37. Analytical techniques

37.3 Carbon-13 NMR spectroscopy

Paper 4

Marking Scheme

Q1.

(g)	5 [1]	**1**

Q2.

(d)	<table><tr><th>compound</th><th>number of peaks observed</th></tr><tr><td>**W**</td><td>6</td></tr><tr><td>**Z**</td><td>6</td></tr></table> Both correct for one mark	**1**

Q3.

(d)	14 / fourteen [1]	**1**

Q4.

(b)	4, 110-160, 1, 25-50 either order [1] 4, 110-160, 1, 160-185 either order [1]	**2**

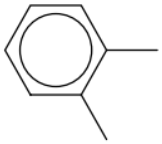
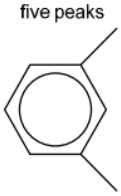
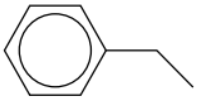
Q5.

(b)	5 5 5 4 4	**2**

Q6.

(f)	6 5 [1] 4 3 [1]	**2**

Q7.

(a)	three peaks  four peaks  five peaks  six peaks  correct isomers and correct assignment to peaks: mark as • ✓ • ✓ • ✓ • ✓	4

Q8.

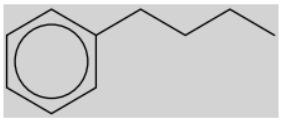
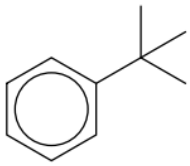
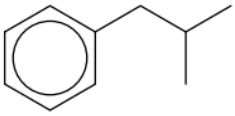
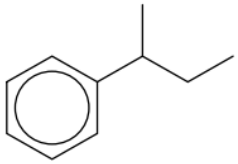
(a)	6 [1]	1

Q9.

(b)	benzene-1,3-dicarboxylic acid	5	[1]	2
	benzene-1,4-dicarboxylic acid	3	[1]	

Q10.

(c)(i)	$CH_3CH_2CH^+CH_3$ $(CH_3)_2CHCH_2^+$ $(CH_3)_3C^+$ Each correct structure = 1 mark	3

(c)(ii)	 number of peaks in carbon-13 NMR = 8  number of peaks in carbon-13 NMR = 6  number of peaks in carbon-13 NMR = 7  number of peaks in carbon-13 NMR = 8 Two correct organic products = 1 mark three correct organic products = 2 marks all products linked correctly to NMR = 2 marks	4

Q11.

(d)	chemical shift (δ) / environment of the carbon atom / hybridisation of the carbon atom 27 / **C**H_3 circled / sp^3 163 / **C**OOH circled / sp^2 192 / **C**=O(COOH) circled / sp^2 Award one mark for each correct column	2

Q12.

(e)(i)	5 peaks	1
(e)(ii)	environment of carbon atom / chemical shift range (δ) carbonyl / RCOR / 190–220 arene / benzene / 110–160 Award one mark for each correct for each row	2