Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL

1410U50-1E

S18-1410U50-1E

CHEMISTRY – A2 unit 5
Practical Methods and Analysis Task

FRIDAY, 11 MAY 2018 – MORNING

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**15**	
2.	**10**	
3.	**5**	
Total	**30**	

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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. Calcium carbonate, $CaCO_3$, is the major component of eggshells. Volumetric analysis can be carried out to determine the percentage by mass of calcium carbonate in eggshells using their reaction with acids. Calcium carbonate is almost insoluble in water but readily reacts with hydrochloric acid, HCl, according to the equation below.

$$2HCl(aq) + CaCO_3(s) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Because the reaction is very slow when it is close to the end point the acid cannot be used directly to titrate the calcium carbonate. However, the percentage by mass of calcium carbonate in eggshells can be determined by carrying out a back titration.

- Initially, an excess of hydrochloric acid is added to react with **all** of the calcium carbonate
- The remaining, unreacted acid is then determined by titration with aqueous sodium hydroxide, NaOH(aq)
- The difference between the number of moles of acid initially added and the number of moles of acid left unreacted after the reaction, is equal to the number of moles of acid that reacted with the calcium carbonate

The percentage by mass of calcium carbonate in an eggshell can be determined as follows.

Part 1: Preparation of the eggshell
1. Wash an empty eggshell with deionised water and peel off the membranes from the inside of the shell. 2. Dry the eggshell with a paper towel and then in an oven. 3. Grind the eggshell to a very fine powder using a pestle and mortar.

Part 2: Reaction of the powdered eggshell with excess HCl(aq) and titration of the unreacted HCl(aq) with NaOH(aq)
4. Accurately weigh between 0.450 g and 0.550 g of powdered eggshell into a small conical flask and record the mass used. 5. Add a few drops of ethanol to the flask. This acts as a wetting agent and 'helps' the HCl(aq) react with the $CaCO_3$. 6. Use a volumetric pipette to add 10.0 cm^3 (an excess) of 1.10 $mol\,dm^{-3}$ HCl(aq) to the flask and swirl. 7. Heat the solution in the flask until it begins to boil and all the solid reacts. 8. Whilst heating, maintain a consistent fluid level in the flask by regularly washing down the walls of the flask with deionised water. 9. After allowing the flask to cool, rinse the walls of the flask with deionised water and add 3-4 drops of phenolphthalein indicator. 10. Rinse a burette twice with small volumes of the standardised NaOH(aq) (0.0805 $mol\,dm^{-3}$). 11. Fill the burette with the standardised NaOH(aq), remove the funnel and record the initial burette reading. 12. Titrate the contents of the flask with the NaOH(aq) from the burette whilst swirling the flask. 13. Continue adding the NaOH(aq) dropwise until the first permanent colour change and record the final burette reading.

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(a) Answer the following questions on the method used.

(i) State why the eggshell is ground to a very fine powder before reaction with the acid (step 3). [1]

....

(ii) State why the burette was rinsed with the sodium hydroxide solution before filling (step 10). [1]

....

....

....

(iii) State why the contents of the conical flask were swirled during the titration (step 12). [1]

....

(b) Lowri followed the method, taking five separate samples of the powdered eggshell. She obtained the following titration results.

Titration number	1	2	3	4	5
Mass / g	0.455	0.516	0.482	0.535	0.469
Volume of NaOH(aq) / cm^3	30.50	16.30	24.80	12.90	22.60

Identify the titration that has the largest percentage error in the volume of NaOH(aq) used and give a reason for your choice. A calculation of the percentage error is **not** required. [1]

....

....

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(c) (i) The six stages of the calculation are shown below. Number these in the correct order. The first stage has been numbered for you. [1]

	Correct order
Calculate the number of moles of NaOH used which is equal to the number of moles of unreacted HCl	
Use the balanced equation to calculate the number of moles of $CaCO_3$	
Calculate the number of moles of HCl added to the powdered eggshell	1
Calculate the percentage by mass of $CaCO_3$ in the powdered eggshell	
Convert the number of moles of $CaCO_3$ to mass of $CaCO_3$ in grams	
Calculate the number of moles of HCl that reacted with the powdered eggshell	

(ii) Carry out the calculation to determine the percentage by mass of $CaCO_3$ in the eggshell using the results from **titration 3 only**. [5]

Percentage by mass = ... %

(d) Lowri's percentage of calcium carbonate in the powdered eggshell was slightly higher than the actual value. When asked to suggest why, she said 'I did not dry the eggshell sufficiently before grinding and weighing.'

Explain whether Lowri's statement could account for this inaccurate result. [1]

....

....

....

(e) Rhodri decided to adapt the method used by Lowri. He took 5.227 g of powdered eggshell (step 4) and added 100.0 cm^3 of the 1.10 mol dm^{-3} HCl(aq) for reaction (step 6). Using a volumetric pipette, he took a number of 10.0 cm^3 samples of the resulting solution, transferring each into clean conical flasks and titrating against the 0.0805 mol dm^{-3} NaOH(aq). He obtained the following results.

Complete the table below and indicate which results, if any, Rhodri should reject for inconsistency. Calculate a mean titre. [2]

Final burette reading / cm^3	15.85	32.45	31.35	20.05
Initial burette reading / cm^3	0.45	17.55	15.85	4.50
Titre / cm^3				
Accept / reject				

Mean titre = ... cm^3

(f) Give **one** advantage of each of these two different methods. Explain your answers. [2]

Lowri's method

....

....

Rhodri's method

....

....

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2. A solution of an unknown salt containing **one s-block metal cation** and **one anion** was tested as shown below.

(a) (i) Complete the chart giving the relevant observations / conclusions. [6]

Solution of unknown salt

Test 1: Add $CO_3^{2-}(aq)$

Observation	Conclusion
white precipitate formed	....

Test 2: Add $OH^{-}(aq)$

Observation	Conclusion
no change observed	....

Test 3: Add $Cl_2(aq)$

Observation	Conclusion
grey solid / brown solution formed	....

Test 4: Add $Cu^{2+}(aq)$

Observation	Conclusion
white precipitate in brown solution	Formula of white precipitate .... Brown coloration due to ....

Test 5: Add sodium thiosulfate solution

Observation
....

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(ii) Explain the observation made in Test 5. Include an equation in your answer. [2]

....

....

....

(b) Describe **one** further test in **each case** to confirm the identity of both the cation and anion in the unknown salt. Include relevant observations. [2]

Cation

....

....

Anion

....

....

10

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3. Aqueous citric acid reacts with sodium hydrogencarbonate according to the following equation.

$$3NaHCO_3(s) + C_6H_8O_7(aq) \longrightarrow C_6H_5O_7Na_3(aq) + 3H_2O(l) + 3CO_2(g) \qquad \Delta H^\theta = +78.8\,kJ\,mol^{-1}$$

The following method was used in an experiment to determine the temperature change during the reaction.

- A burette was used to measure 50.0 cm^3 of 1.00 $mol\,dm^{-3}$ citric acid into a polystyrene cup
- 16.0 g of powdered sodium hydrogencarbonate was weighed
- The initial temperature of the solution in the polystyrene cup was recorded as 24.4°C
- The sodium hydrogencarbonate was added and the solution stirred slowly and constantly using the thermometer whilst measuring the temperature

(a) Using the values given above, show that the sodium hydrogencarbonate was present in excess. [2]

(b) Using the given value of ΔH^θ, calculate the expected temperature change and hence the final temperature recorded on carrying out this reaction. [3]

Final temperature = ... °C

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END OF PAPER

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