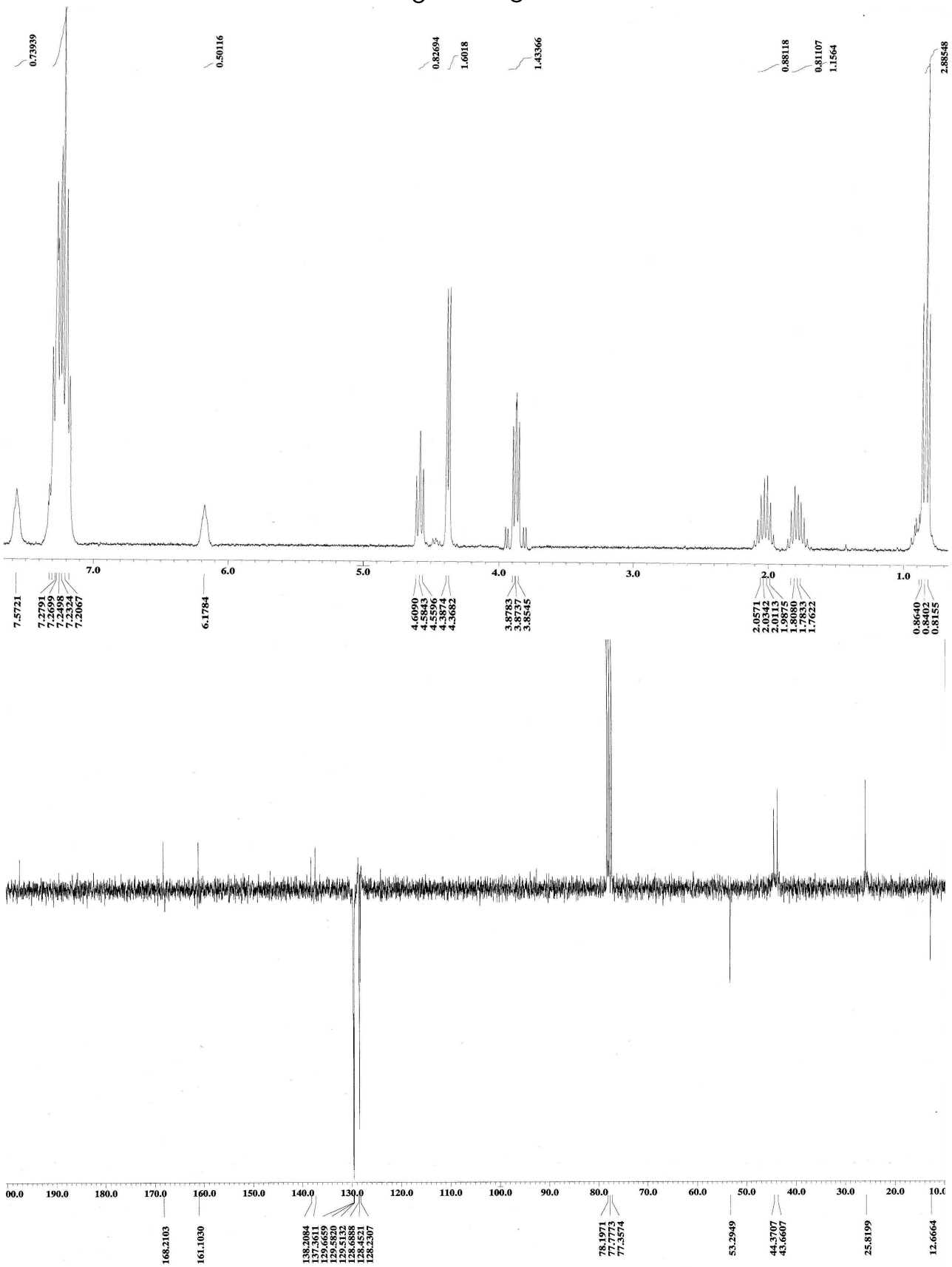

1.0
0.97131
2.12983
2.22463
2.21605
3.677
9.6060
4.56108
2.7171
4.88077
O
H
N
O
O
N
H
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.8101
7.7927
7.7763
6.4431
3.9452
3.9259
3.2346
3.2145
3.1907
2.8912
2.8665
2.8409
1.7275
1.5800
1.5617
1.5571
1.5443
1.5333
1.4793
1.4546
1.4445
1.4090
1.3090
1.2824
1.2138
0.8970
0.8731
0.8484
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
197.7769
167.2484
160.2861
77.0597
76.6398
76.2123
42.4163
39.1261
38.9887
35.7289
32.0264
31.0340
28.8506
24.6595
19.5600
13.2314

