Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL

A410U30-1

S19-A410U30-1

WEDNESDAY, 19 JUNE 2019 – MORNING

CHEMISTRY – A level component 3
Chemistry in Practice

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**15**	
3.	**17**	
4.	**6**	
5.	**17**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **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 60.

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

The assessment of the quality of extended response (QER) will take place in **Q.4**.

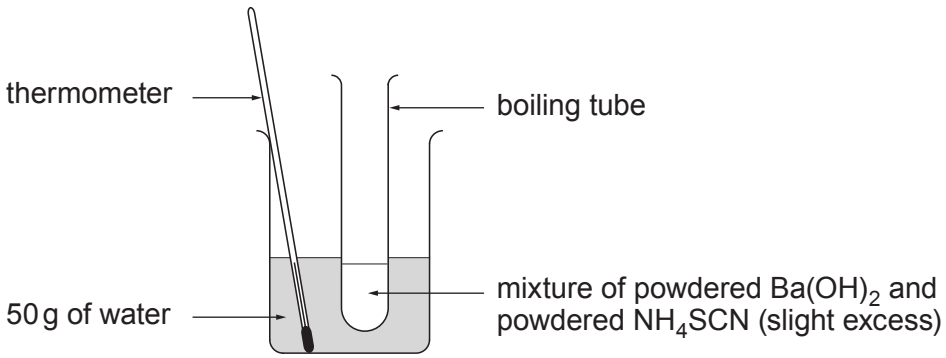
If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

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

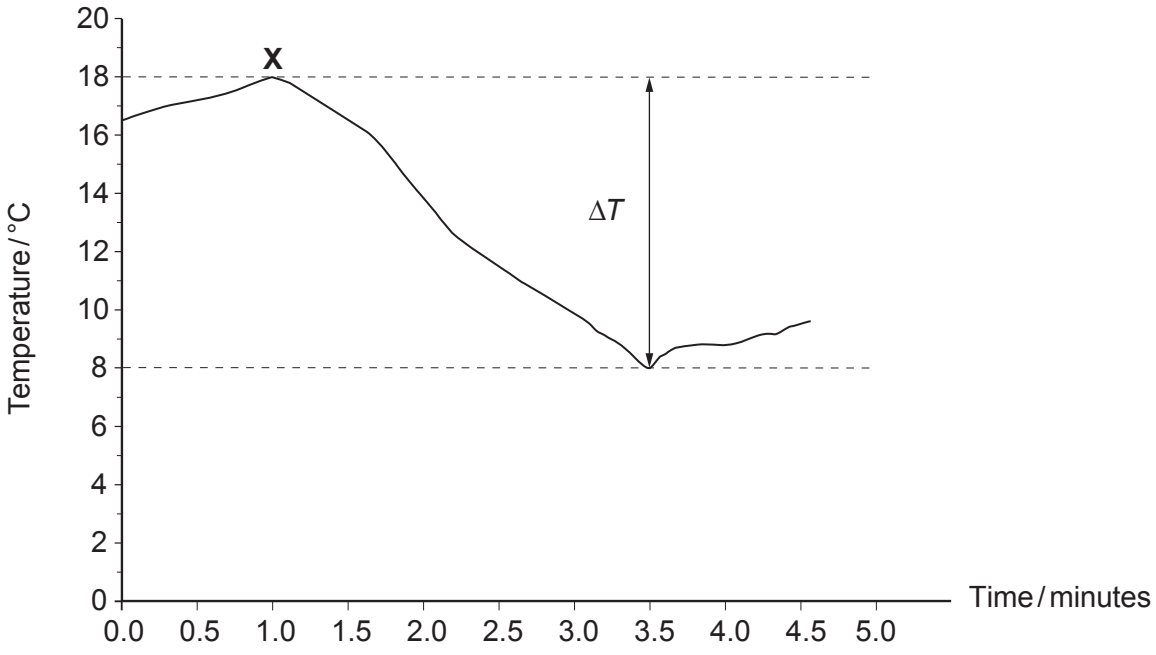
1. The reaction between solid barium hydroxide and solid ammonium thiocyanate is endothermic. The equation for the reaction is shown below.

$$Ba(OH)_2(s) + 2NH_4SCN(s) \longrightarrow 2NH_3(g) + 2H_2O(l) + Ba(SCN)_2(s)$$

A student carries out an experiment to determine the enthalpy change of reaction using the apparatus below.



