Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL

1410U50-1E

S19-1410U50-1E

CHEMISTRY – A2 unit 5
Practical Methods and Analysis Task

FRIDAY, 10 MAY 2019 – MORNING

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**13**	
2.	**8**	
3.	**9**	
Total	**30**	

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01

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator, pencil and ruler;
- **Data Booklet** supplied by WJEC.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions in the spaces provided.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

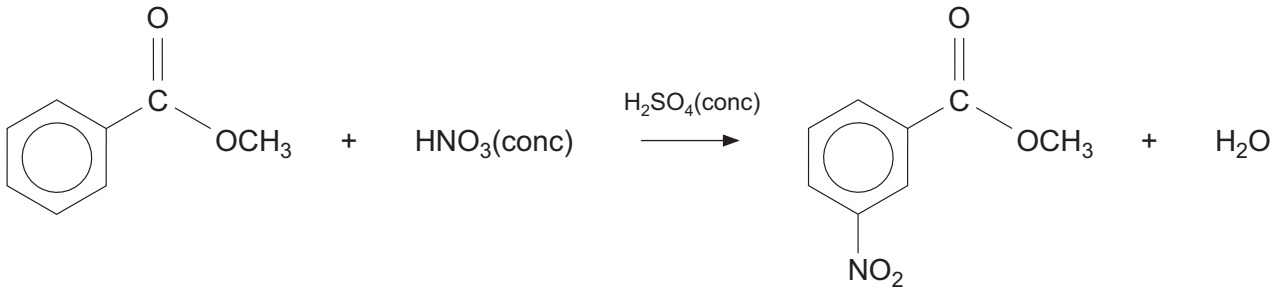
The maximum mark for this paper is 30.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

Answer **all** *questions.*

1. Compound **A** in the equation below can be prepared in the laboratory by nitration of methyl benzenecarboxylate using a nitrating mixture of concentrated nitric acid and concentrated sulfuric acid.



methyl benzenecarboxylate

compound **A**

A sample of compound **A** was prepared as follows.

Stage 1
5.0 cm^3 of methyl benzenecarboxylate was placed in a dry 100 cm^3 conical flask and 8 cm^3 of concentrated sulfuric acid was added with swirling to ensure thorough mixing. The flask was then cooled by partially immersing it in an ice-water bath.

Stage 2
A nitrating mixture was prepared by adding 3 cm^3 of concentrated nitric acid to a dry beaker and cooling by partially immersing it in an ice-water bath. Then 3 cm^3 of concentrated sulfuric acid was added slowly, with swirling, and the mixture was then allowed to cool for 10 minutes.

Stage 3
The nitrating mixture was then added drop-wise to the contents of the conical flask. The flask was swirled as the nitrating mixture was added and the temperature of the reaction mixture kept below 5 °C.

Stage 4
Once addition was complete, the reaction mixture was kept at room temperature for a further 15 minutes before it was poured onto a small amount of crushed ice in a beaker. Solid compound **A** was formed.

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(a) Suggest why the reaction mixture was cooled during stage 3. [1]

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(b) Compound **A** is very much more soluble in hot ethanol than it is in cold ethanol.

Describe how you would purify the sample of compound **A**. [3]

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(c) After purification 4.56 g of compound **A** was isolated.

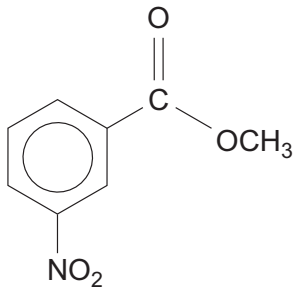
Calculate the percentage yield of this reaction. [4]

(density of methyl benzenecarboxylate is 1.08 g cm^{-3})

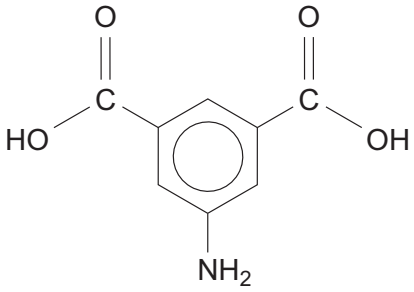
Percentage yield = ... %

Examiner only

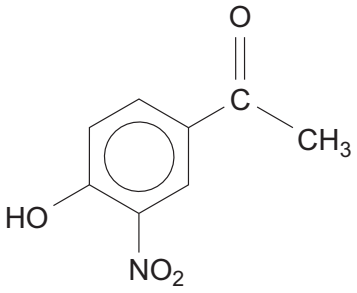
(d) $C_8H_7NO_4$ has a number of different isomers. Three of them are shown below.



compound **A**



5-aminobenzene-1,3-dicarboxylic acid



1-(4-hydroxy-3-nitrophenyl)ethanone

(i) State **two** chemical tests that will give a positive result for 5-aminobenzene-1,3-dicarboxylic acid but **not** for compound **A**.

Give the reagent(s) and observation(s) for a positive test. [2]

Test 1

Reagent(s) .....

Observation(s) .....

Test 2

Reagent(s) .....

Observation(s) .....

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(ii) State **three** chemical tests that will give a positive result for 1-(4-hydroxy-3-nitrophenyl)ethanone but **not** for compound **A**.

Give the reagent(s) and observation(s) for a positive test. [3]

Test 1

Reagent(s) .....

Observation(s) .....

Test 2

Reagent(s) .....

