Carbonyl Compounds, Carboxylic Acids, Esters & Polyesters AS & A Level

Question Paper 2

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Organic Chemistry & Analysis
Topic	Carbonyl Compounds, Carboxylic Acids, Esters & Polyesters
Paper	AS & A Level
Booklet	Question Paper 2

Time allowed: **61 minutes**

Score: **/45**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

A student was researching the development of polymers and discovered three polyesters, PET, PEN and PGA, that are used in the manufacture of plastic bottles.

(a) The student discovered that the first polyester developed was Terylene which is also known as poly(ethylene terephthalate) or PET.

PET can be made by reacting benzene-1,4-dicarboxylic acid with ethane-1,2-diol.

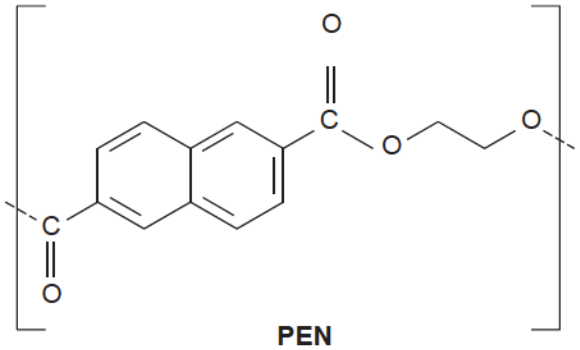
(i) Draw the **displayed** formula of the repeat unit in PET. [2]

(ii) The industrial manufacture of PET involves two main stages. The first stage, known as 'pre-polymerisation', forms compound **F** with molecular formula $C_{12}H_{14}O_6$.

Draw the structure of compound **F**. [1]

(b) PEN is a new kind of polyester. PEN is rigid at high temperature whereas PET readily softens.

The repeat unit of PEN is shown below.



PEN

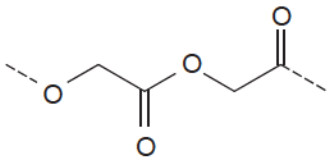
(i) What is the empirical formula of the repeat unit in PEN? [1]

(ii) Draw the structures of **two** monomers that could be used to make PEN.

[2]

(c) Polyglycolic acid, PGA, is a polymer that is being developed as an inner coating for PET bottles.

A short section of PGA is shown below.



PGA

(i) Compared with other synthetic polymers, PGA can be easily hydrolysed.

Draw the skeletal formula of the organic product formed from the complete hydrolysis of PGA by NaOH(aq). [2]

(ii) Explain why scientists now think that polymers such as PGA are better for the environment than hydrocarbon-based polymers.

In your answer, you should use appropriate technical terms, spelt correctly. [1]

[Total 9 Marks]

Two esters, $CH_3(CH_2)_2COO(CH_2)_3CH_3$ and $CH_3(CH_2)_2COOCH_2CH_3$, contribute to the odour of pineapple. A food scientist analysed a sample of pineapple essence by separating the two esters using gas chromatography, GC, and measuring their retention times.

(a) (i) State what is meant by *retention time*. [1]

(ii) Explain the possible limitations of GC in separating the two esters. [1]

(iii) Give the systematic name for the ester $CH_3(CH_2)_2COO(CH_2)_3CH_3$ [1]

(b) The unsaturated ester, ethyl deca-2,4-dienoate contributes to the flavour of pears.

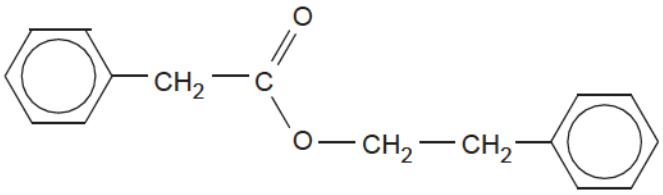
(i) Draw the structure of this ester. [2]

(ii) When pears ripen, ethyl deca-2,4-dienoate is formed following the breakdown of triglycerides.

Draw the general structure of a triglyceride with any functional groups fully displayed.

You can use 'R' to represent the carbon chains. [1]

(c) The food scientist decided to synthesise the ester shown below, for possible use as a flavouring.



