


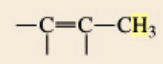

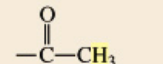

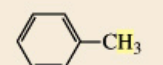

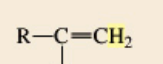
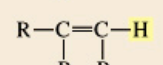



**TABLE 13.1 Approximate Values of Chemical Shifts for  $^1\text{H}$  NMR<sup>a</sup>**

Type of proton	Approximate chemical shift (ppm)	Type of proton	Approximate chemical shift (ppm)
$(\text{CH}_3)_4\text{Si}$	0		6.5–8
$-\text{CH}_3$	0.9		9.0–10
$-\text{CH}_2-$	1.3		2.5–4
	1.7		2.5–4
	2.1		3–4
	2.3		4–4.5
$-\text{C}\equiv\text{C}-\text{H}$	2.4	$\text{RNH}_2$	variable, 1.5–4
$\text{R}-\text{O}-\text{CH}_3$	3.3	$\text{ROH}$	variable, 2–5
	4.7	$\text{ArOH}$	variable, 4–7
	5.3		variable, 10–12

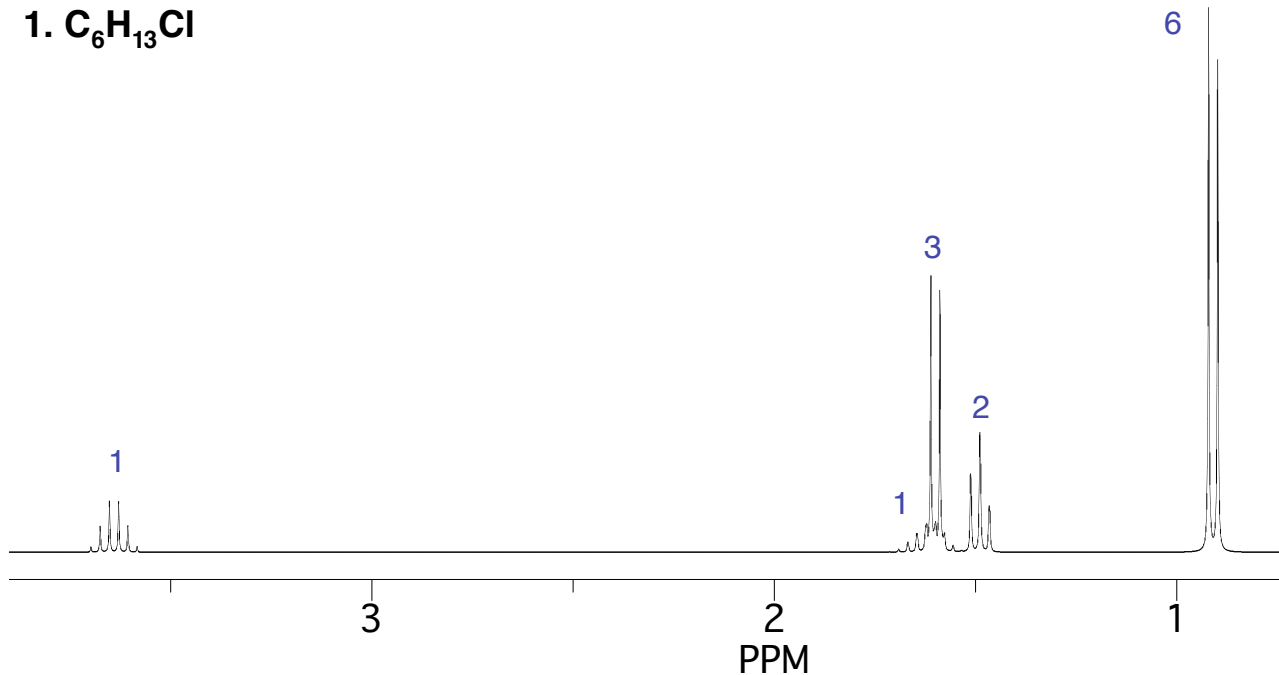
<sup>a</sup>The values are approximate because they are affected by neighboring substituents.

