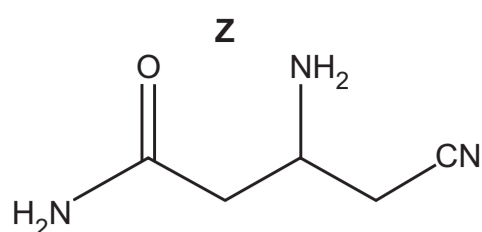


- 6 (a) Compound **Z** is used in organic synthesis.



Complete Table 6.1 to show the number of sp , sp^2 and sp^3 hybridised carbon atoms present in one molecule of **Z**.

Table 6.1

| type of hybridisation | sp | sp^2 | sp^3 |
|------------------------|------|--------|--------|
| number of carbon atoms | | | |

[1]

- (b) **Z** can undergo different reactions, as shown in Fig. 6.1.

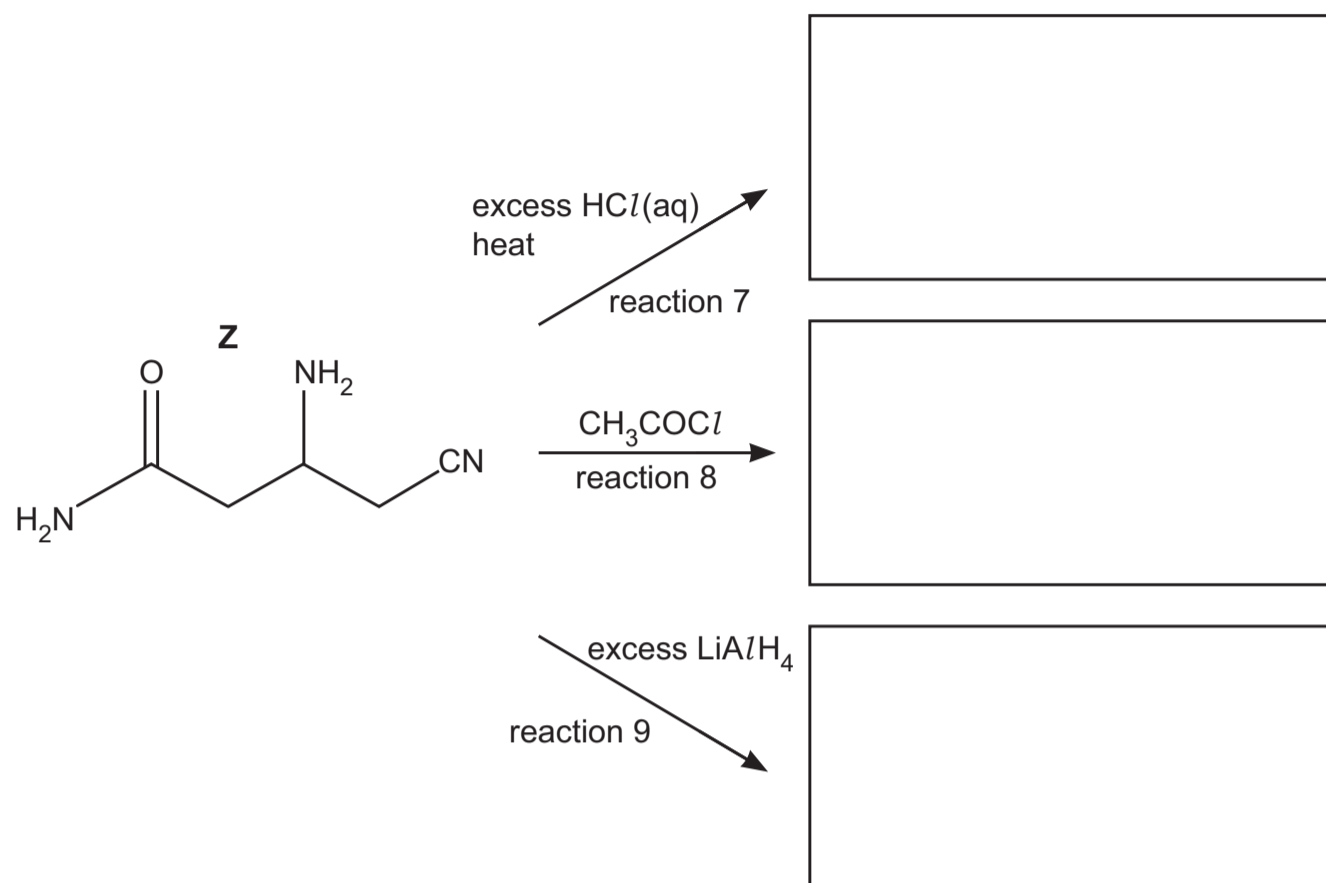


Fig. 6.1

- (i) Name the **two** types of reaction occurring in reaction 7 in Fig. 6.1.
 and [1]
- (ii) Draw the structures of the organic products of reactions 7, 8 and 9 in Fig. 6.1. [4]
- (c) Compound **Z** is dissolved in D_2O and analysed by carbon-13 NMR and proton (1H) NMR spectroscopy.
- (i) Predict the number of peaks in the carbon-13 NMR spectrum of **Z**.
 [1]
- (ii) The proton (1H) NMR spectrum of **Z** in D_2O gives three peaks for the proton environments, labelled **a**, **b** and **c**, as shown on Fig. 6.2.

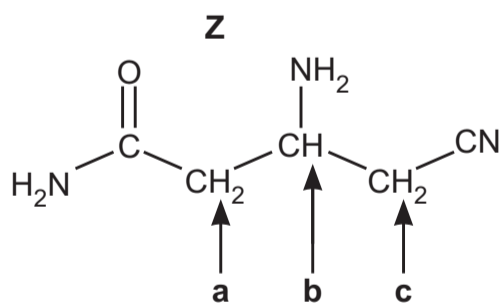


Fig. 6.2

Complete Table 6.2 for the proton (1H) NMR spectrum of **Z** in D_2O .

Table 6.2

| proton environment | a | b | c |
|-------------------------------------|----------|----------|----------|
| name of splitting pattern | | | |
| chemical shift range, δ /ppm | | | |

[2]

Table 6.3

| environment of proton | example | chemical shift range, δ /ppm |
|------------------------------------|--------------------------------------|-------------------------------------|
| alkane | $-CH_3$, $-CH_2-$, $>CH-$ | 0.9–1.7 |
| alkyl next to $C=O$ | $CH_3-C=O$, $-CH_2-C=O$, $>CH-C=O$ | 2.2–3.0 |
| alkyl next to nitrile | $-CH_2-CN$ | 2.0–3.0 |
| alkyl next to electronegative atom | CH_3-O , $-CH_2-O$, $-CH_2-N$ | 3.2–4.0 |
| attached to alkene | $=CHR$ | 4.5–6.0 |
| alkyl amine | $R-NH-$ | 1.0–5.0 |
| amide | $RCONHR$ | 5.0–12.0 |

[Total: 9]