



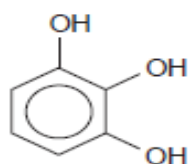
# **GCE A LEVEL CHEMISTRY**

S21-A410

## **Assessment Resource I**

Organic Chemistry and Analysis

1. Benzene-1,2,3-triol can be used to find the percentage of oxygen in a gas mixture.



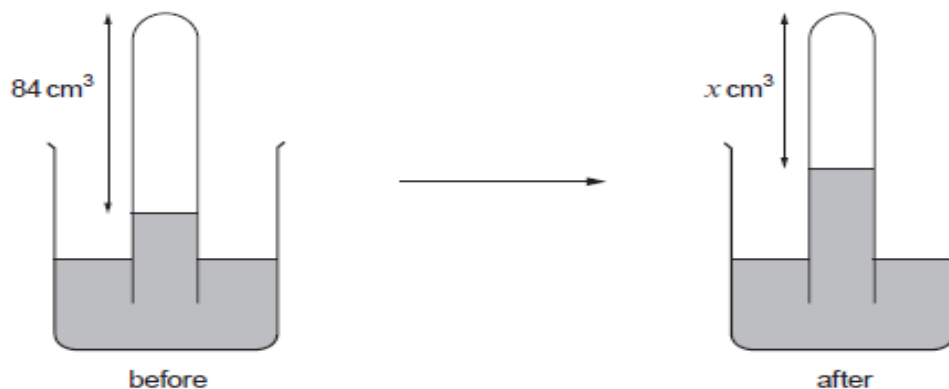
- (a) Give the empirical formula of benzene-1,2,3-triol. [1]

.....

- (b) Oxygen reacts with an alkaline solution of benzene-1,2,3-triol.

A gas mixture contains 26% of oxygen by volume, with the remaining gas being largely nitrogen with a smaller amount of helium.

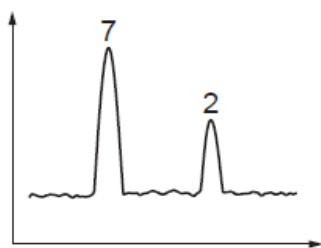
When  $84 \text{ cm}^3$  of this mixture reacts with alkaline benzene-1,2,3-triol, its volume is reduced to  $x \text{ cm}^3$  as shown in the diagram.



- (i) Use the information given to calculate the value  $x$  in  $\text{cm}^3$ . [1]

$x = \text{.....} \text{ cm}^3$

- (ii) After removal of oxygen the remaining gas was passed through a gas chromatograph and gave the following result, where the figures are relative peak areas.

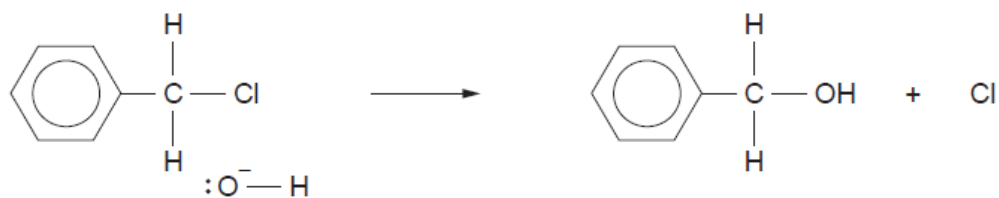


Use your answer to part (i) and the chromatogram to calculate the volumes of helium and nitrogen in the original gas mixture. [2]

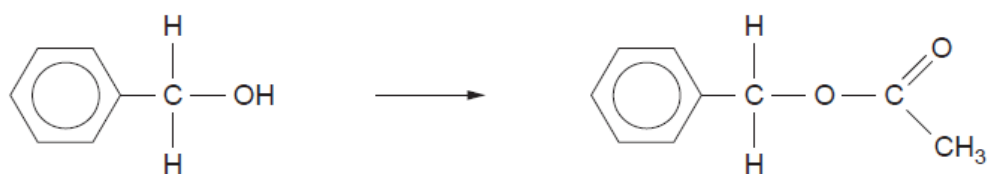
Volume of nitrogen = .....  $\text{cm}^3$

Volume of helium = .....  $\text{cm}^3$

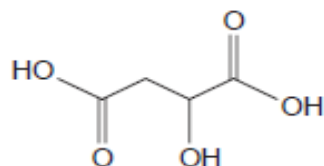
2. (a) Complete the mechanism for the reaction below by adding suitable curly arrows and partial/full charges. You do **not** need to show lone pairs of electrons. [2]



- (b) State a reagent for the following reaction. [1]



3. (a) The acid present in apples is almost entirely malic acid (2-hydroxybutanedioic acid),  $M_r$  134.



