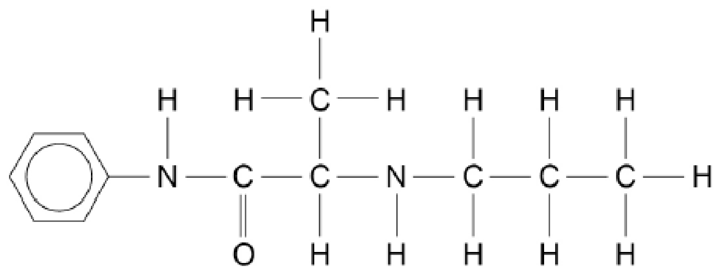
AQA – Organic Synthesis – A2 Chemistry P2

1. June/ 2020/Paper_2/No.2

0 2 Prilocaine is used as an anaesthetic in dentistry.
Figure 3 shows the structure of prilocaine.

Figure 3



0 2 . 1 Draw a circle around any chiral centre(s) in **Figure 3**.

[1 mark]

0 2 . 2 Identify the functional group(s) in the prilocaine molecule.

[1 mark]

Tick (✓) the box(es) corresponding to the functional group(s).

Amide	Amine	Ester	Ketone

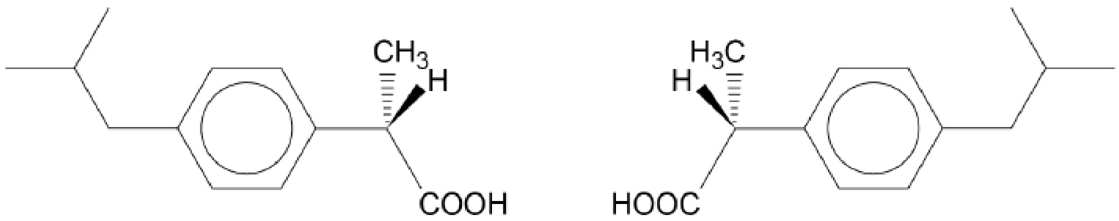
0 2 . 3 Prilocaine is completely hydrolysed in the human body to give a mixture of products.

Draw the structures of the two organic products formed in the complete hydrolysis of prilocaine in acidic conditions.

[3 marks]

0 2 . 4 **Figure 4** shows optical isomers **F** and **G**.

Figure 4



Isomer **F** Isomer **G**

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]

2. June/ 2020/Paper_2/No.4

0 4 Aspirin can be produced by reacting salicylic acid with ethanoic anhydride. An incomplete method to determine the yield of aspirin is shown.

1. Add about 6 g of salicylic acid to a weighing boat.
2. Place the weighing boat on a 2 decimal place balance and record the mass.
3. Tip the salicylic acid into a 100 cm^3 conical flask.
4. ____
5. Add 10 cm^3 of ethanoic anhydride to the conical flask and swirl.
6. Add 5 drops of concentrated phosphoric acid.
7. Warm the flask for 20 minutes.
8. Add ice-cold water to the reaction mixture and place the flask in an ice bath.
9. Filter off the crude aspirin from the mixture and leave it to dry.
10. Weigh the crude aspirin and calculate the yield.

0 4 . 1 Describe the instruction that is missing from step **4** of the method.

Justify why this step is necessary.

[2 marks]

Instruction ____

Justification ____

____

____

0 4 . 2 Suggest a suitable piece of apparatus to measure out the ethanoic anhydride in step **5**.

[1 mark]

____

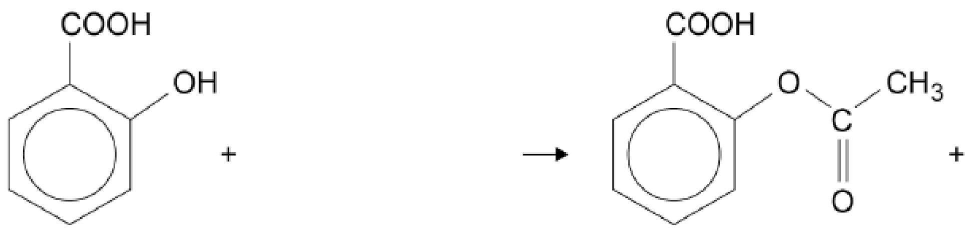
0 4 . 3 Identify a hazard of using concentrated phosphoric acid in step **6**.