### Table of IR Absorptions

Functional Group	Characteristic Absorption(s) ( $\text{cm}^{-1}$ )
Alkyl C-H Stretch	2950 - 2850 (m or s)
Alkenyl C-H Stretch	3100 - 3010 (m)
Alkenyl C=C Stretch	1680 - 1620 (v)
Alkynyl C-H Stretch	~3300 (s)
Alkynyl C=C Stretch	2260 - 2100 (v)
Aromatic C-H Stretch	~3030 (v)
Aromatic C-H Bending	860 - 680 (s)
Aromatic C=C Bending	1700 - 1500 (m,m)
Alcohol/Phenol O-H Stretch	3550 - 3200 (broad, s)
Carboxylic Acid O-H Stretch	3000 - 2500 (broad, v)
Amine N-H Stretch	3500 - 3300 (m)
Nitrile C $\equiv$ N Stretch	2260 - 2220 (m)
Aldehyde C=O Stretch	1740 - 1690 (s)
Ketone C=O Stretch	1750 - 1680 (s)
Ester C=O Stretch	1750 - 1735 (s)
Carboxylic Acid C=O Stretch	1780 - 1710 (s)
Amide C=O Stretch	1690 - 1630 (s)
Amide N-H Stretch	3700 - 3500 (m)

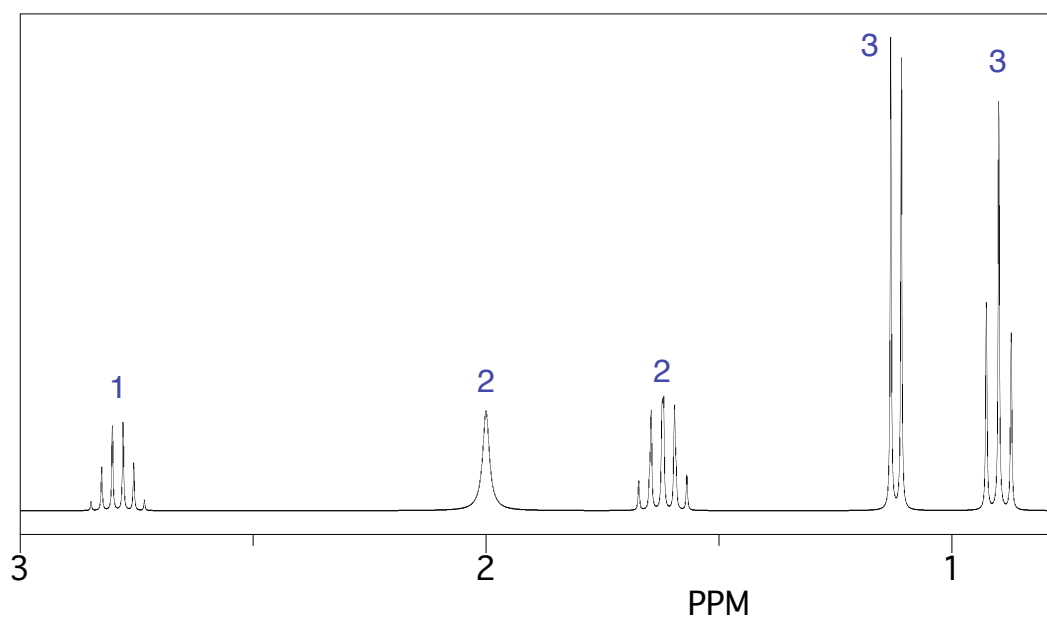
Determine the structures of the molecules with the following spectra:

1.  $C_6H_{13}Cl$



$^1H$  NMR: 0.91 ppm (d, 6H); 1.49 ppm (t, 2H); 1.60 ppm (d, 3H); 1.62 ppm (multiplet, 1H); 3.64 ppm (sextet, 1H);

