2 A student was investigating the reactions and uses of organic amines.

(a) The student found that amines such as ethylamine, $C_2H_5NH_2$, and phenylamine, $C_6H_5NH_2$, both behave as bases.

(i) Explain why amines can behave as bases.

.....

..... **[1]**

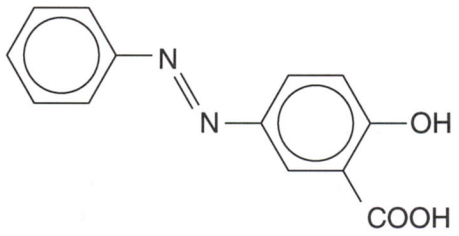
(ii) The student reacted an excess of $C_2H_5NH_2$ with two different acids.

Write the formulae of the salts that would be formed when an **excess** of $C_2H_5NH_2$ reacts with:

sulfuric acid, ...

ethanoic acid. ..... **[2]**

(b) The student reacted phenylamine with a mixture of $NaNO_2(aq)$ and $HCl(aq)$ whilst keeping the temperature below 10 °C. A diazonium ion was formed. The student then reacted the diazonium ion with compound **B**. After neutralisation, compound **A** was formed.



compound **A**

(i) Draw the structures of the diazonium **ion** and compound **B**.

Display the functional group in the diazonium ion.

diazonium **ion**	compound **B**

[2]

(ii) State the conditions required for the reaction of the diazonium ion with compound **B** and state a possible use for compound **A**.

conditions .....

possible use for compound **A**. ..... **[1]**

(iii) The student added Na_2CO_3 to a solution of compound **A**.

Draw the structure of the organic product and state the formulae of any other products from this reaction.

[2]

(c) The student repeated the experiment in part **(b)** but allowed the temperature to rise above 10 °C.

Under these conditions, the diazonium **ion** in **(b)(i)** reacts with water to produce phenol. A gas with molar mass of 28.0 g mol^{-1} and one other product are also formed.

Construct an equation for this reaction.

[1]

[Total: 9]

(c) When ethyl methacrylate, $CH_2C(CH_3)COOC_2H_5$, is heated under reflux with aqueous dilute acid, a hydrolysis reaction takes place forming compound **C** and ethanol.

When compound **C** is heated with steam in the presence of an acid catalyst, an addition reaction takes place forming two organic products **D** and **E**.

Compounds **D** and **E** are structural isomers with the molecular formula $C_4H_8O_3$.

Draw the structures of compounds **C**, **D** and **E**.

compound **C**

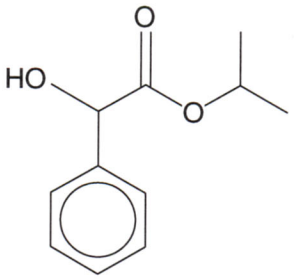
compound **D**

compound **E**

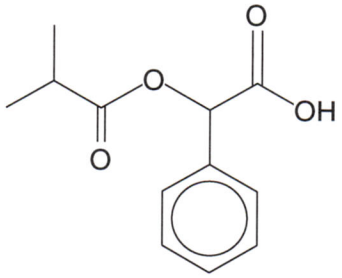
[3]

TURN OVER FOR PART (d)

(d) Mandelic acid has anti-bacterial properties and is used in some skin creams. A cosmetic chemist used mandelic acid to prepare two different esters that might be suitable for new skin creams. The structures of the two esters are shown below.



ester 1



ester 2

(i) Draw the structure of an organic compound that could react with mandelic acid, $C_6H_5CH(OH)COOH$, to produce **ester 1**.

[1]

(ii) Identify an organic compound that could react with mandelic acid to produce **ester 2.**

[1]

June 2011

4 'Methylglyoxal', CH_3COCHO, is formed in the body during metabolism.

Describe **one** reduction reaction and **one** oxidation reaction of methylglyoxal that could be carried out in the laboratory.

Your answer should include reagents, equations and observations, if any.

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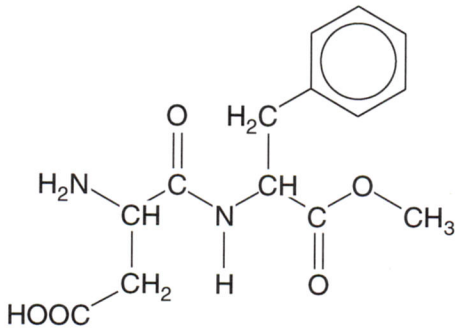
.....

..... **[5]**

[Total: 5]

6 The addition of sucrose, table sugar, to food and drink has been linked to the increased risk of obesity and insulin resistance. Aspartame is used as an alternative to sugar.

The structure of aspartame is shown below.



aspartame

(a) Aspartame contains five functional groups including the benzene ring, and has two chiral carbon atoms.

(i) Circle the **two** chiral carbon atoms on the structure above. **[1]**

(ii) **Name** the **four** functional groups, other than the benzene ring, in aspartame.

....

.... **[2]**

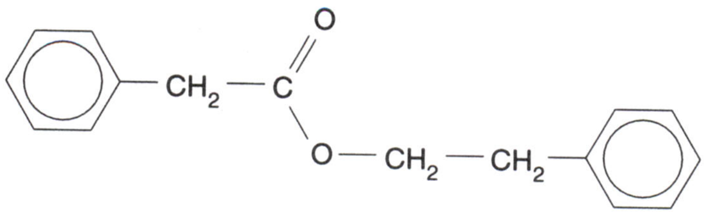
(b) Aspartame consumed in food or drink might be hydrolysed by the acid in the stomach. This acid consists mainly of hydrochloric acid.

Draw the structures of the **three** organic products formed by the **complete** acid hydrolysis of aspartame.

[4]

June 2010

4 **(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]

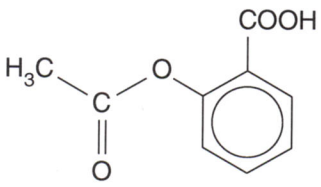
[Total: 13]

/47

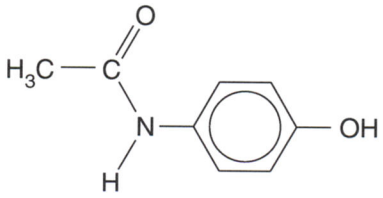
(5)

Jan 2010

5 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.

.....

.....

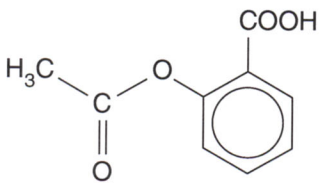
..... **[1]**

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

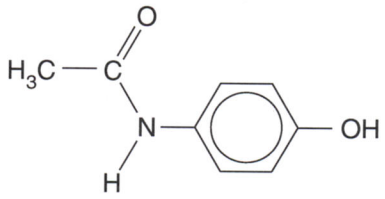
aspirin .....

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]

END OF QUESTION PAPER