The amount of malic acid in apple juice was found using the following method.

- 6.80g of apple juice was placed in a flask containing 50.0 cm<sup>3</sup> of water and the mixture stirred.
- The diluted apple juice was titrated with aqueous sodium hydroxide of concentration 0.120 mol dm<sup>-3</sup> until the acid was just neutralised.
- The volume of aqueous sodium hydroxide needed was 5.60 cm<sup>3</sup>.

- (i) Calculate the percentage by mass of malic acid in the apple juice.

You should assume that both carboxylic acid groups in malic acid react in this titration. [3]

Percentage = ..... %

- (ii) The experiment was repeated using 6.80g of apple juice which was added to 100.0 cm<sup>3</sup> of water before mixing.

Explain why this change to the method would not give a different result for the percentage of malic acid present. [1]

.....  
.....

- (iii) The amount of malic acid present in apple juice is generally less than 1 %.

Suggest **two** ways by which the method could be improved to give a more reliable result. Give reasons for your answers. [2]

1. ....

.....

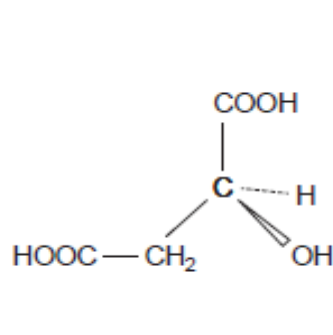
2. ....

.....

(b) (i) Naturally-occurring malic acid is one of two enantiomers. One is drawn below.

Draw the structure of the other enantiomer.

[1]



(ii) The two enantiomers of malic acid rotate the plane of plane polarised light. The extent to which this occurs can be calculated from the formula

$$[\alpha^{20}_D] = \frac{100 \times \alpha}{c \times L}$$

where  $[\alpha^{20}_D]$  has a value of  $27^\circ$  under the conditions used

$\alpha$  is the rotation in degrees

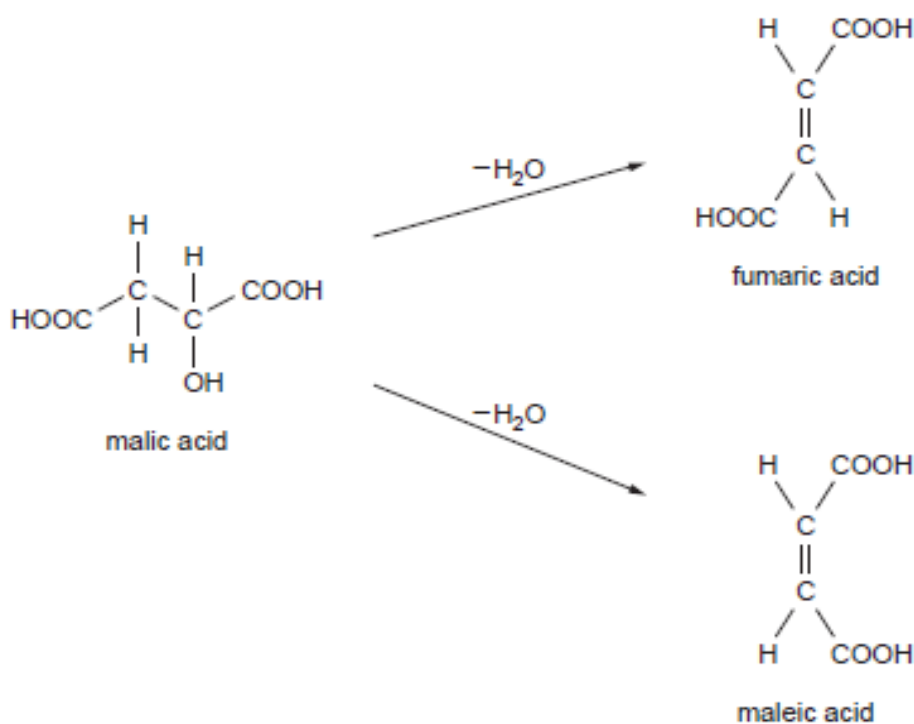
$c$  is the concentration of the malic acid in g per  $100\text{cm}^3$

$L$  is the length of the polarimeter tube in dm

Use the formula to calculate the concentration in  $\text{mol dm}^{-3}$  of one enantiomer of malic acid when  $L$  has a length of 1 dm and  $\alpha$  has a value of  $4.5^\circ$ . The relative molecular mass of malic acid is 134. [3]

Concentration = .....  $\text{mol dm}^{-3}$

- (c) The action of heat on malic acid gives initially a mixture of two stereoisomers, maleic acid and fumaric acid.