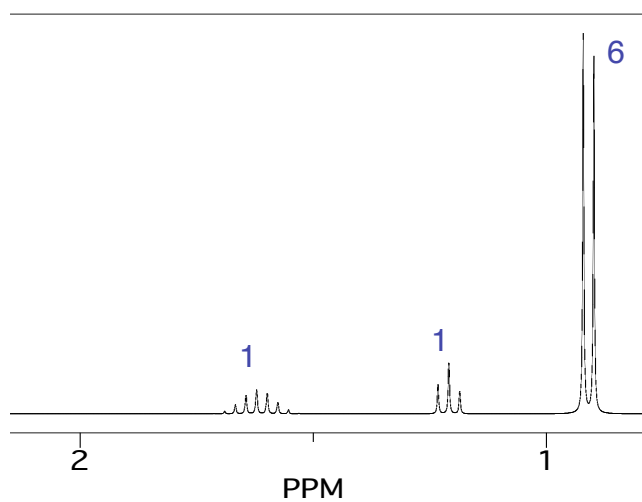
2.  $C_4H_{11}N$



IR : 3310  $cm^{-1}$  (weak), 3340  $cm^{-1}$  (weak)

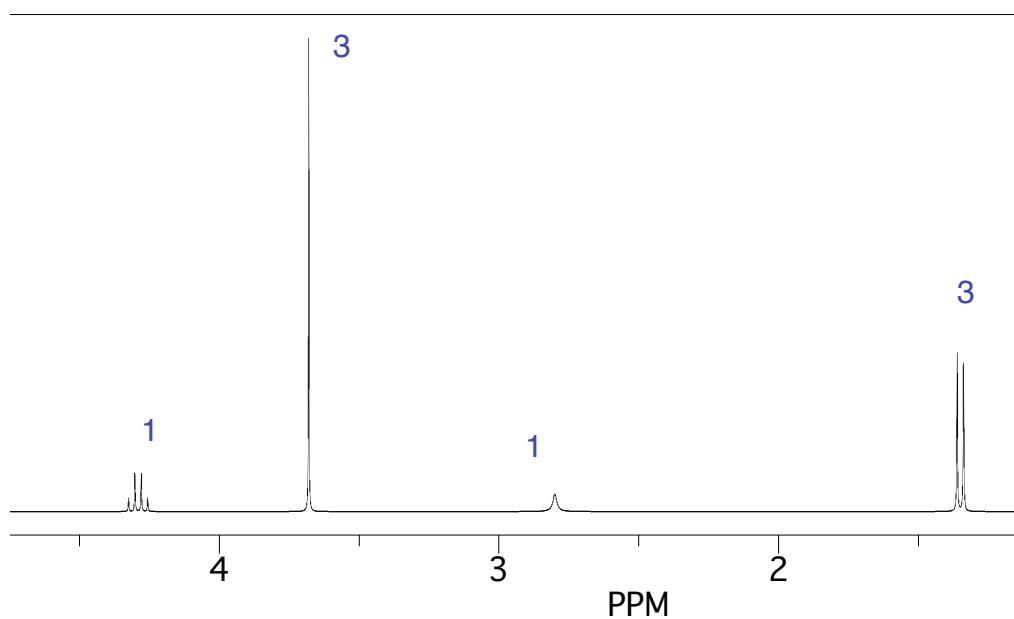
$^1H$  NMR: 0.9 ppm (t, 3H); 1.12 ppm (d, 3H); 1.62 ppm (quintet, 2H);  
2.0 ppm (broad singlet, 2H); 2.8 ppm (sextet, 1H);

3.  $C_7H_{16}$



$^1H$  NMR: 0.91 ppm (d, 6H); 1.21 ppm (t, 1H); 1.62 ppm (multiplet, 1H)

