Past-paper walk-through

Carboxylic acids ▪ 33.1

eXercise

Questions in this set

- 9701/41 N25 Q7 ▪ 12 marks
- 9701/44 N25 Q6 ▪ 9 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 7

9701/41 N25 ▪ Q7 ▪ 12 marks

7 **(a)** State the relative acidities of bromoethanoic acid, $BrCH_2COOH$, chloroethanoic acid, $ClCH_2COOH$, ethanoic acid, CH_3COOH and ethanol, CH_3CH_2OH.

Explain your answer.

Question 7

most acidic

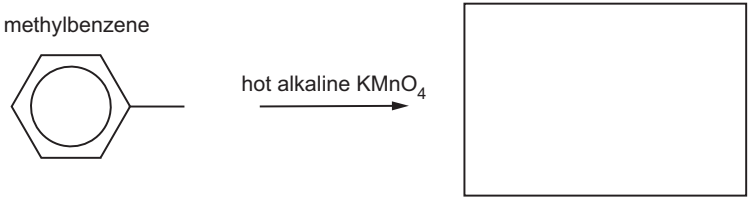
least acidic

Question 7

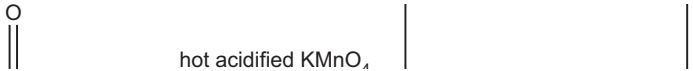
[4]

(b) Fig. 7.1 shows the reaction of methylbenzene and ethanedioic acid with $KMnO_4$.

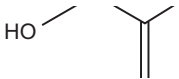
Predict the major carbon-containing product for each of these reactions.



Question 7



Question 7



Question 7

Fig. 7.1

[2]

(c) Polyamide **X** can be synthesised from ethanedioic acid and benzene-1,4-diamine.

benzene-1,4-diamine

(i) Draw the repeat unit of polyamide **X** in the box.

The new functional group formed should be shown displayed.

polyamide **X**

Question 7

polyamide A

Question 7

[2]

(ii) Benzene-1,4-diamine can be formed by reduction of 1,4-dinitrobenzene.

Complete the equation for this reduction.

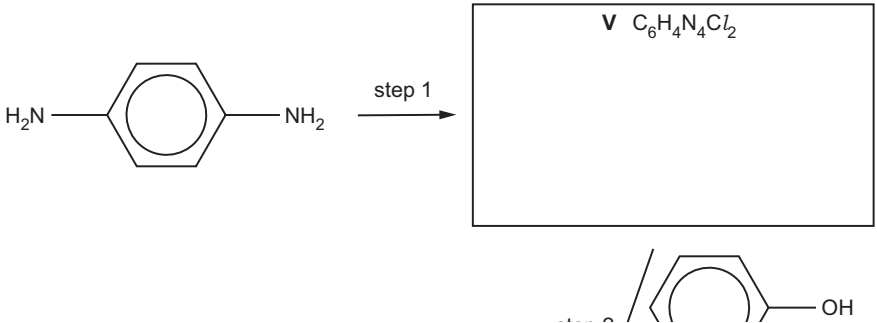
[H] represents one atom of hydrogen from a reducing agent.

Question 7

.....

[1]

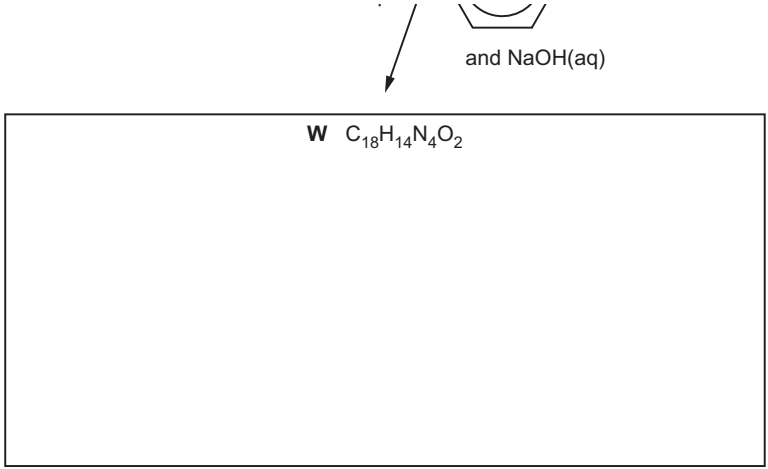
(d) Fig. 7.2 shows the two-step synthesis of the azo compound **W**.



Question 7

step 2 / \\ //

Question 7



Question 7

Question 7

Fig. 7.2

(i) Suggest structures for compounds **V** and **W** and draw them in the boxes in Fig. 7.2. [2]

(ii) Give the reagents and conditions for step 1.