[1 mark]

____

0 4 . 4 Complete the equation for the reaction of salicylic acid with ethanoic anhydride to produce aspirin.

[1 mark]



Salicylic acid Aspirin

0 4 . 5 A 6.01 g sample of salicylic acid (M_r = 138.0) is reacted with 10.5 cm^3 of ethanoic anhydride (M_r = 102.0).
In the reaction the yield of aspirin is 84.1%

The density of ethanoic anhydride is 1.08 g cm^{-3}

Show by calculation which reagent is in excess.

Calculate the mass, in g, of aspirin (M_r = 180.0) produced.

[5 marks]

Reagent in excess ______________________

Mass of aspirin ______________ g

0 4 . 6 Suggest **two** ways in which the melting point of the crude aspirin collected in step **9** would differ from the melting point of pure aspirin.

[2 marks]

Difference 1 ______________________________

____

Difference 2 ______________________________

____

0 4 . 7 The crude aspirin can be purified by recrystallisation using hot ethanol (boiling point = 78 °C) as the solvent.

Describe **two** important precautions when heating the mixture of ethanol and crude aspirin.

[2 marks]

Precaution 1 ______________________________

____

Precaution 2 ______________________________

____

0 4 . 8 The pure aspirin is filtered under reduced pressure.
A small amount of cold ethanol is then poured through the Buchner funnel.

Explain the purpose of adding a small amount of cold ethanol.

[1 mark]

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____

____

0 4 . 9 A sample of the crude aspirin is kept to compare with the purified aspirin.

Describe **one** difference in appearance you would expect to see between these two solid samples.

[1 mark]

____

____

____

3. June/ 2020/Paper_2/No.5

0 5 This question is about 2-bromopropane.

0 5 . 1 Define the term electronegativity.

Explain the polarity of the C–Br bond in 2-bromopropane.

[3 marks]

Electronegativity ____

____

____

Explanation ____

____

____

0 5 . 2 Outline the mechanism for the reaction of 2-bromopropane with an **excess of ammonia**.

[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 ____

4. June/ 2019/Paper_2/No.7

0 7 Isomers **X** and **Y** have the molecular formula C_5H_8O

Isomer **X** Isomer **Y**

0 7 . 1 Give the IUPAC name for isomer **X**.

[1 mark]

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0 7 . 2 Explain how and why isomers **X** and **Y** can be distinguished by comparing **each** of their

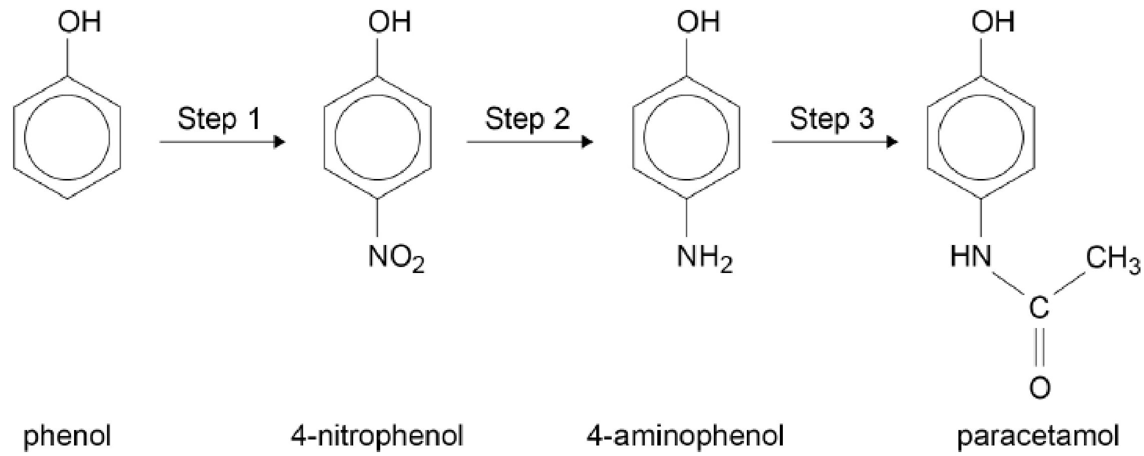
- boiling points
- ^{13}C NMR spectra
- infrared spectra.

Use data from Tables **A** and **C** in the Data Booklet in your answer.

[6 marks]

5. June/ 2019/Paper_2/No.8

0 8 Paracetamol is a medicine commonly used to relieve mild pain.
Traditionally, paracetamol has been made industrially in a three-step synthesis from phenol.



