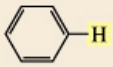
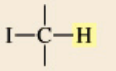
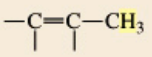
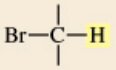
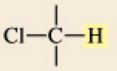
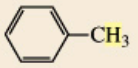
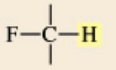
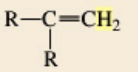
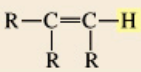
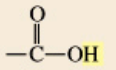
TABLE 13.1 Approximate Values of Chemical Shifts for ^{1}H NMR[a]

Type of proton	Approximate chemical shift (ppm)	Type of proton	Approximate chemical shift (ppm)
$(CH_3)_4Si$	0		6.5–8
$-CH_3$	0.9		
$-CH_2-$	1.3		9.0–10
	1.4		2.5–4
	1.7		2.5–4
	2.1		3–4
	2.3		4–4.5
$-C\equiv C-H$	2.4	RNH_2	variable, 1.5–4
$R-O-CH_3$	3.3	ROH	variable, 2–5
	4.7	ArOH	variable, 4–7
	5.3		variable, 10–12

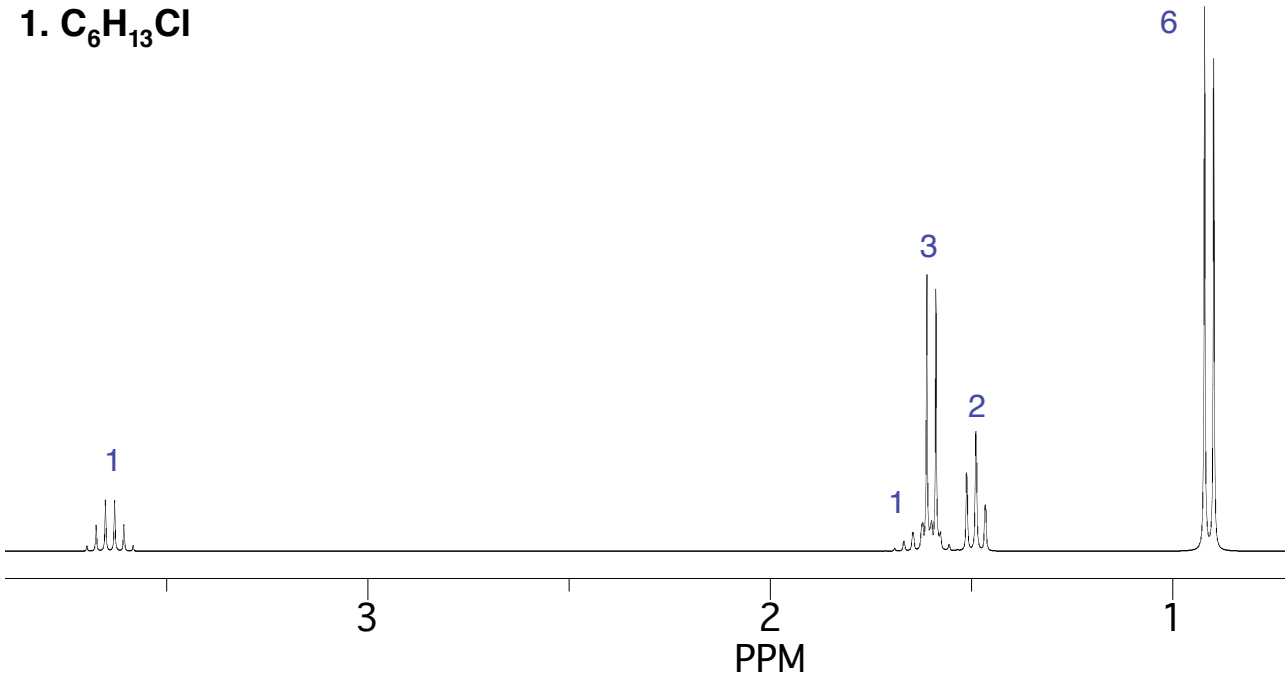
[a]The values are approximate because they are affected by neighboring substituents.

