

A- level  
Chemistry  
Organic Chemistry

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Total number of marks: 49

0 7

This question is about NMR spectroscopy.

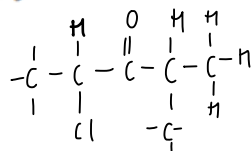
Table B from Data Booklet

Table B  
<sup>1</sup>H NMR chemical shift data

| Type of proton  | $\delta$ /ppm |
|---|---------------|
| ROH   | 0.5–5.0       |
| RCH <sub>3</sub>  | 0.7–1.2       |
| RNH <sub>2</sub>  | 1.0–4.5       |
| R <sub>2</sub> CH <sub>2</sub>  | 1.2–1.4       |
| R <sub>3</sub> CH   | 1.4–1.6       |
| $\begin{array}{c}   \\ \text{R}-\text{C}-\text{C}- \\    \quad   \\ \text{O} \quad \text{H} \end{array}$              | 2.1–2.6       |
| $\begin{array}{c}   \\ \text{R}-\text{O}-\text{C}- \\   \\ \text{H} \end{array}$                                      | 3.1–3.9       |
| RCH <sub>2</sub> Cl or Br   | 3.1–4.2       |
| $\begin{array}{c}   \\ \text{R}-\text{C}-\text{O}-\text{C}- \\    \quad   \\ \text{O} \quad \text{H} \end{array}$     | 3.7–4.1       |
| $\begin{array}{c} \text{R} \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \end{array}$ | 4.5–6.0       |
| $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C} \\   \\ \text{H} \end{array}$                                   | 9.0–10.0      |
| $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C} \\   \\ \text{O}-\text{H} \end{array}$                          | 10.0–12.0     |

0 7 . 2

Deduce the splitting pattern for each of the peaks given by the H atoms labelled **x**, **y** and **z** in the <sup>1</sup>H NMR spectrum of the compound shown.



[3 marks]

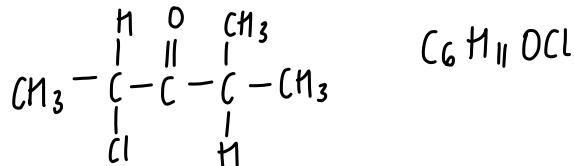
x doublety quartetz doublet

0 7 . 3

Suggest why it is difficult to use **Table B** in the Data Booklet to predict the chemical shift ( $\delta$  value) for the peak given by the H atom labelled **y**.

[1 mark]

there's no H atom in the table bonded to a  
C-Cl



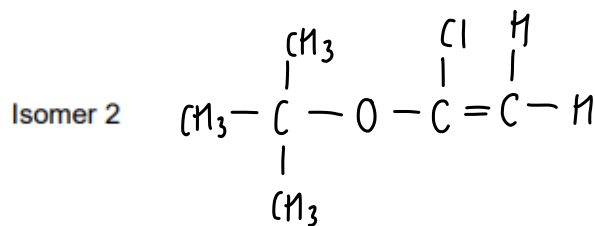
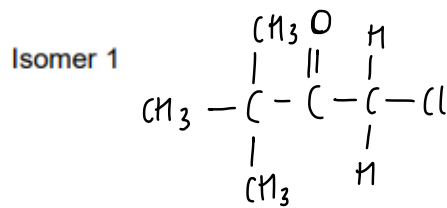
0 7 . 4

Two isomers of  $\text{CH}_3\text{CHClCOCH}(\text{CH}_3)_2$  each have two singlet peaks only in their  $^1\text{H}$  NMR spectra.

In both spectra the integration ratio for the two peaks is 2:9

Deduce the structures of these two isomers.

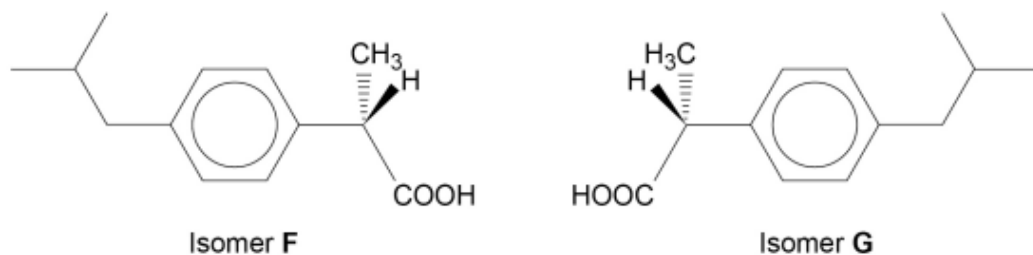
[2 marks]



0 2 . 4

Figure 4 shows optical isomers F and G.