Question 7

[Total: 12]

Solution 7

(a) Mark scheme

- M1: Cl CH2COOH
- BrCH2COOH CH3COOH CH3CH2OH
- most acidic
- least acidic
- M2: electron withdrawing groups / electronegative groups / negative inductive effect
- AND weakens O–H bond / more stable anion
- OR

Solution 7

- electron donating groups / positive inductive effect AND strengthens O-H bond / less stable anion **M3**
- M4:
- ▪
- chlorine is more electron-withdrawing / electronegative than bromine (related to XCH2COOH)
- ▪
- electron withdrawing of C=O / negative inductive effect of C=O (related to COOH)
- ▪

Solution 7

- positive inductive effect / electron donating of alkyl / ethyl / R group (related to ROH)
- any two [1], all three [2]
- 4

Solution 7

(b)

Mark scheme

- M1:
- M2: CO_2
- 2
- 9701/41
- October/November 2025

Solution 7

(c)(i)

Mark scheme

- M1: correct displayed amide bond with C=O, (C6H5)–N and (C–)C=O
- M2: rest of the structure correct with continuation bonds
- 2

(c)(ii)

Mark scheme

- 1

Solution 7

(d)(i)

Mark scheme

- M1:
- M2:
- 2
- 9701/41
- October/November 2025

Solution 7

(d)(ii)

Mark scheme

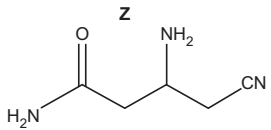
- HNO2 (and HCl) AND 10 °C
- OR
- NaNO2 AND HCl AND 10 °C
- 1

Question 6

9701/44 N25 ▪ Q6 ▪ 9 marks

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

Z



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

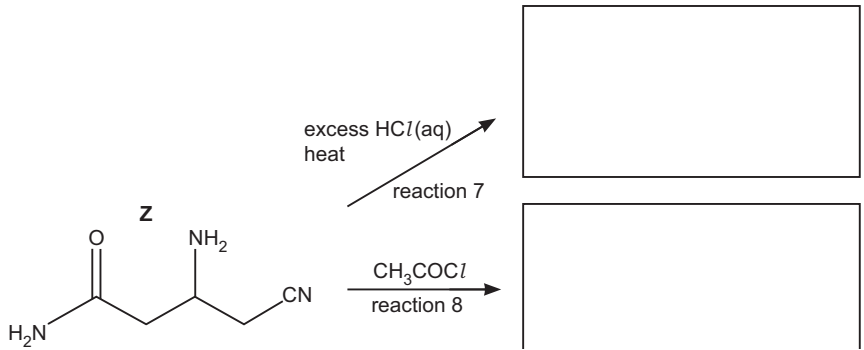
Table 6.1

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

Question 6

[1]

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



Question 6

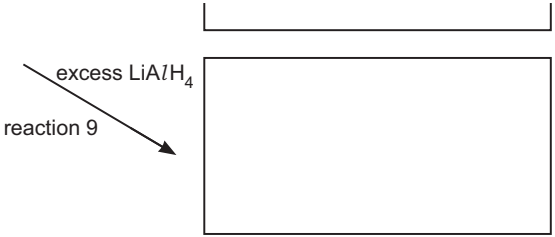


Fig. 6.1

(i) Name the **two** types of reaction occurring in reaction 7 in Fig. 6.1.

Question 6

(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**.

Question 6

(ii) The proton (^{1}H) 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.

Z

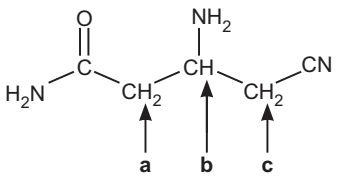


Fig. 6.2

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

Table 6.2

Question 6

Question 6

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	–C**H**$_3$, –C**H**$_2$–, >C**H**–	0.9–1.7
alkyl next to C=O	C**H**$_3$–C=O, –C**H**$_2$–C=O, >C**H**–C=O	2.2–3.0
alkyl next to nitrile	–C**H**$_2$–CN	2.0–3.0

Question 6

alkyl next to nitrile	CH_2 CN	2.0 3.0

Question 6

alkyl next to electronegative atom	C**H**$_3$–O, –C**H**$_2$–O, –C**H**$_2$–N	3.2–4.0
attached to alkene	=C**H**R	4.5–6.0
alkyl amine	R–N**H**–	1.0–5.0
amide	RCON**H**R	5.0–12.0

[Total: 9]

Solution 6

(a)

Mark scheme

- sp $= 1$ AND sp2 $= 1$ AND sp3 $= 3/1$

Solution 6

(b)(i)

Mark scheme

- acid-base / neutralisation AND hydrolysis
- 1

(b)(ii)

Mark scheme

- any two * [1], any three * [2], any five * [3], all six * [4]
- 4

Solution 6

(c)(i)

Mark scheme

- five / 5/1

Solution 6

(c)(ii) Mark scheme

- proton environment
- a
- b
- c
- name of splitting pattern
- doublet
- multiplet
- doublet

Solution 6

- chemical shift range,
- δ / ppm
- 2.2–3.0
- 3.2– 4.0
- 2.0–3.0
- any three [1], all six [2]
- 2
- reaction 7
- reaction 8
- reaction 9

Solution 6

- *
- *
- *
- *
- *
- *
- *
- *
- 9701/44
- October/November 2025