Table of IR Absorptions

Functional Group	*Characteristic Absorption(s)* (cm^{-1})
Alkyl C-H Stretch	2950 - 2850 (m or s)
Alkenyl C-H Stretch Alkenyl C=C Stretch	3100 - 3010 (m) 1680 - 1620 (v)
Alkynyl C-H Stretch Alkynyl C≡C Stretch	~3300 (s) 2260 - 2100 (v)
Aromatic C-H Stretch Aromatic C-H Bending Aromatic C=C Bending	~3030 (v) 860 - 680 (s) 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≡N Stretch	2260 - 2220 (m)
Aldehyde C=O Stretch Ketone C=O Stretch Ester C=O Stretch Carboxylic Acid C=O Stretch Amide C=O Stretch	1740 - 1690 (s) 1750 - 1680 (s) 1750 - 1735 (s) 1780 - 1710 (s) 1690 - 1630 (s)
Amide N-H Stretch	3700 - 3500 (m)

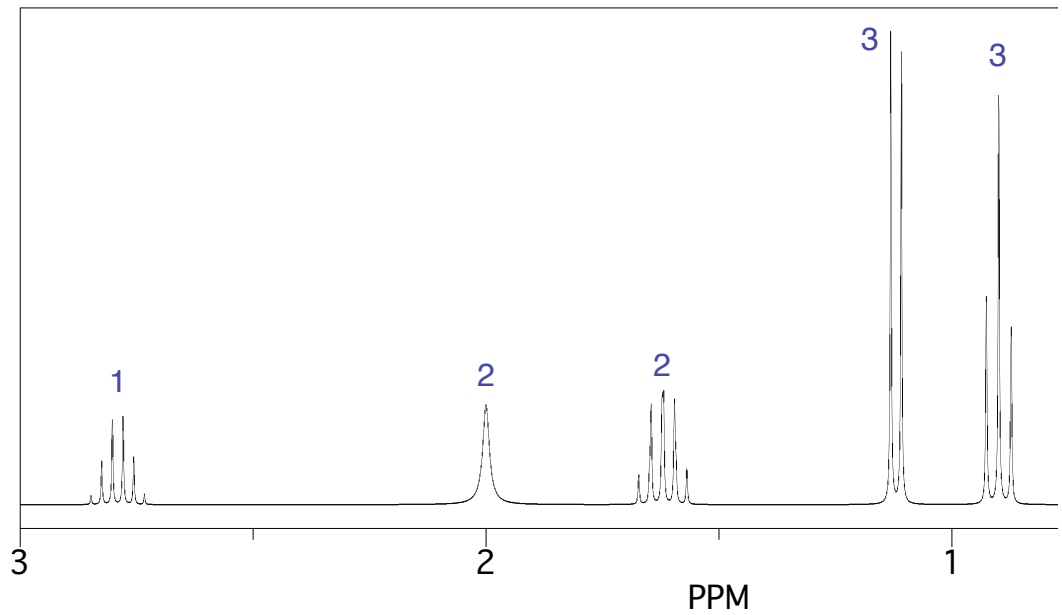
Determine the structures of the molecules with the following spectra:

1. $C_6H_{13}Cl$



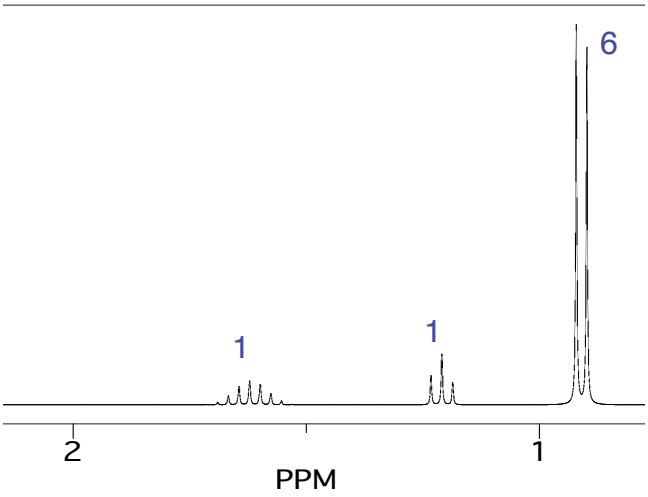
^{1}H NMR: 0.91 ppm (d, 6H); 1.49 ppm (t, 2H); 1.60 ppm (d, 3H); 1.62 ppm (multiplet, 1H); 3.64 ppm (sextet), 1H);