The temperature / time curve shown below was plotted. A slight excess of ammonium thiocyanate was added to the barium hydroxide at point **X**.



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(a) The value of ΔT obtained was much lower than expected.

Briefly indicate **three** possible sources of error in the ΔT measurement from the information provided. [2]

Possible sources of error
1.
2.
3.

(b) The student measured a 10.0 °C temperature change on mixing both solids and used this value to calculate the enthalpy change of reaction as +10.5 kJ mol^{-1}.

Calculate the mass of powdered $Ba(OH)_2$ used in the experiment. [2]

Mass = ... g

(c) Deduce the maximum temperature change if the experiment were repeated using 100 g of water rather than the 50 g used in the first experiment, with all other factors kept the same. Give a reason for your answer. [1]

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2. *(a)* The following pH values were measured during the titration of 25.0 cm^3 of aqueous ethanoic acid, of approximate concentration 0.1 mol dm^{-3}, with aqueous sodium hydroxide of concentration 0.0962 mol dm^{-3}.

Volume of sodium hydroxide added / cm^3	pH
0.0	2.9
5.0	4.1
10.0	4.5
15.0	4.9
20.0	5.3
22.0	5.5
24.0	5.8
25.0	6.1
26.0	6.6
27.0	11.2
28.0	11.4
29.0	11.7
30.0	11.8

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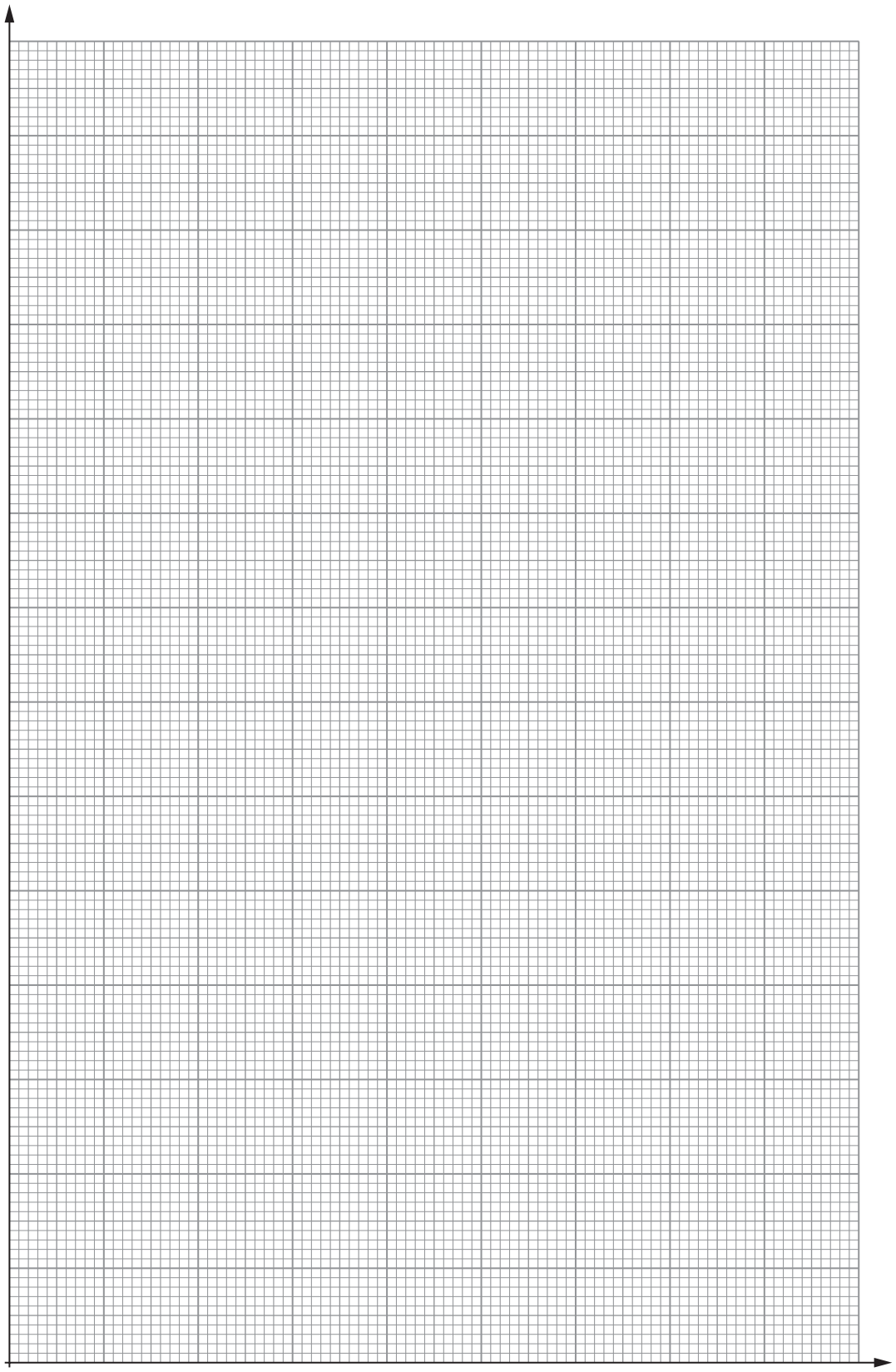
(i) Plot the titration curve on the grid, clearly labelling the axes. [4]