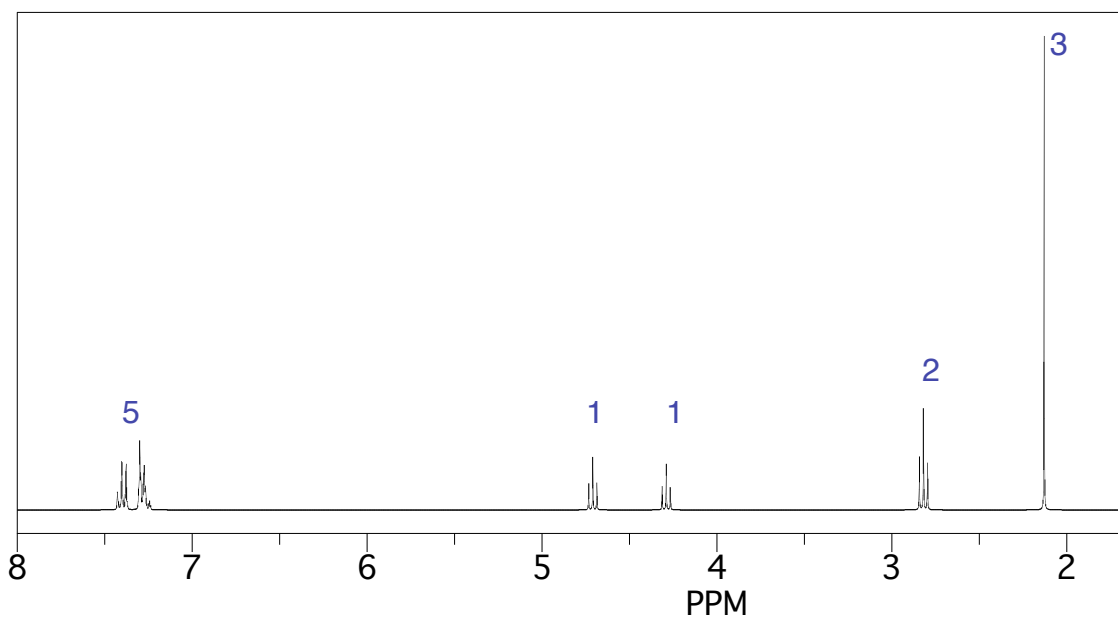
4.  $C_4H_8O_3$



IR :  $3400\text{ cm}^{-1}$ , (broad, strong)

$^1H$  NMR: 1.35 ppm (d, 3H); 2.80 ppm (s, broad, 1H); 3.68 ppm (s, 3H);  
4.29 ppm (q, 1H);