2. $C_4H_{11}N$



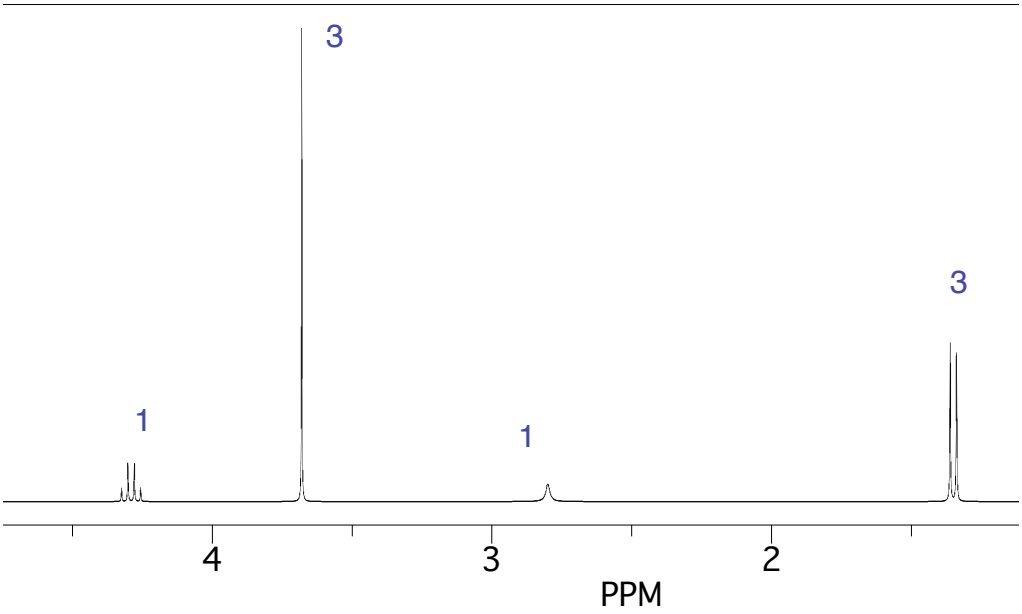
IR : 3310 cm^{-1} (weak), 3340 cm^{-1} (weak)
^{1}H NMR: 0.9 ppm (t, 3H); 1.12 ppm (d, 3H); 1.62 ppm (quintet, 2H);
2.0 ppm (broad singlet, 2H); 2.8 ppm (sextet, 1H);

3. C_7H_{16}



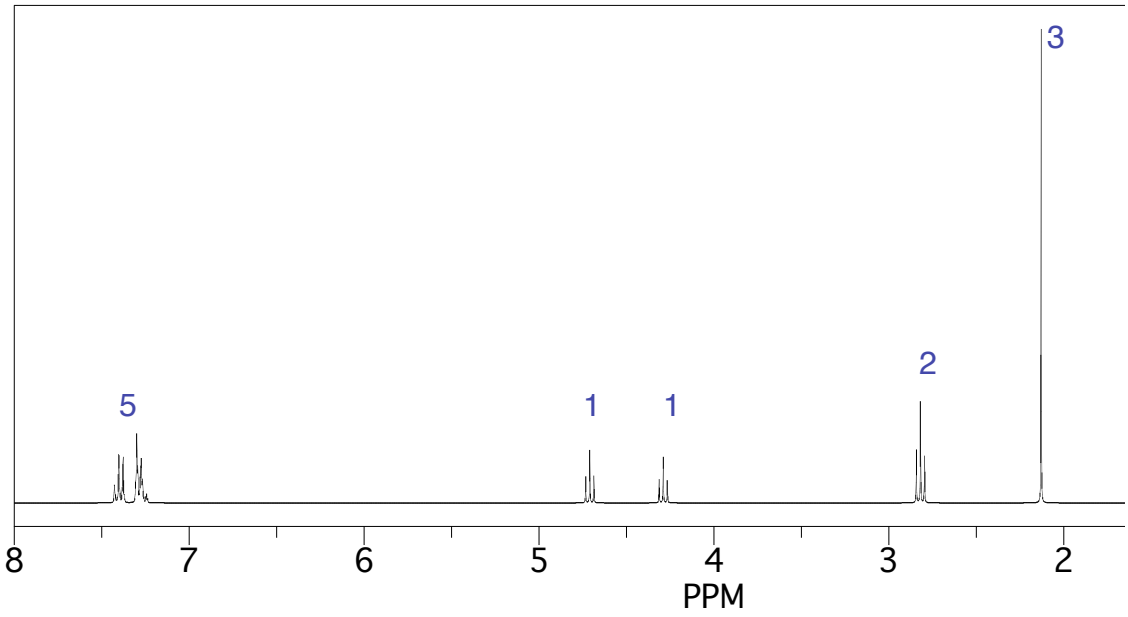
^{1}H NMR: 0.91 ppm (d, 6H); 1.21 ppm (t, 1H); 1.62 ppm (multiplet, 1H)