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(ii) Use information from the titration curve in answering parts I-III.

I. Calculate the concentration, in mol dm^{-3}, of the aqueous ethanoic acid. [3]

Concentration = ... mol dm^{-3}

II. Determine the pH of the sodium ethanoate solution formed at the equivalence point. [1]

.....

III. Calculate the acid dissociation constant, K_a, of the ethanoic acid. [2]

K_a = ... mol dm^{-3}

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(b) State the colour obtained if a few drops of the acid-base indicator methyl red are added to a sodium ethanoate solution. Give a reason for your answer. [1]

pH	Methyl red indicator colour
≤ 4.8	yellow
≥ 6.0	red

.....

.....

(c) Aqueous propanoic acid and sodium propanoate can form a buffer solution.

A student requires a buffer of pH 4.46 for an experiment. He adds solid sodium propanoate to 500 cm^3 of aqueous propanoic acid of concentration 0.210 $mol\,dm^{-3}$. Calculate the mass of sodium propanoate needed assuming no change in volume. [4]

(K_a for propanoic acid is 1.35×10^{-5} $mol\,dm^{-3}$)

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Mass = ... g

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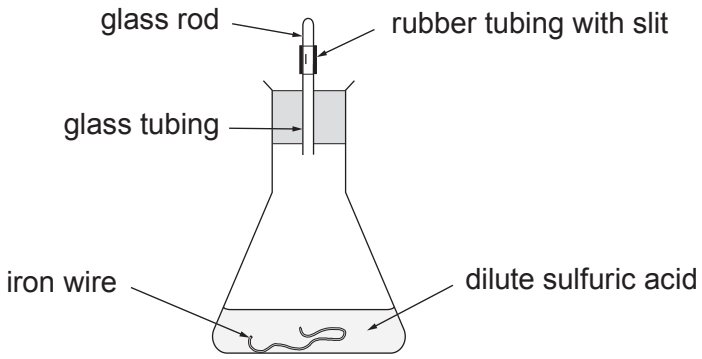
3. A student carried out the following experiment to determine the percentage of iron in a wire.

Step 1 Preparation of a solution of iron(II) ions

2.78 g of the wire was placed in a conical flask. 100 cm^3 of dilute sulfuric acid (an excess) was added and the flask was warmed in order to maintain a steady reaction.

The diagram shows the apparatus used. The piece of rubber tubing with a slit in it lets hydrogen escape but stops any air entering the flask.



When all the iron had reacted the solution was transferred to a volumetric flask and made up to 500 cm^3 with deionised water.

(a) (i) Give the ionic equation for the reaction of iron with dilute acid. [1]

.....

(ii) Describe a chemical test to show that the solution contains iron(II) ions. [3]

Reagent(s) .....

Observation(s) .....

Ionic equation .....

(b) Suggest why it was necessary to prevent any air from entering the flask. [1]

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Step 2 Titration of the iron(II) solution against a standard solution of potassium dichromate(VI)

Unlike manganate(VII), dichromate(VI) titrations require an indicator. One indicator that may be used is diphenylamine sulfonate. At the end-point, the indicator colour changes from green to violet on addition of one drop of the dichromate(VI) solution.