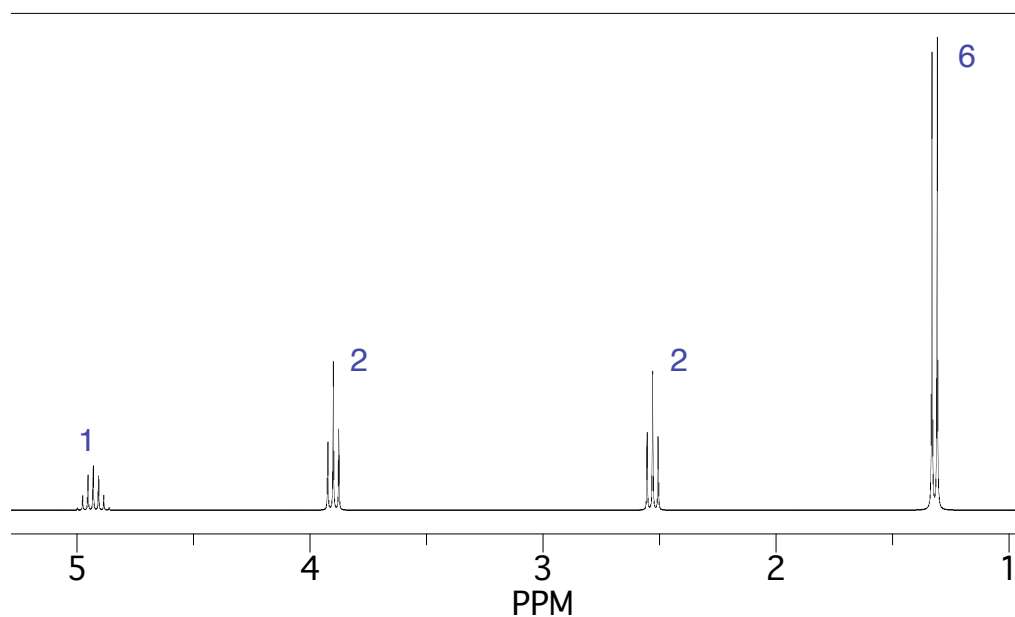
5.  $C_{11}H_{12}Br_2O$



IR :  $1690\text{ cm}^{-1}$  (strong)

$^1H$  NMR: 2.13 ppm (s, 3H); 2.82 ppm (t, 2H); 4.29 ppm (t, 1H); 4.71 ppm (t, 1H);  
7.27-7.40 ppm (multiplet, 5H)

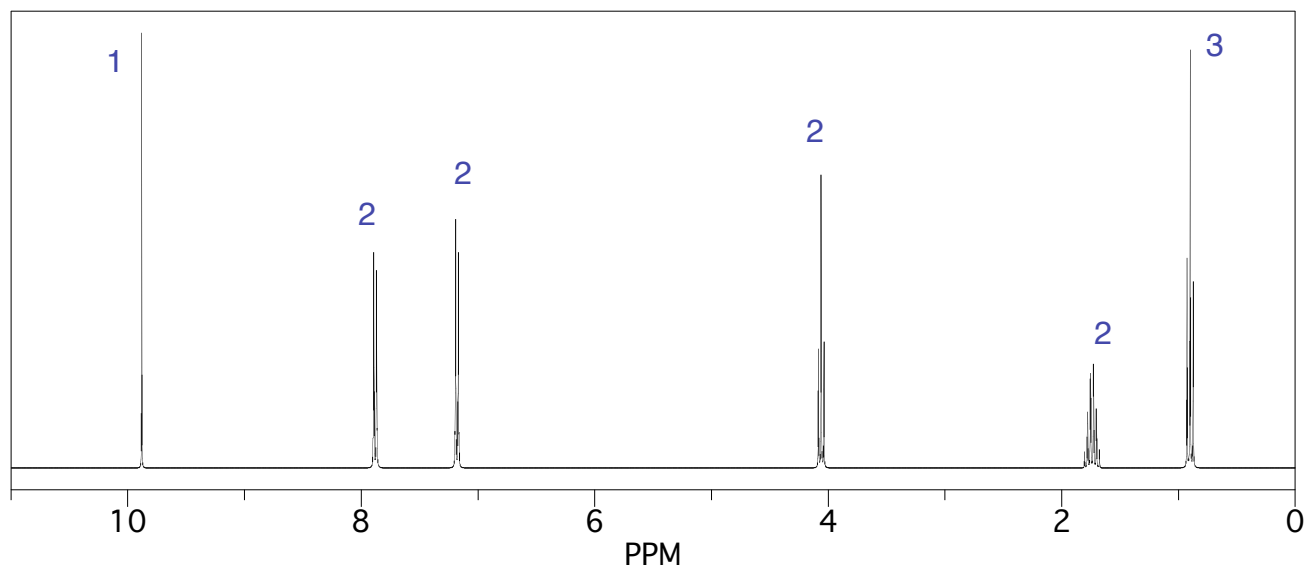
6.  $C_6H_{11}O_2Cl$



IR :  $1734\text{ cm}^{-1}$ , (strong)