The **only** organic compound available to the food scientist was phenylethanal ($C_6H_5CH_2CHO$).

Explain how the food scientist was able to synthesise this ester using only phenylethanal and standard laboratory reagents.

In your answer, you should use appropriate technical terms, spelt correctly. [7]

[Total 13 Marks]

Hydroxyethanal, $HOCH_2CHO$, is sometimes referred to as the 'first sugar' as it is the simplest possible molecule that contains both an aldehyde group and an alcohol group.

A biochemist investigated some redox reactions of hydroxyethanal and found that several different products were produced.

(a) The biochemist reacted hydroxyethanal with Tollens' reagent.

(i) State what the biochemist would see when hydroxyethanal reacts with Tollens' reagent. [1]

(ii) Write the structural formula of the organic product formed when hydroxyethanal reacts with Tollens' reagent. [1]

(b) The biochemist also reacted hydroxyethanal with acidified dichromate by heating under reflux.

Write an equation for this oxidation. [2]

Use **[O]** to represent the oxidising agent.

(c) The biochemist then reduced hydroxyethanal using aqueous $NaBH_4$.

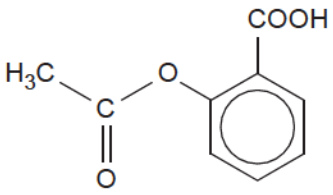
(i) Write the structural formula of the organic product. [1]

(ii) Outline the mechanism for this reduction.

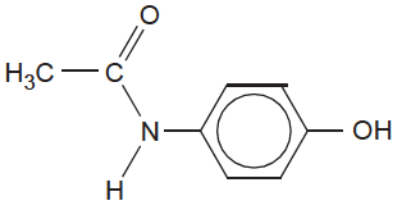
Use curly arrows and show any relevant dipoles. [4]

[Total 9 Marks]

Aspirin and paracetamol are commonly available painkillers.



aspirin



paracetamol

Aspirin and paracetamol can be prepared using ethanoic anhydride, $(CH_3CO)_2O$.

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

reaction 1 $(CH_3CO)_2O + CH_3OH \rightarrow CH_3COOCH_3 + CH_3COOH$

reaction 2 $(CH_3CO)_2O + CH_3NH_2 \rightarrow CH_3CONHCH_3 + CH_3COOH$

reaction 3 $(CH_3CO)_2O + C_6H_5OH \rightarrow CH_3COOC_6H_5 + CH_3COOH$

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

[1]

(b) Ethanoic anhydride can react with 4-aminophenol to produce paracetamol.

(i) Write an equation, showing structural formulae, for this formation of paracetamol. [2]

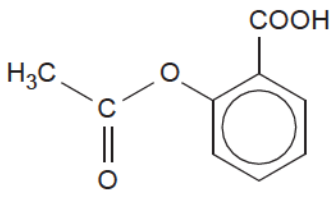
(ii) An impurity with molecular formula $C_{10}H_{11}NO_3$ is also formed.

Draw the structure of this impurity. [1]

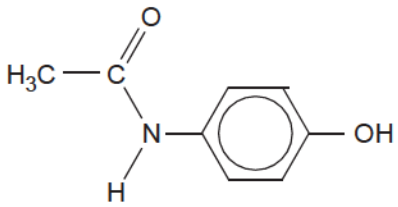
(iii) Explain why it is necessary for pharmaceutical companies to ensure that drugs and medicines are pure. [1]

(c) Name the functional groups in aspirin and in paracetamol. [2]

(d) A student carried out some reactions with samples of aspirin and paracetamol in the laboratory. Their structures are repeated below.



aspirin



paracetamol

The student tried to react each of the reagents **A**, **B** and **C** with aspirin and paracetamol.

- Reagent **A** reacted with aspirin **and** with paracetamol.
- Reagent **B** reacted **only** with aspirin.
- Reagent **C** reacted **only** with paracetamol.

Suggest possible identities of reagents **A**, **B** and **C** and the organic products that would be formed.

(i) Reagent **A**:

Organic product with aspirin:

Organic product with paracetamol:

[3]

(ii) Reagent **B**:

Organic product with aspirin:

[2]

(iii) Reagent **C**:

Organic product with paracetamol:

[2]

[Total 14 Marks]