Figure 4



Isomer F is the active compound in the medicine ibuprofen.

In the manufacture of ibuprofen both isomers F and G are formed. An enzyme is then used to bind to isomer G and catalyse its hydrolysis.

After the products of hydrolysis of G are removed, a pure sample of isomer F is collected.

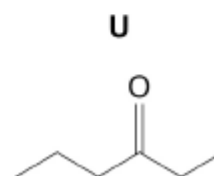
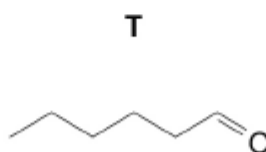
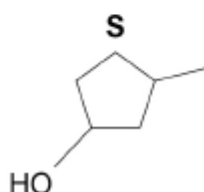
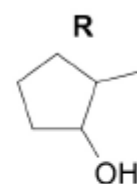
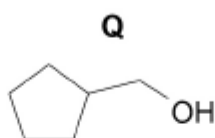
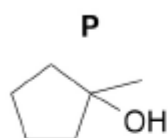
Explain how a structural feature of this enzyme enables it to catalyse the hydrolysis of isomer G but not the hydrolysis of isomer F.

[2 marks]

the active site of the enzyme is complementary in shape to a part of isomer G that is different in shape to isomer F since F and G are optical isomers of each other, so only isomer G can bind to the active site of the enzyme.

0 3

This question is about the structural isomers shown.



0 3 . 1

Identify the isomer(s) that would react when warmed with acidified potassium dichromate(VI).

State the expected observation when acidified potassium dichromate(VI) reacts.

[2 marks]

Isomer(s) Q, R, S & T

Expected observation colour change from orange to green

0 3 . 2

Identify the isomer(s) that would react with Tollens' reagent.

State the expected observation when Tollens' reagent reacts.

[2 marks]

Isomer(s) T

Expected observation silver mirror forms

0 3 . 4

State the type of structural isomerism shown by isomers P, Q, R and S.

[1 mark]

positional isomerism

0 3 . 5

Describe fully how infrared spectra can be used to distinguish between isomers R, S and T.

Use data from **Table A** in the Data Booklet in your answer.

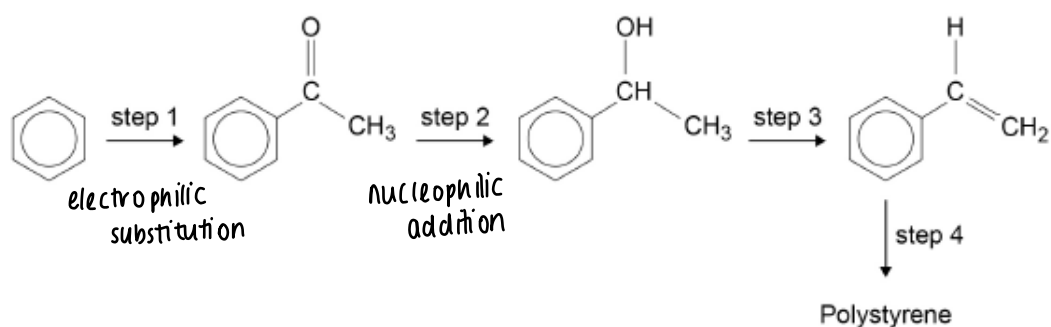
[4 marks]

isomers R and S would produce a strong peak at 3230 - 3550 cm<sup>-1</sup> for the O-H alcohol group.

isomer T would not produce this peak; instead, it would produce a peak at 1680 - 1750 cm<sup>-1</sup> for the C=O group, and would not have the O-H peak. To distinguish between isomers R and S the fingerprint regions of these two isomers would be different.

0 6

Polystyrene can be made from benzene in the series of steps shown.



0 6 . 1 State the type of reaction in step 1.

Identify the reagent(s) and conditions needed for step 1.

[3 marks]

Type of reaction Friedel-Crafts acylation

Reagent(s)  $\text{AlCl}_3$  and  $\text{CH}_3\text{COCl}$

Conditions heat under reflux

0 6 . 2 State the name of the mechanism for the reaction in step 2.

Identify the inorganic reagent needed for step 2.

Name the organic product of step 2.

