Question 18 A Friedel–Crafts reaction between Compound **10**, C_3H_7Cl, and Compound **11**, C_8H_{10}, gave Compound **12**, $C_{11}H_{16}$, as the major product:

$$\underset{\mathbf{10}}{C_3H_7Cl} + \underset{\mathbf{11}}{C_8H_{10}} \xrightarrow{AlCl_3} \underset{\mathbf{12}}{C_{11}H_{16}} \qquad (12)$$

The ^{13}C NMR chemical shifts (in p.p.m.) and off-resonance multiplicities for Compounds **10**, **11** and **12** are given in Table 2. The infrared spectrum of Compound **11** is given in Figure 1.

Table 2 ^{13}C NMR data* (in p.p.m.) for Compounds **10**, **11** and **12**

Compound **10**		Compound **11**		Compound **12**	
$\delta = 26$	(q)	$\delta = 16$	(q)	$\delta = 16$	(q)
$\delta = 48$	(d)	$\delta = 29$	(t)	$\delta = 24$	(q)
		$\delta = 126$	(d)	$\delta = 29$	(t)
		$\delta = 128$	(d)	$\delta = 34$	(d)
		$\delta = 129$	(d)	$\delta = 127$	(d)
		$\delta = 144$	(s)	$\delta = 128$	(d)
				$\delta = 142$	(s)
				$\delta = 145$	(s)

* s = singlet, d = doublet, t = triplet, q = quartet.

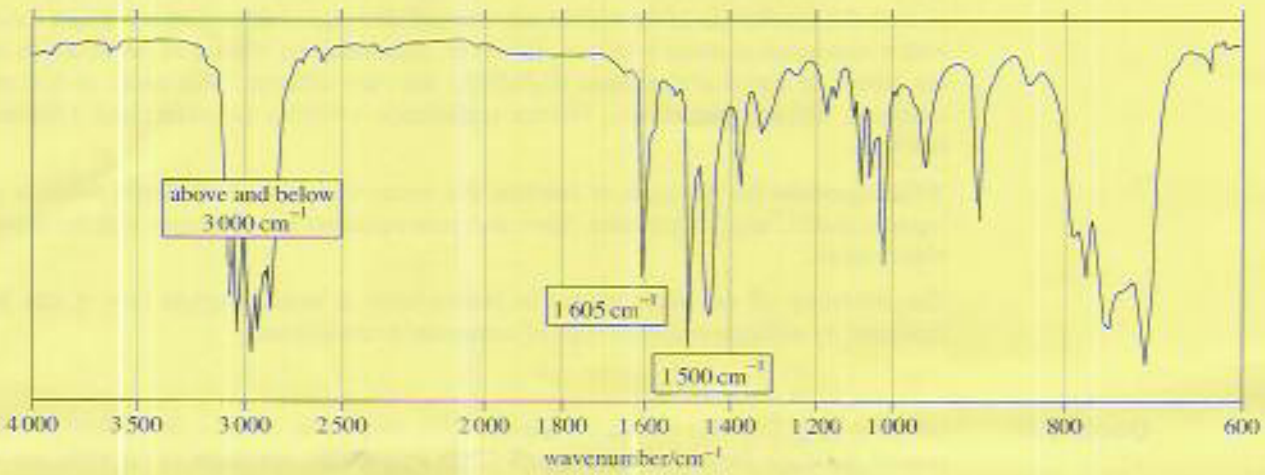

Figure 1 The infrared spectrum of Compound **11**.

(*a*) (*3 marks*) Calculate the number of double-bond equivalents in Compound **11**, and suggest *four* possible structures.

(*b*) (*12 marks*) Using the correlation charts in the S205 *Data Book* (pp. 41 and 43), and your knowledge of the Friedel–Crafts reaction, analyse and discuss the above spectral information as fully as you can. Use this information to establish the structures of Compounds **10**, **11** and **12**.