Observation(s) .....

Test 3

Reagent(s) .....

Observation(s) .....

13

Turn over.

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2. You are supplied with four unlabelled aqueous solutions containing the following species.

CO_3^{2-}	I^-	Cl_2	$S_2O_3^{2-}$
carbonate	iodide	chlorine	thiosulfate

You are also provided with the following reagents.

- dilute H_2SO_4
- $AgNO_3(aq)$

Devise a scheme whereby **all** four of the unlabelled solutions could be **positively identified**.

You should include observations and **ionic** equations for any reactions occurring. [8]

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3. A solid mixture contains sodium carbonate, sodium hydrogencarbonate and an unreactive impurity. It is known to contain 62.3 % by mass of sodium carbonate.

A student prepared a solution of the solid mixture by dissolving 8.72 g of it in water, transferring the solution into a 500 cm^3 volumetric flask and making up to the mark with deionised water. The solution was shaken vigorously and labelled as solution **X**.

The percentage by mass of sodium hydrogencarbonate in the solid mixture was then determined by two different methods.

Method 1: Titration

- 25.0 cm^3 of solution **X** was transferred into a conical flask and 3-5 drops of phenolphthalein indicator added.
- At the phenolphthalein end-point (indicator colour change pink to colourless) the following reaction is complete.

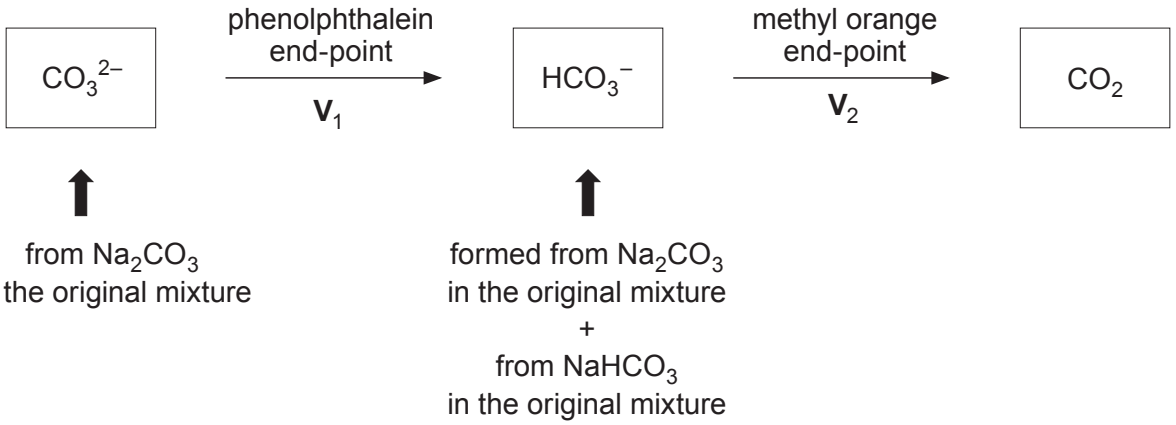
$$Na_2CO_3(aq) + HCl(aq) \longrightarrow NaHCO_3(aq) + NaCl(aq)$$

- 0.196 mol dm^{-3} hydrochloric acid was added from a burette whilst swirling, until the first permanent colour change occurred. The volume of hydrochloric acid used (volume $\mathbf{V}_1$) was recorded.
- 3-5 drops of methyl orange indicator were added to the solution in the conical flask.
- At the methyl orange end-point (indicator colour change yellow to pink) the following reaction is complete.

$$NaHCO_3(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l) + CO_2(g)$$

- The titration was continued with more of the hydrochloric acid added from the burette whilst swirling, until the first permanent colour change occurred. The **additional volume** of hydrochloric acid used (volume $\mathbf{V}_2$) was recorded.
- After carrying out one rough titration, the titration was repeated several times and mean values for $\mathbf{V}_1$ and $\mathbf{V}_2$ calculated.

Summary



Results

- Mean volume $\mathbf{V}_1$ of hydrochloric acid used = 13.10 cm^3
- Mean volume $\mathbf{V}_2$ of hydrochloric acid used = 20.80 cm^3

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(a) Why did the student repeat the titration? [1]

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(b) (i) Explain why the difference between volume $\mathbf{V}_2$ and $\mathbf{V}_1$ represents the volume of acid required to react with the original sodium hydrogencarbonate in the solid mixture. [1]

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(ii) Use the difference between volume $\mathbf{V}_2$ and $\mathbf{V}_1$ to calculate the percentage by mass of sodium hydrogencarbonate in the original solid mixture. [3]

Percentage by mass = ... %

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Method 2: Gas collection

- 25.0 cm^3 of solution **X** was transferred to a conical flask and excess hydrochloric acid added.
- 99.7 cm^3 of carbon dioxide gas was formed and collected in a gas syringe.

(Assume the reaction was carried out at 298 K and 1 atm pressure)

(c) (i) The original solid mixture contained 62.3 % by mass of sodium carbonate. Of the 99.7 cm^3 of carbon dioxide gas produced in this reaction, calculate the volume produced by the reaction between hydrochloric acid and the sodium carbonate in 25.0 cm^3 of solution **X**. [2]

Volume = ... cm^3

(ii) Hence, calculate the percentage by mass of sodium hydrogencarbonate in the original solid mixture. [2]

Percentage by mass = ... %

9

END OF PAPER

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