[3 marks]

Name of mechanism reduction

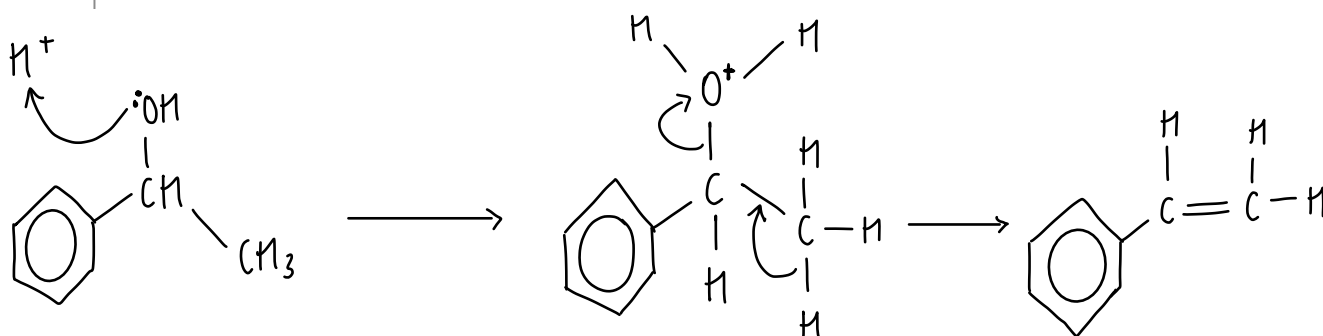
Inorganic reagent  $\text{NaBH}_4$

Name of organic product 1-phenylethanol

0 6 . 3 The organic product of step 2 is reacted with concentrated sulfuric acid in step 3.

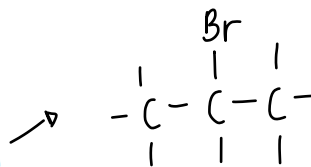
Outline the mechanism for step 3.

[3 marks]



0 5

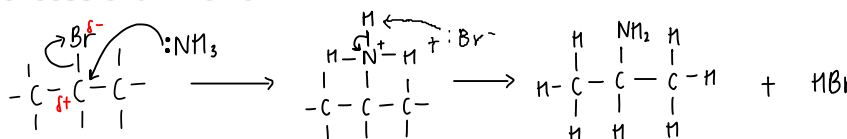
This question is about 2-bromopropane.



0 5 . 2

Outline the mechanism for the reaction of 2-bromopropane with an excess of ammonia. (1° amine major product)

[4 marks]



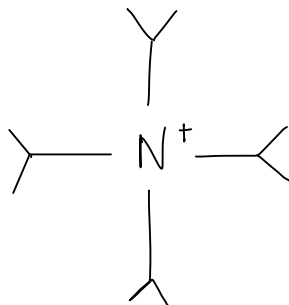
0 5 . 3

Draw the skeletal formula of the main organic species formed in the reaction between a large excess of 2-bromopropane and ammonia.

Give a use for the organic product.

[2 marks]

Skeletal formula

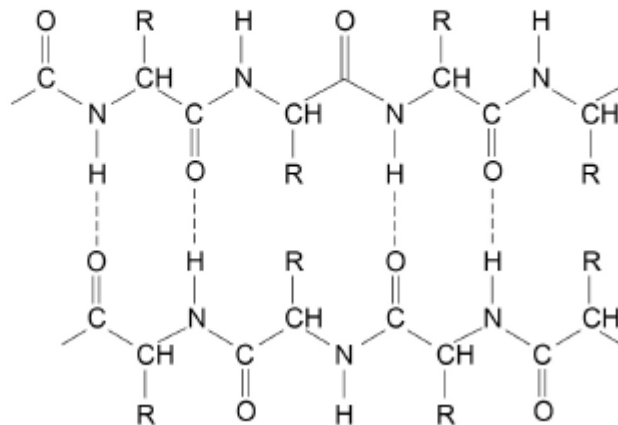


Use cationic surfactant

08

Use the Data Booklet to help you answer this question about amino acids.  
**Figure 1** shows parts of two polypeptide chains in a beta-pleated sheet of a protein.

**Figure 1**

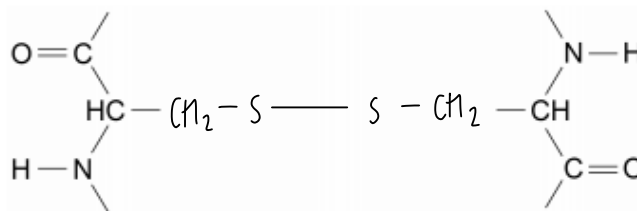


08.2

A different type of bond can form between two polypeptide chains when the chains each contain the amino acid cysteine.

Complete the structure to show the bond that forms between the side chains of two cysteine molecules.

[1 mark]



08.3

The type of bond in Question 08.2 between two polypeptide chains influences the three-dimensional structure of the protein.

