Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL

1410U50-1A

S18-1410U50-1A

CHEMISTRY – A2 unit 5

Practical Examination

Experimental Task

TEST 1

WEDNESDAY, 9 MAY 2018

3 hours

For Teacher's use only Award a mark of 0 or 1 for each of the following	
Efficient use of solutions (**Part A**)	
Efficient use of time (**Part B**)	
Working safely (**Parts A & B**)	

For Examiner's use only	
Mark Awarded	
Total	

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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. Pencil may be used to draw tables and graphs.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The total number of marks available for this task is 30.
Your teacher will directly assess your practical skills in **Parts A** and **B**.
The number of marks is given in brackets at the end of each question or part-question.
You are reminded of the necessity for orderly presentation in your answers.

This experimental task is in two parts.

Part A – Quantitative analysis of a carboxylic acid

Standardisation of a sodium hydroxide solution followed by an acid-base titration of unknown carboxylic acid $C_nH_{2n+1}COOH$.

Part B – Qualitative analysis to identify Y in $C_nH_{2n+1}Y$

A series of organic tests to identify the functional group **Y**.

The apparatus and chemicals required are listed on the following pages.

You should record all observations in the spaces provided and then use the results in the analysis section later in this paper.

Part A – Quantitative analysis of a carboxylic acid

Apparatus

You will need eye protection and the following apparatus:

1 × 50 cm^3 burette
2 × 25 cm^3 pipettes
2 × 250 cm^3 conical flasks
1 × 250 cm^3 beaker
1 × 100 cm^3 beaker
1 × small filter funnel
1 × wash bottle (deionised water)
1 × clamp & stand
1 × pipette filler
1 × white tile

Chemicals

You will need:

150 cm^3 of approximately 6.50 g dm^{-3} solution of unknown carboxylic acid $\mathbf{C_nH_{2n+1}COOH}$
150 cm^3 of approximately 0.100 mol dm^{-3} hydrochloric acid solution
250 cm^3 of sodium hydroxide solution of **unknown** concentration
deionised water
phenolphthalein indicator

Note

Your teacher will give you the **exact** concentrations of both acid solutions.
Record these on page 6.

You will standardise the sodium hydroxide solution as part of this experimental task.

Turn over.

Part B – Qualitative analysis to identify Y in $C_nH_{2n+1}Y$

Apparatus

You will need eye protection and the following apparatus:

dropping pipettes
3 × test tubes & rack
1 × test tube holder
sticky labels or marker pen suitable for writing on glass

Ready access to a water bath at 80 °C

Chemicals

You will need:

10 cm^3 of $\mathbf{C_nH_{2n+1}Y}$

Dichromate(VI) test
2 cm^3 of sulfuric acid solution
1 cm^3 of potassium dichromate(VI) solution

Iodoform test
1 cm^3 of iodine solution
2 cm^3 of sodium hydroxide solution

Silver nitrate test
2 cm^3 of sodium hydroxide solution
2 cm^3 of nitric acid solution
1 cm^3 of silver nitrate solution

Part A – Quantitative analysis of a carboxylic acid

Many substituted carboxylic acids (**$C_nH_{2n}YCOOH$**) are well recognised as “corrosion inhibitors” of metals. The carboxylic acid **$C_nH_{2n+1}COOH$** is used as the starting material in the industrial preparation of **$C_nH_{2n}YCOOH$**.

The purity of the starting material must be 100% or the formation of side products will reduce the purity of the required substituted carboxylic acid.

$$C_nH_{2n+1}COOH \rightarrow C_nH_{2n}YCOOH$$

Finding the acid’s relative molecular mass is a good way of measuring its purity.

This can be done by titrating the carboxylic acid against a standardised solution of sodium hydroxide.

Procedure

- **Wear eye protection at all times.**
- **Assume that all solutions are toxic and corrosive.**

Titration 1 – Standardisation of sodium hydroxide solution

1. Fill a burette with the sodium hydroxide solution provided.
2. Transfer exactly 25.0 cm^3 of the known hydrochloric acid solution provided to a 250 cm^3 conical flask.
3. Add a few drops of phenolphthalein indicator to the conical flask and then add from the burette the exact volume of sodium hydroxide required to just give a permanent pink colour.
4. Repeat the titration until you have **two** concordant titre values (within a range of 0.20 cm^3).

   As a guideline, the accurate titres should lie between 25 cm^3 and 35 cm^3.
5. Calculate and record your mean titre indicating which values you have selected to carry out your calculation.

Titration 2 – Carboxylic acid against sodium hydroxide

6. Repeat the process described above using the unknown carboxylic acid solution instead of the hydrochloric acid.

   The accurate titres should lie between 17 cm^3 and 27 cm^3.
7. Calculate and record your mean titre indicating which values you have selected to carry out your calculation.

Use both of your mean titre values in the **Analysis of Results** section after you have completed **Part B** of this experimental task.

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Results Sheet for Part A – Quantitative analysis of a carboxylic acid

Your teacher will give you exact concentrations for the following solutions.

Exact concentration of $\mathbf{C_nH_{2n+1}COOH}$ solution	$g\,dm^{-3}$
Exact concentration of hydrochloric acid solution	$mol\,dm^{-3}$

Titration data

Draw two tables to record **all** burette readings and titre values.

Record your mean titres. **Indicate clearly** which values you have used to calculate your mean values.