- (i) Explain the term stereoisomerism.

[1]

- (ii) All three acids show stereoisomerism.

Explain how the type of stereoisomerism shown by malic acid differs from that shown by maleic acid and fumaric acid.

You should comment on both types of stereoisomerism in your answer.

[2]



- (d) (i) Phenylamine is made in the laboratory by the reduction of nitrobenzene.

State the reagents used for this reduction.

[1]

- (ii) The direct nitration of phenylamine gives a mixture of products as well as the required nitrophenylamine.

To obtain a better yield of nitrophenylamine, phenylamine is firstly converted to N-phenylethanamide.



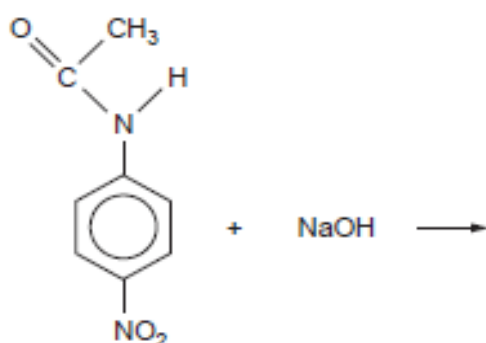
State a reagent that could be used for this reaction.

[1]

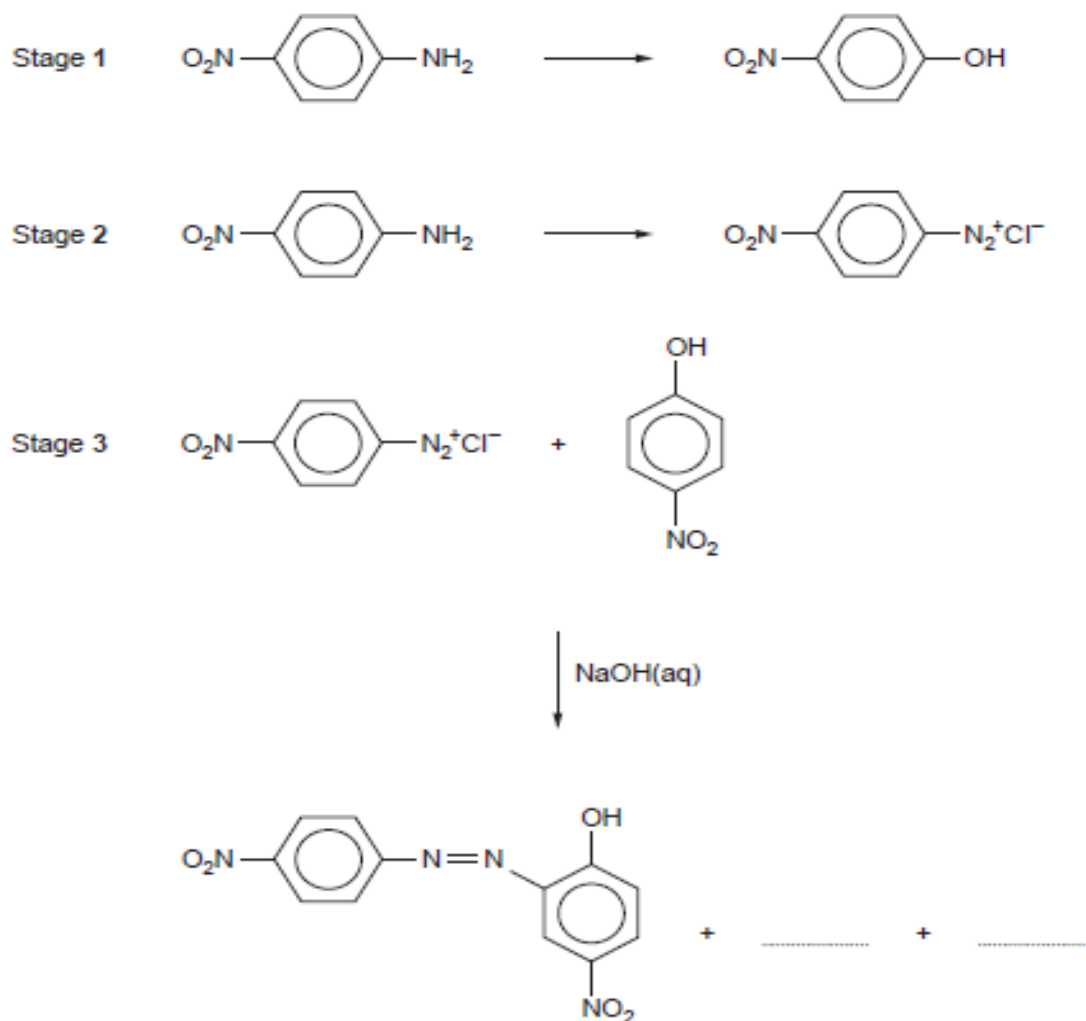
- (iii) Nitration of N-phenylethanamide gives N-(4-nitrophenyl)ethanamide which is then reacted with aqueous sodium hydroxide to give 4-nitrophenylamine.