Name this type of protein structure.

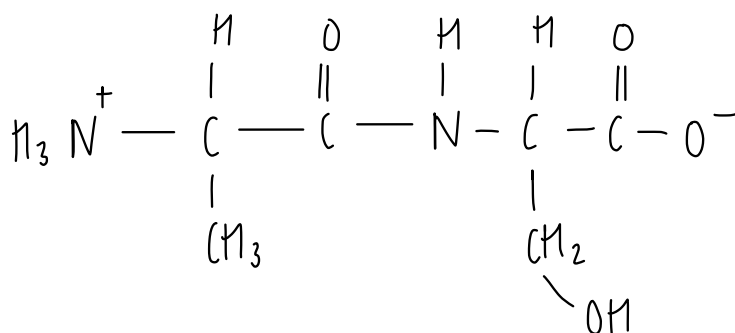
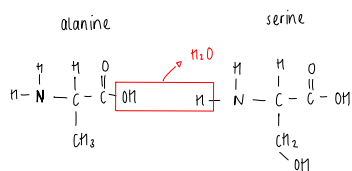
[1 mark]

tertiary structure

08.4

Draw the structure of the zwitterion of a dipeptide formed by **alanine** and **serine**.

[2 marks]



09

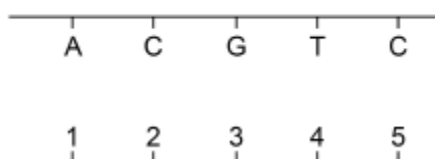
Use the Data Booklet to help you answer this question about DNA.

**Figure 2** shows a fragment of a DNA double helix.

The letters A, C, G and T represent the four bases in one strand.

The numbers 1, 2, 3, 4 and 5 represent the bases in the complementary strand.

**Figure 2**



09.1

Complete **Table 4** to show the correct sequence of bases in the complementary strand represented by the numbers 1 to 5

[1 mark]

**Table 4**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| T | G | C | A | G |

09.2

Deduce the total number of hydrogen bonds formed between the five bases in each strand.

Tick (✓) **one** box.

[1 mark]

|    |    |    |    |
|----|----|----|----|
| 10 | 12 | 13 | 15 |
|    |    | ✓  |    |

09.3

Base A is part of a nucleotide in the DNA strand shown in **Figure 2**.

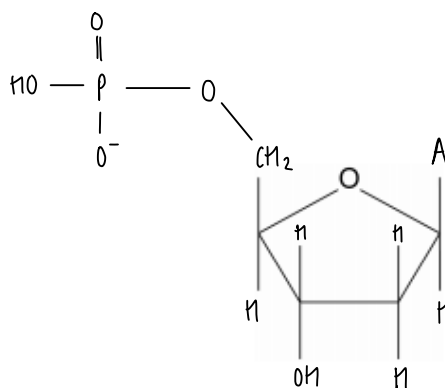
A nucleotide contains a 2-deoxyribose molecule.

An incomplete 2-deoxyribose molecule is shown.

Complete the structure to show the nucleotide that contains base A.

You should represent base A by the letter A.

[2 marks]



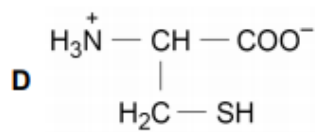
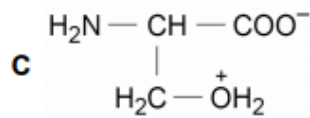
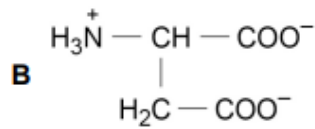
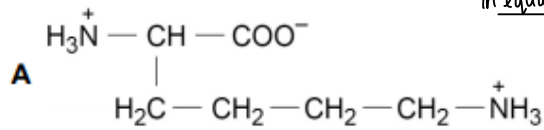


3 0

Which structure shows the **zwitterion** of an amino acid?

↳ both positive and negative charges  
in equal amounts

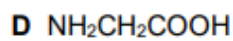
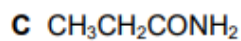
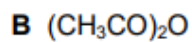
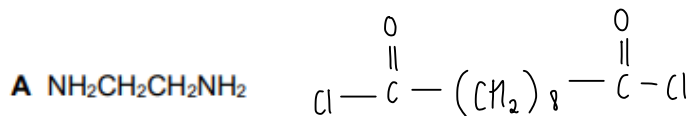
[1 mark]



2 9

Which forms a polymer with  $\text{ClOC}(\text{CH}_2)_8\text{COCl}$ ?