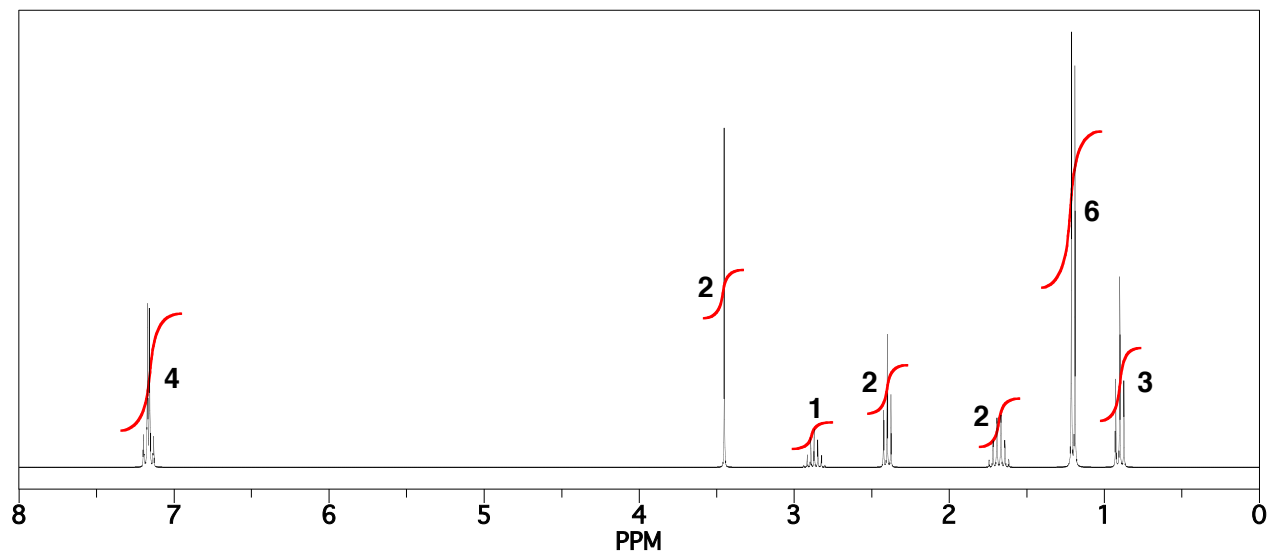
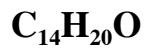
$^1H$  NMR: 1.32 ppm (d, 6H); 2.53 ppm (t, 2H); 3.90 ppm (t, 2H);  
4.93 ppm (septet, 1H);

7.  $C_{10}H_{12}O_2$



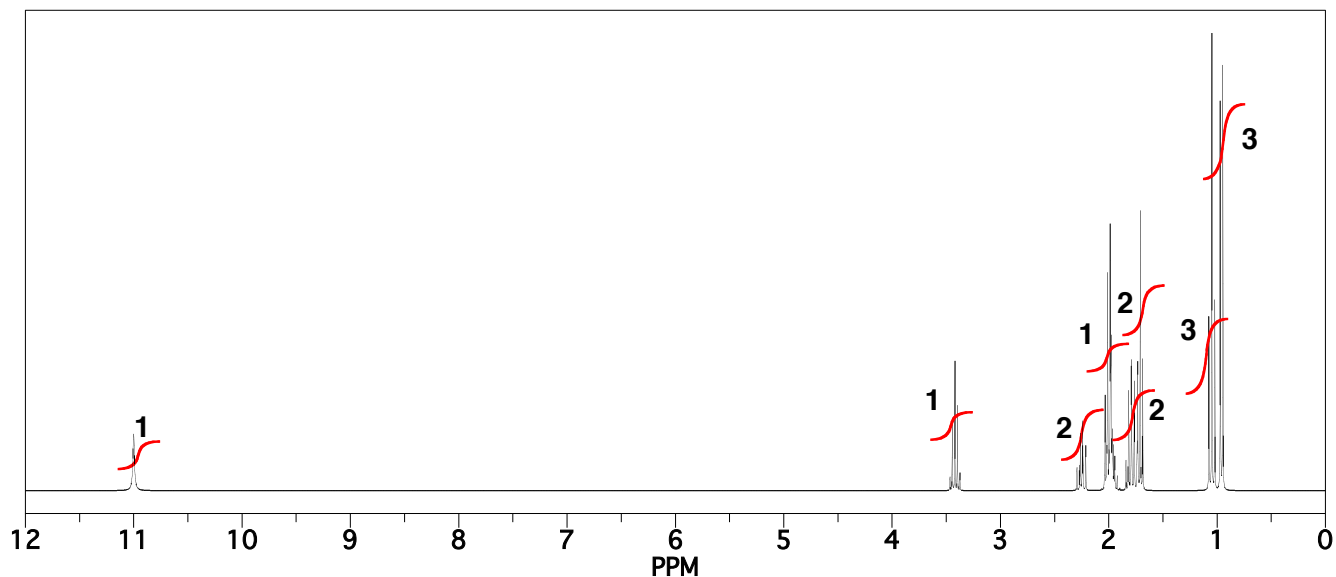
IR :  $1705\text{ cm}^{-1}$  (strong)