4. $C_4H_8O_3$



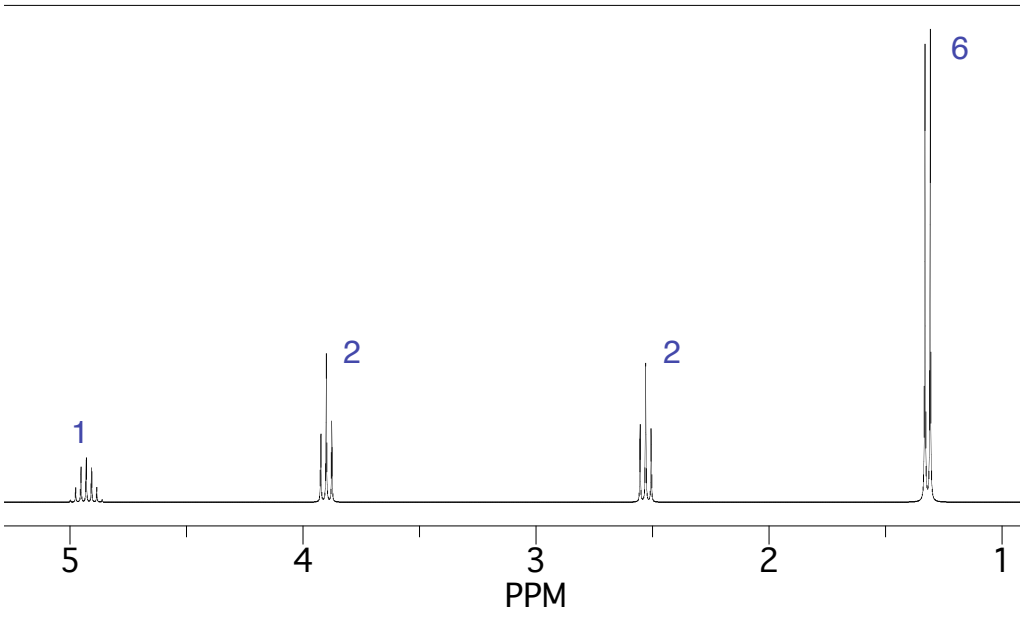
IR : 3400 cm^{-1}, (broad, strong)
^{1}H NMR: 1.35 ppm (d, 3H); 2.80 ppm (s, broad, 1H); 3.68 ppm (s, 3H);
4.29 ppm (q, 1H);

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



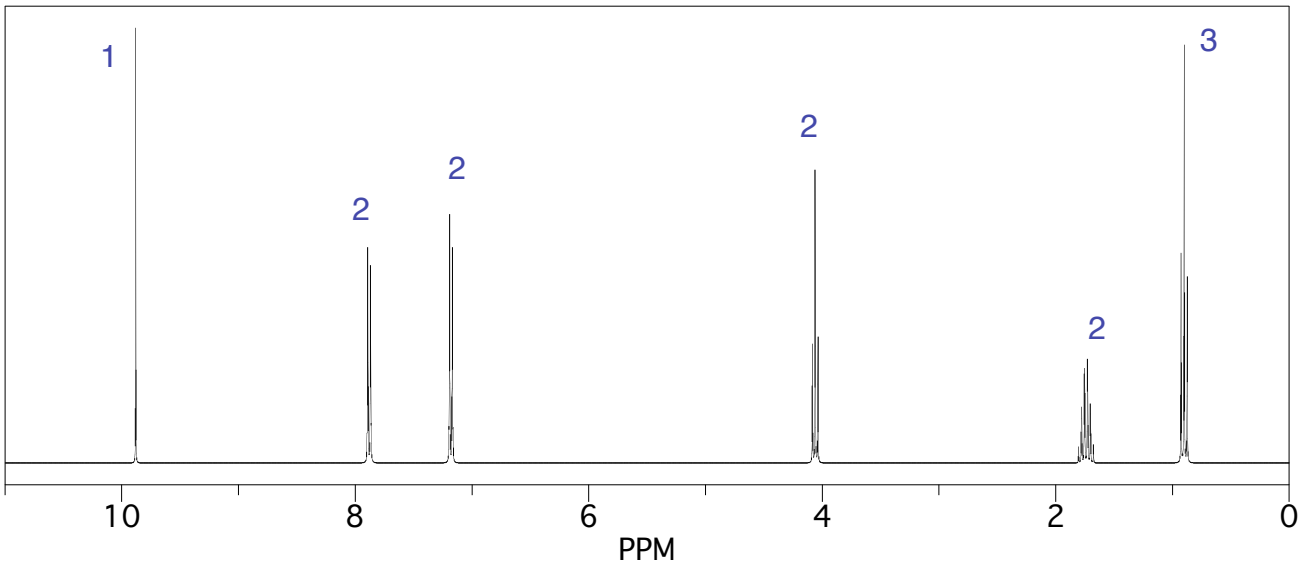
IR : 1690 cm^{-1} (strong)
^{1}H NMR: 2.13 ppm (s, 3H); 2.82 ppm (t, 2H); 4.29 ppm (t, 1H); 4.71 ppm (t, 1H);
7.27-7.40 ppm (multiplet, 5H)

6. $C_6H_{11}O_2Cl$



IR : 1734 cm^{-1}, (strong)
^{1}H 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 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)