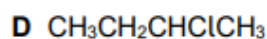
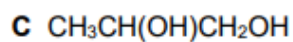
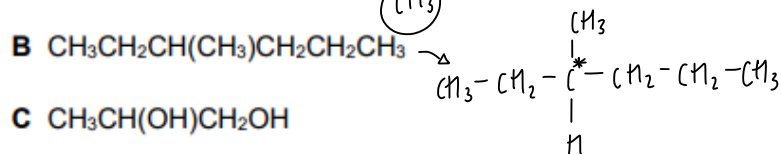
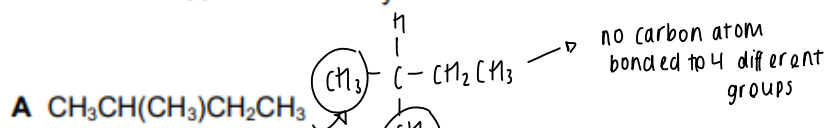
[1 mark]



2 6

Which does **not** contain an asymmetric carbon atom?

[1 mark]

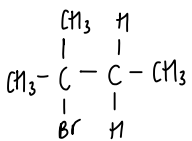
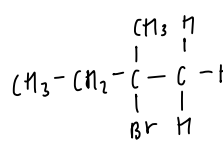


2 8

Which compound reacts with hydrogen bromide to give 2-bromo-3-methylbutane as the major product?

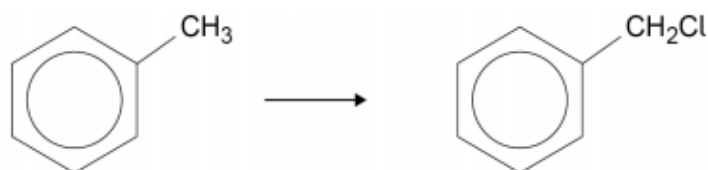
(1Br)

[1 mark]

- A  $(\text{CH}_3)_2\text{C}=\text{CHCH}_3$  
- B  $\text{CH}_3(\text{CH}_2)_2\text{CH}=\text{CH}_2$
- C  $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)=\text{CH}_2$  
- D  $(\text{CH}_3)_2\text{CHCH}=\text{CH}_2$

2 3

Which is the mechanism for this conversion?



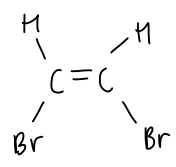
[1 mark]

- A Addition-elimination
- B Electrophilic substitution
- C Free-radical substitution
- D Nucleophilic substitution

2 2

Which has *E-Z* isomers?

[1 mark]

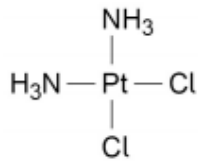
- A  $\text{C}_2\text{H}_2\text{Br}_2$  
- B  $\text{C}_2\text{H}_3\text{Br}$
- C  $\text{C}_2\text{H}_4\text{Br}_2$
- D  $\text{C}_2\text{H}_5\text{Br}$

1 5

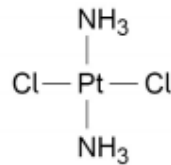
Cisplatin is an anti-cancer drug.

Which structure represents a stereoisomer of cisplatin?

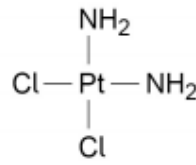
[1 mark]



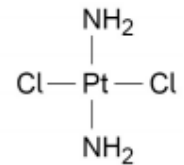
A



B



C



D

A

B

C

D

2 5

Which compound can form a polymer without needing another reagent?

[1 mark]

A HOCH<sub>2</sub>CH<sub>2</sub>OH

B HOOCCH<sub>2</sub>CH<sub>2</sub>COOH

C HOCH<sub>2</sub>CH<sub>2</sub>COCl

D ClCH<sub>2</sub>CH<sub>2</sub>COOH

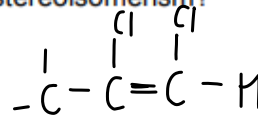
2 4

Which compound does **not** show stereoisomerism?

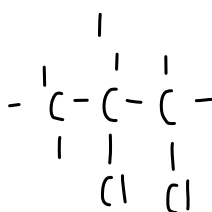
either optical or E-Z

[1 mark]

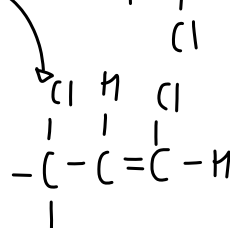
A 1,2-dichloropropene



B 1,2-dichloropropane



C 1,3-dichloropropene



D 1,3-dichloropropane