$^1H$  NMR: 0.90 ppm (t, 3H); 1.74 ppm (sextet, 2H); 4.06 ppm (t, 2H);  
7.18 ppm (d, 2H); 7.88 ppm (d, 2H); 9.88 ppm (s, 1H)



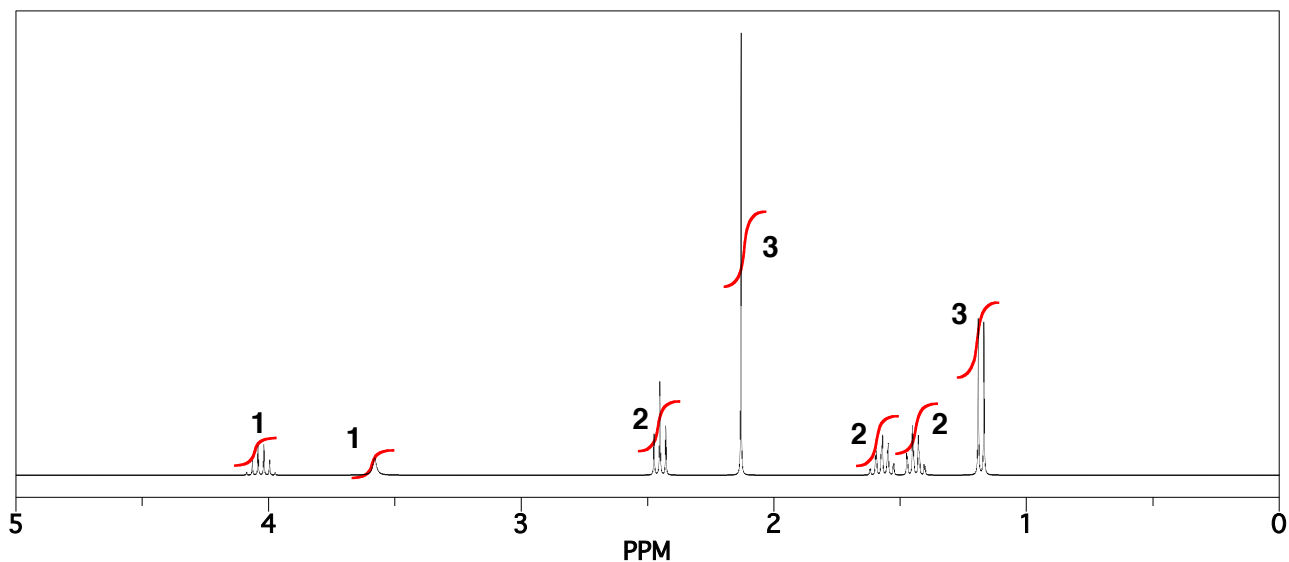
**IR:**  $1720\text{ cm}^{-1}$  (strong peak)

**$^1H$ -NMR:** 0.90 ppm (t, 3H); 1.20 ppm (d, 6H); 1.68 ppm (sextet, 2H); 2.40 ppm (t, 2H); 2.87 ppm (septet, 1H); 3.45 ppm (s, 2H); 7.16 ppm (4H).