6l


1
0.93174
2.18645
2.29277
2.37365
2.21083
2.31168
7.7406
6.2883
3.9461
3.9278
3.2511
3.2319
3.2081
2.8867
2.8629
2.8381
1.4656
1.3200
1.3063
1.2904
1.2815
1.2705
1.2568
1.2486
1.2284
197.7388
167.2484
160.3319
77.0826
76.6627
76.2352
42.5003
39.0650
36.3931
31.1103
30.8050
29.2934
22.4304
21.9647
13.7047
13.4451
13.2848

6m


Ph
O
H
N
Ph
N
H
O
O


0.73939
0.50116
0.82694
1.6018
1.43366
0.88118
0.81107
1.1564
2.88548
7.0
6.0
5.0
4.0
3.0
2.0
1.0
7.5721
7.2791
7.2699
7.2498
7.2324
7.2067
6.1784
4.6090
4.5843
4.5596
4.3874
4.3682
3.8783
3.8737
3.8545
2.0571
2.0342
2.0113
1.9875
1.8080
1.7833
1.7622
0.8640
0.8402
0.8155
168.2103
161.1030
138.2084
137.3611
129.6629
129.5703
129.5133
128.6888
128.4521
128.2307
78.1971
77.7773
77.3574
53.2949
44.3707
43.6607
25.8199
12.6664

