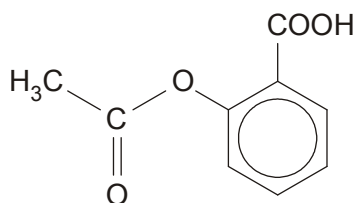


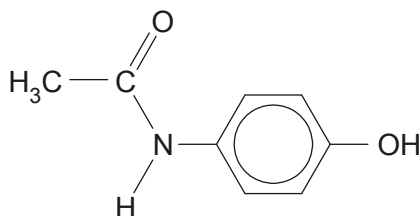
F324: Rings, Polymers and Analysis

4.1.3 Carboxylic Acids and Esters

1. Aspirin and paracetamol are commonly available painkillers.



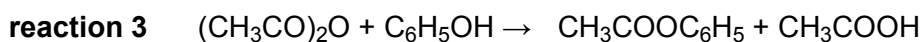
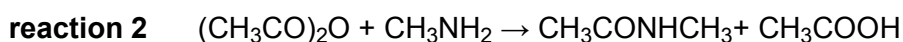
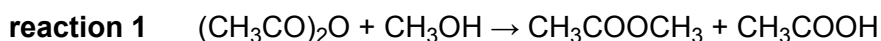
aspirin



paracetamol

Aspirin and paracetamol can be prepared using ethanoic anhydride, $(\text{CH}_3\text{CO})_2\text{O}$.

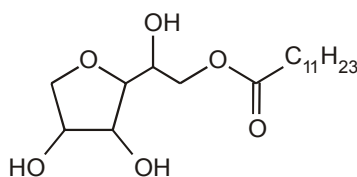
Some examples of the reactions of ethanoic anhydride are shown below.



Draw the structure of a compound that could react with ethanoic anhydride to form aspirin.

[Total 1 mark]

2. The demand for 'natural' shampoos and detergents has led to the development of more biodegradable detergents such as sorbitan monolaurate, which is made from plants.



sorbitan monolaurate

- (i) Suggest a type of reaction that could break down sorbitan monolaurate when it is washed into drains and rivers.

Explain your answer and state the type of organic products formed.

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[3]

- (ii) Suggest **one other** reason why detergents such as sorbitan monolaurate are regarded as 'environmentally friendly'.

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[1]

[Total 4 marks]

3. An ester **D** with the formula, $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}(\text{CH}_3)_2$, is used in rum flavouring.

- (a) Draw a displayed formula of ester **D**.

[2]

- (b) Outline how you could obtain a sample of ester **D**, starting with a named carboxylic acid and a named alcohol.

Include any essential reaction conditions and write an equation for the reaction. You do not need to include any details of the separation or purification of the ester.

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[6]

- (c) State a spectroscopic method that could be used to confirm that a sample of ester **D** has a molecular mass of 130.

Explain how you would obtain the molecular mass of **D** from the spectrum.

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[2]

[Total 10 marks]

4. Linoleic acid, $C_{17}H_{31}COOH$, is an unsaturated fatty acid found in triglycerides from sunflower oil.

(i) Draw the structure of the triglyceride made from linoleic acid, $C_{17}H_{31}COOH$, and propane-1,2,3-triol. Show clearly all the bonds in the ester groups.

[2]

(ii) Deduce the number of carbon to carbon double bonds in a molecule of the triglyceride.

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[1]

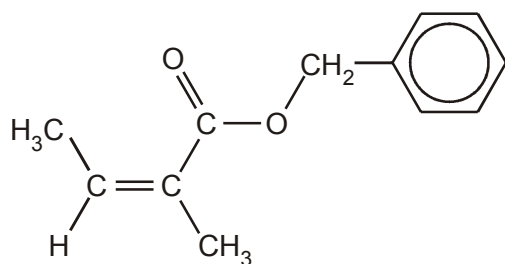
[Total 3 marks]

5. Explain why triglycerides are soluble in non-polar solvents and not in water.

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[Total 3 marks]

6. Compound **A** is used to add the flavour of mushrooms to foods.



compound **A**

- (a) (i) Apart from the benzene ring, name the two functional groups in compound **A**.

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[2]

- (ii) Draw the skeletal formula of compound **A**.

[1]

- (iii) Deduce the molecular formula of compound **A**.

.....

[1]

- (b) Compound **B** is a stereoisomer of compound **A**.

Explain what is meant by the term *stereoisomerism*. Use compounds **A** and **B** to illustrate your answer.

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[2]

- (c) If the food is cooked for a long time, naturally occurring acids catalyse the hydrolysis of compound **A**.

Draw structures to show the **two** organic compounds formed by the acid hydrolysis of compound **A**.

[2]

- (d) The hydrolysis of compound **A** can be monitored by sampling the mixture at regular intervals, separating the components, and recording their infra-red spectra.

- (i) State **two** absorptions that would be expected in the infra-red spectrum of compound **A**, and identify the parts of the molecule responsible for each.

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[2]

- (ii) Suggest a wavenumber range within the spectrum that could be used to clearly distinguish compound **A** from the products formed by the hydrolysis reaction.

Explain your answer.

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[2]

[Total 12 marks]

7. Glyceryl trihexanoate is a triglyceride that can be made from glycerol (propane-1,2,3-triol) and hexanoic acid, $C_5H_{11}COOH$.

Draw the structure of glyceryl trihexanoate. Show every bond in the functional groups.

[Total 2 marks]

8. As a wine ages, some of the acids slowly react with ethanol in the wine to produce esters.

(i) Draw a displayed formula to show the structure of the ester formed when **lactic acid** reacts with ethanol.

[1]

(ii) Suggest what effect this process might have on the flavour of the wine. Explain your reasoning.

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[1]

[Total 2 marks]

9. Reaction of geraniol with ethanoic acid can be used to make ester **Z**, which is used in chewing gum and desserts.

(i) Suggest why esters are used in the manufacture of foods.

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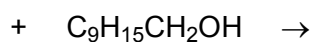
[1]

(ii) State the conditions needed to make ester **Z** from geraniol and ethanoic acid.

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.....

[2]

(iii) Complete the equation for the formation of ester **Z**.



[3]

[Total 6 marks]

10. Benzoic acid and phenylmethanol will react with each other in the presence of a suitable catalyst.

(i) State a suitable catalyst for this reaction.

.....

[1]

(ii) Draw the displayed formula of the organic product.

[2]

[Total 3 marks]