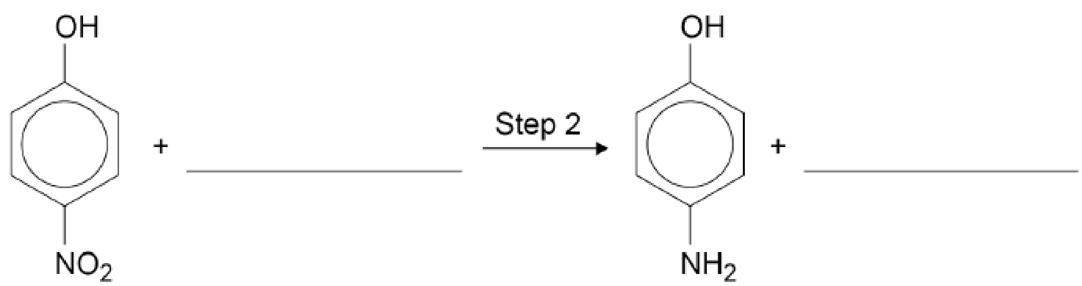
0 8 . 1 Name the mechanism of the reaction in Step **1**.

[1 mark]

____

0 8 . 2 Complete the equation for the reaction in Step **2**.

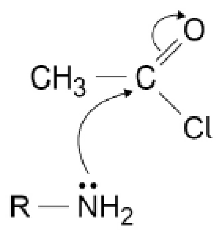
[1 mark]



0 8 . 3 In theory, either ethanoyl chloride or ethanoic anhydride could be used in Step **3**.

Complete the mechanism for the reaction of 4-aminophenol with ethanoyl chloride. RNH_2 is used to represent 4-aminophenol in this mechanism.

[2 marks]



0 8 . 4 In practice, ethanoic anhydride is used in the industrial synthesis rather than ethanoyl chloride.

Give **one** reason why ethanoyl chloride is **not** used in the industrial synthesis.

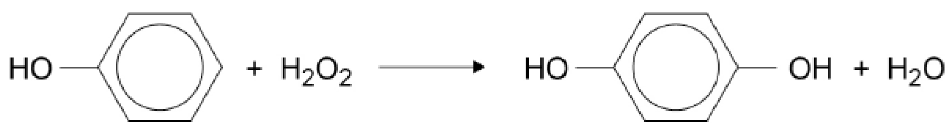
[1 mark]

0 8 . 5 In Step **3** other aromatic products are formed as well as paracetamol.

Draw the structure of **one** of these other aromatic products.

[1 mark]

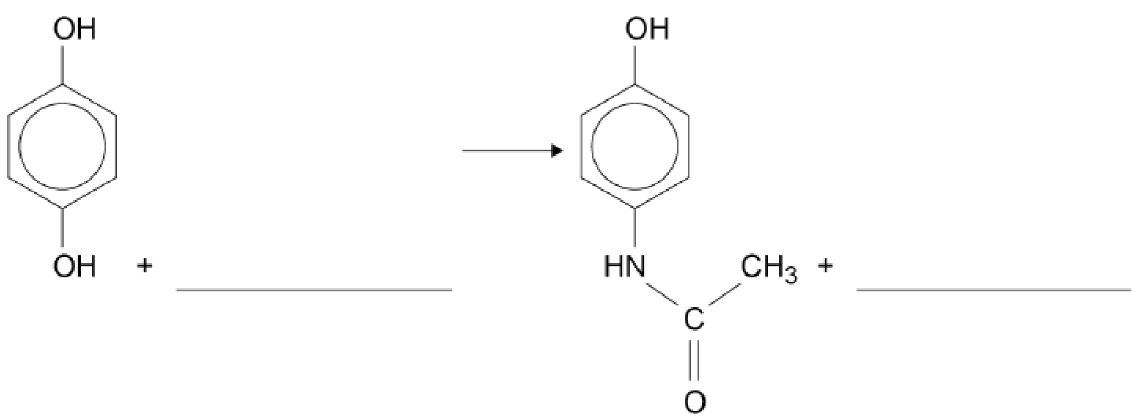
0 8 . 6 Chemists have recently developed a two-step process to produce paracetamol from phenol.
In the first step, phenol is oxidised to hydroquinone.



hydroquinone

In the second step, hydroquinone reacts with ammonium ethanoate to form paracetamol.