Titration 1 – Standardisation of sodium hydroxide solution

Mean titre 1	$\mathbf{cm^3}$

Titration 2 – Carboxylic acid against sodium hydroxide

Mean titre 2	$\mathbf{cm^3}$

Examiner only

Mark awarded for titration recording	

[5]

Titration 1

Expected titre (based on teacher values)	**cm^3**
Mark awarded for titration accuracy	

Titration 2

Expected titre (based on teacher values)	**cm^3**
Mark awarded for titration accuracy	

[6]

Part B – Qualitative analysis to identify Y in $C_nH_{2n+1}Y$

Unfortunately, during the formation of **$C_nH_{2n}YCOOH$** from **$C_nH_{2n+1}COOH$**, the substituted carboxylic acid **$C_nH_{2n}YCOOH$** can undergo decarboxylation to **$C_nH_{2n+1}Y$**.

$$C_nH_{2n+1}COOH \rightarrow C_nH_{2n}YCOOH \rightarrow C_nH_{2n+1}Y + CO_2$$

You will carry out three qualitative tests to find the identity of the functional group **Y** in **$C_nH_{2n+1}Y$**.

Record your observations in the table provided on the **Results Sheet for Part B**.

For each of the tests, if there is no change in appearance or smell you should write 'no observable change'.

You are **not** required to identify **Y** until the **Analysis of Results** section.

Procedure

- **Wear eye protection at all times.**
- **Assume that all solutions are toxic and corrosive.**

Dichromate(VI) test

1. Add 5 drops of **$C_nH_{2n+1}Y$** to a clean test tube.
2. Add 10 drops of sulfuric acid and 4 drops of potassium dichromate(VI).
3. Warm the mixture using the water bath.

Iodoform test

1. Add 5 drops of **$C_nH_{2n+1}Y$** to a clean test tube.
2. Add 5 drops of iodine.
3. Add sodium hydroxide dropwise with gentle swirling until the dark colour of the iodine fades.
4. Warm the mixture using the water bath.

Silver nitrate test

1. Add 10 drops of **$C_nH_{2n+1}Y$** to a clean test tube.
2. Add 5 drops of sodium hydroxide followed by 10 drops of nitric acid and then 5 drops of silver nitrate.

Results Sheet for Part B – Qualitative analysis to identify Y in $C_nH_{2n+1}Y$

Record your observations in the table. The observation for another test has been included to help you in the **Analysis of Results** section.

	Observations
Dichromate(VI) test	
Iodoform test	
Silver nitrate test	
Nitric(III) acid test	**no observable change**

Use these observations in the **Analysis of Results** section.

Examiner only

Mark awarded for observations	

[3]

Examiner only

Analysis of Results

Part A – Quantitative analysis of a carboxylic acid

(i) Sodium hydroxide and hydrochloric acid react as shown in the following equation.

$$\mathbf{NaOH + HCl \rightarrow NaCl + H_2O}$$

Use the concentration of hydrochloric acid (given by your teacher) and the mean titre from **Titration 1** to calculate the concentration of the sodium hydroxide solution. [2]

[NaOH] = ... mol dm^{-3}

Examiner only

(ii) Sodium hydroxide and the unknown carboxylic acid react as shown in the following equation.

$$NaOH + C_nH_{2n+1}COOH \rightarrow C_nH_{2n+1}COONa + H_2O$$

Use this equation, the concentrations of the relevant solutions and the mean titre from **Titration 2** to calculate the relative molecular mass of $C_nH_{2n+1}COOH$ and hence its molecular formula. [4]

Relative molecular mass = ...

Molecular formula ....

Examiner only

Part B – Qualitative analysis to identify Y in $C_nH_{2n+1}Y$

(iii) Complete the following table by writing your inferences from the results of each of the qualitative tests. [3]

	Inference from results
Dichromate(VI) test	
Iodoform test	
Silver nitrate test	
Nitric(III) acid test	**Y cannot be $-NH_2$**

(iv) Use the information from **Part A** and **Part B** to suggest a structure for $C_nH_{2n}YCOOH$. Show your reasoning clearly. [2]

....

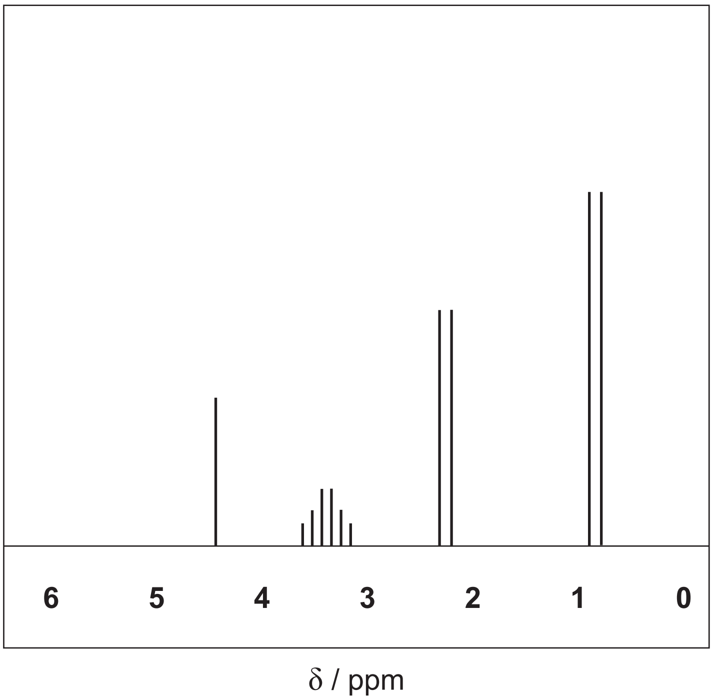
....

....

Examiner only

(v) **Part** of the ^{1}H NMR spectrum of $\mathbf{C_nH_{2n}YCOOH}$ is shown below. Explain whether or not this spectrum fits the structure suggested in part (iv). [2]

δ / ppm	4.50	3.40	2.30	0.9



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