7

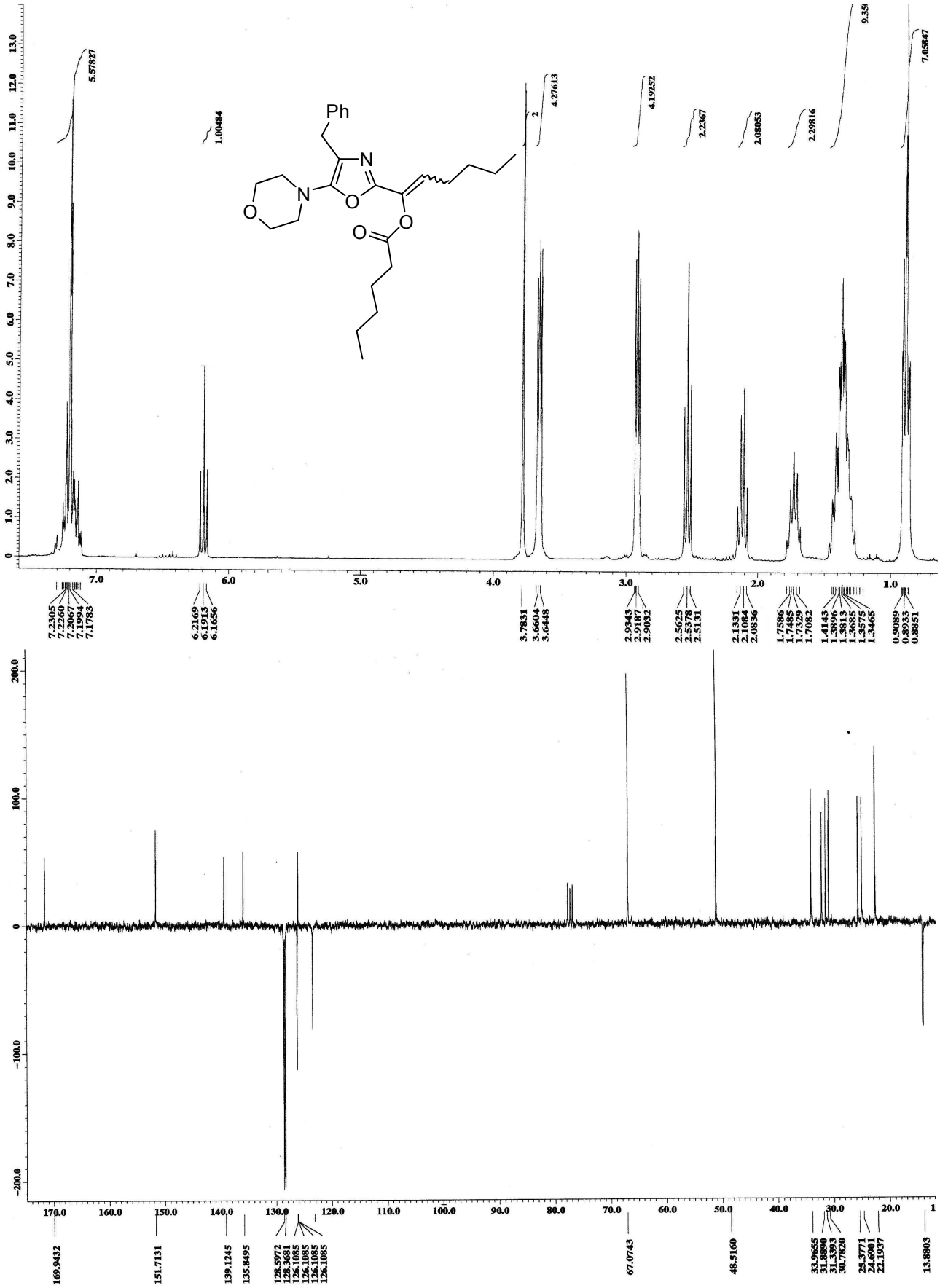

Ph
N
O
N
O
O
O
5.57827
1.00484
2
4.27613
4.19252
2.2367
2.08053
2.29816
7.05847
7.2305
7.2260
7.2067
7.1994
7.1783
6.2169
6.1913
6.1656
3.7831
3.6604
3.6448
2.9343
2.9187
2.9032
2.5625
2.5378
2.5131
2.1331
2.1084
2.0836
1.7586
1.7485
1.7329
1.7082
1.4143
1.3896
1.3813
1.3685
1.3575
1.3465
0.9089
0.8933
0.8851
169.9432
151.7131
139.1245
135.8495
128.5972
128.3681
126.1085
126.1085
126.1085
126.1085
67.0743
48.5160
33.9655
31.8890
31.3393
30.7820
25.3771
24.0901
22.1957
13.8803

Table of elemental analyses for all target compounds

Compound	Formula	Calculated			Obtained		
		% C	%H	%N	%C	%H	%N
6a	$C_{20}H_{28}N_2O_4$	66,64	7,83	7,77	66,70	7,91	7,68
6b	$C_{23}H_{26}N_2O_4$	70,03	6,64	7,10	69,88	6,49	7,38
6c	$C_{17}H_{22}N_2O_4$	64,13	6,96	8,80	64,25	7,05	8,93
6d	$C_{20}H_{26}N_2O_3$	70,15	7,65	8,18	70,23	7,48	8,25
6e	$C_{21}H_{24}N_2O_3$	71,57	6,86	7,95	71,68	6,91	8,05
6f	$C_{14}H_{18}N_2O_3$	64,10	6,92	10,68	64,45	7,02	10,79
6g	$C_{18}H_{24}N_2O_3$	68,33	7,64	8,85	68,51	7,73	8,99
6h	$C_{16}H_{22}N_2O_3$	66,18	7,64	9,65	66,25	7,81	9,78
6i	$C_{12}H_{18}N_2O_3$	60,49	7,61	11,76	60,31	7,58	11,58
6j	$C_9H_{12}N_2O_3$	55,09	6,16	14,28	54,98	6,02	13,98
6k	$C_{15}H_{26}N_2O_3$	63,80	9,28	9,92	63,94	9,52	9,81
6l	$C_{13}H_{24}N_2O_3$	60,91	9,44	10,93	60,88	9,41	10,88
6m	$C_{20}H_{22}N_2O_3$	70,98	6,55	8,28	70,75	6,38	8,10