Complete the equation for this second step.



hydroquinone paracetamol

[1 mark]

0 8 . 7 Calculate the mass, in kg, of hydroquinone (M_r = 110.0) needed to produce 250 kg of paracetamol.

[3 marks]

Mass ____________________________ kg

6. June/2021/Paper_2/No.2

0 2 This question is about fuels.

0 2 . 1 The petrol fraction obtained from crude oil can be used as fuel in cars.

State the meaning of fraction, as used in the term petrol fraction.

[1 mark]

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____

____

0 2 . 2 Hexadecane ($C_{16}H_{34}$) can be cracked at high temperature to form petrol.

Complete the equation to show the cracking of one molecule of hexadecane to form hexane and cyclopentane only.

Give the name of a catalyst used in this cracking reaction.

[3 marks]

$$C_{16}H_{34} \rightarrow \_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_$$

Catalyst ____

0 2 . 3 Carbon dioxide is formed when petrol is burned.
Carbon dioxide acts as a greenhouse gas when it absorbs infrared radiation.

Give a reason why carbon dioxide absorbs infrared radiation.

[1 mark]

____

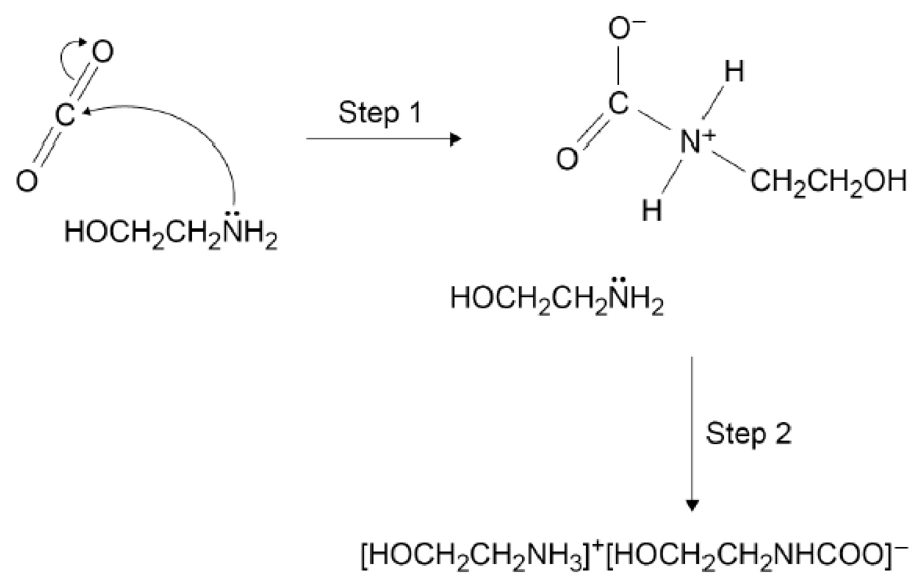
____

____

0 2 . 4 Compound **Z** ($HOCH_2CH_2NH_2$) can be used to remove carbon dioxide from the mixture of waste gases produced in some power stations.

Figure 1 shows part of a suggested mechanism for the reaction of **Z** with carbon dioxide.

Figure 1



Draw **two** curly arrows to complete the mechanism in **Figure 1**.

Name compound **Z** ($HOCH_2CH_2NH_2$)

Deduce the role of **Z** in step **2** of the mechanism.

[4 marks]

Name ______________________________

Role ______________________________

____

0 2 . 5 $HOCH_2CH_2NH_2$ can be represented as XNH_2
$[HOCH_2CH_2NH_3]^+$ can be represented as $[XNH_3]^+$

Draw the shape of XNH_2 and of $[XNH_3]^+$

State whether the H–N–H bond angle in XNH_2 is greater than, the same as, or smaller than that in $[XNH_3]^+$

Explain your answer.

[4 marks]

Shape of XNH_2 Shape of $[XNH_3]^+$

Bond angle ______________________________

Explanation ______________________________

____

0 2 . 6 Bioethanol is used as an alternative to fossil fuels.

This statement appeared on a website.

"The fact that bioethanol is a carbon-neutral fuel outweighs the environmental disadvantages of producing bioethanol."

Evaluate this statement.

In your answer you should include:
- an outline of how bioethanol is produced
- relevant equations
- analysis of the environmental impacts.

[6 marks]