Complete the equation for this reaction.

[1]



(e) A method for making an azo dye from 4-nitrophenylamine is shown below.



(i) State the temperature used for

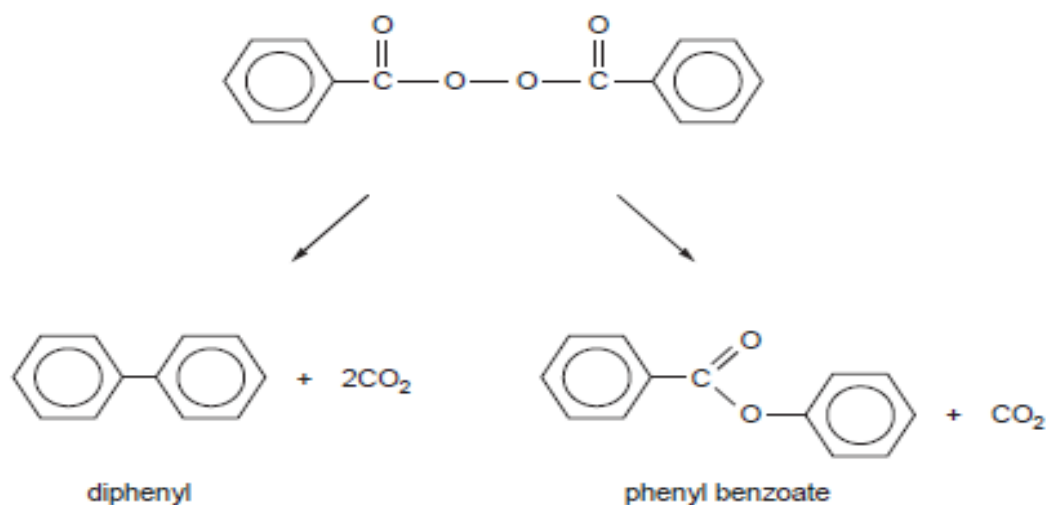
Stage 1 .....

Stage 2 .....

[2]

(ii) Complete the equation shown in stage 3 by giving the formulae of the other products formed. [1]

4. (a) Di(benzoyl) peroxide has important industrial and medicinal uses. On heating it decomposes via two different routes as shown.



In an experiment 0.0350 mol of di(benzoyl) peroxide was heated and gave a 67.5% yield of the ester phenyl benzoate.

- (i) Calculate the mass of phenyl benzoate produced. [2]

Mass = ..... g

- (ii) Calculate the total volume of carbon dioxide produced measured at 298 K and 1 atm pressure, assuming that the di(benzoyl) peroxide decomposed by the two routes shown above. [4]

Volume = ..... dm<sup>3</sup>

(iii) After heating, a white solid containing only diphenyl and phenyl benzoate remained. To obtain diphenyl, the white solid was heated with aqueous sodium hydroxide. Only the ester reacted, giving an aqueous solution containing sodium phenoxide and sodium benzoate.

I. State the type of reaction occurring. [1]

.....

II. Describe how a dry sample of diphenyl was obtained from this mixture. [1]

.....