**IR:** 2800 cm<sup>-1</sup>(broad); 1760 cm<sup>-1</sup> (strong peak)

**<sup>1</sup>H-NMR:** 0.96 ppm (d, 3H); 1.05 ppm (t, 3H); 1.71 ppm (t, 2H); 1.79 ppm (quintet, 2H); 1.98 ppm (quintet, 1H); 2.20 ppm (d, 2H); 3.42 ppm (quintet, 1H); 11 ppm (broad singlet, 1H).

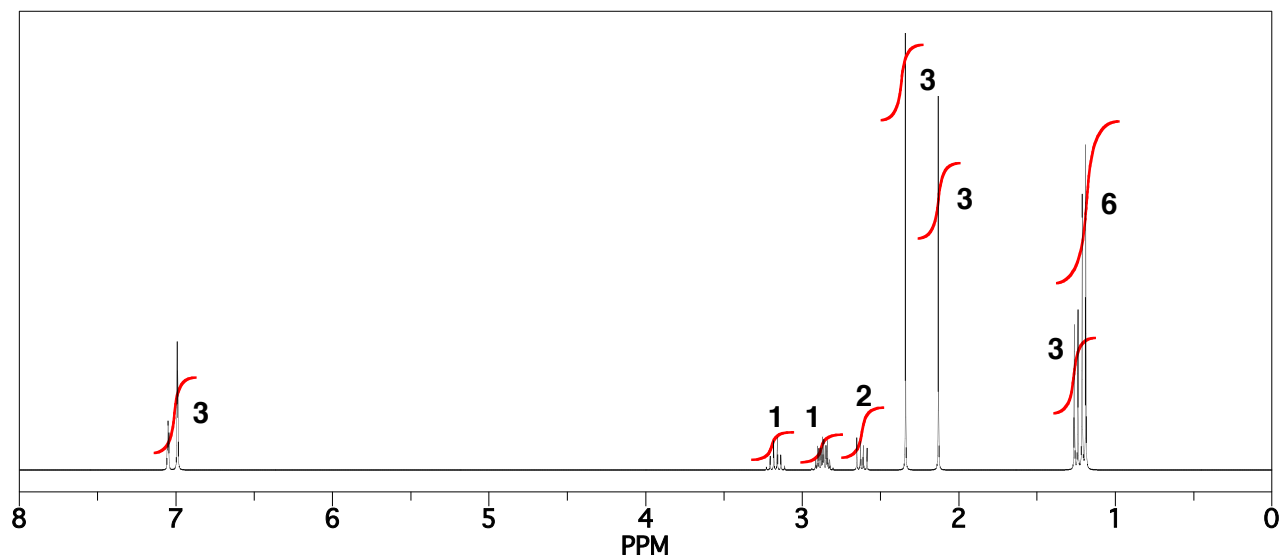


**IR:**  $3300\text{ cm}^{-1}$ (broad);  $1730\text{ cm}^{-1}$ .

**$^1H$ -NMR:** 1.18 ppm (d, 3H); 1.44 ppm (q, 2H); 1.57 ppm (quintet, 2H); 2.13 ppm (s, 3H); 2.45 ppm (t, 2H); 3.58 (broad singlet, 1H); 4.03 ppm (sextet, 1H).



$C_{15}H_{22}O$



**IR:**  $1730\text{ cm}^{-1}$ .

**$^1H$ -NMR:** 1.20 ppm (d, 6H); 1.25 ppm (d, 3H); 2.13 ppm (s, 3H); 2.34 ppm (s, 3H); 2.70 ppm (d, 2H); 2.87 (septet, 1H); 3.17 ppm (sextet, 1H); 7.00-7.05 ppm (3H).