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \longrightarrow 2Cr^{3+}(aq) + 7H_2O(l)$$

(c) (i) The student was asked to prepare a 0.0200 mol dm^{-3} standard solution of potassium dichromate(VI), $K_2Cr_2O_7$. Calculate the mass of potassium dichromate(VI) needed to prepare 250 cm^3 of this solution. [2]

Mass = ... g

(ii) The student pipetted 25.0 cm^3 of the iron(II) solution into a conical flask. He added 25 cm^3 of dilute sulfuric acid and titrated against the 0.0200 mol dm^{-3} potassium dichromate(VI) solution.

Describe how the student should perform **one** titration to find the volume of potassium dichromate(VI) needed for complete reaction. You can assume that the dichromate(VI) solution is already in the burette. [4]

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(d) Four 25.0 cm^3 samples of the iron(II) solution were acidified and titrated against the dichromate(VI) solution. The mean volume of dichromate(VI) required for complete reaction was 19.85 cm^3.

(i) Why did the student carry out several titrations and then calculate a mean volume of potassium dichromate(VI) used? [1]

.....

.....

(ii) Write the equation for the reaction of iron(II) ions with dichromate(VI) ions in acid solution. [1]

.....

(iii) Calculate the percentage of iron in the wire. [3]

Percentage = ... %

(iv) The balance used in weighing the wire has an uncertainty for each reading of ± 0.005 g. Estimate the maximum percentage error in weighing the wire.
Show your working. [1]

Percentage error = ... %

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4. A solid waste sample is known to contain only sodium carbonate, sodium nitrate and sodium sulfate.

Outline an experimental procedure to show that

- the sample contains sodium sulfate
- sodium sulfate makes up 25.7 % by mass of 4.55 g of the waste sample

Include relevant observations and equations for any reactions taking place and the gravimetric data that would be recorded in confirming the percentage by mass of sodium sulfate in the waste sample. [6 QER]

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5. You are given solutions of six organic compounds, labelled **A**-**F**, and the following reagents.

Reagent	Name
1	red litmus paper
2	I_2(aq) / NaOH(aq) or KI(aq) / NaClO(aq)
3	2,4-dinitrophenylhydrazine (2,4-DNPH)
4	dilute sodium hydroxide solution
5	sodium hydrogencarbonate solution

(a) Answer parts (i) and (ii) by completing the table opposite.

(i) Name compounds **D** and **F**. [2]

(ii) Give the results you would expect to observe on addition of reagents **2** and **3** to **each** of the compounds. Write 'NR' if there is no reaction.

Three of the compounds do not react with either of the reagents. [3]

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Compound		Reagent: **2** Conditions: room temperature / gentle heat	Reagent: **3** Conditions: room temperature
A	$CH_3CH_2CH_2CH_2NH_2$ butylamine		
B	$CH_3CH_2CH_2COOH$ butanoic acid		
C	$CH_3CH_2CH_2CHO$ butanal		
D	$CH_3CH_2CH_2CONH_2$		
E	$CH_3COCH_2CH_3$ butanone		
F	$CH_3CH(OH)CH_2CH_3$		

Turn over.

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(b) Explain the results observed for compound **F**. [1]

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(c) Devise a scheme of **three** further tests, using only reagents **1**, **4** and **5**, that would allow you to positively identify each of the **remaining** compounds.

(i) Complete the table below giving the reagent(s) and briefly describing each test. Give the observations made for each compound. Any test you suggest **must** lead to some observable result.

You do **not** need to include observations for compounds identified by a previous test. [4]

Compound	Reagent:	Reagent:	Reagent:
	Description of test:	Description of test:	Description of test:
	Observations		

(ii) Explain each of the positive results observed. [3]

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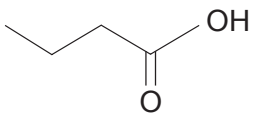
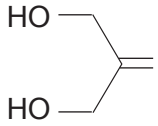
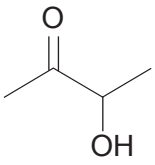
(d) $C_4H_8O_2$ has a number of different isomers, four of which are shown below.



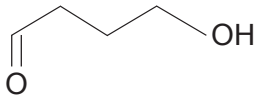
butanoic acid
compound **B**



2-methylenepropane-1,3-diol
compound **H**



3-hydroxybutanone
compound **I**



compound **J**

(i) Name compound **J**. [1]

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Do not use any of the reagents used in parts (a)-(c) [shown below] in your answers to parts (ii)-(iv).

red litmus paper
I_2(aq) / NaOH(aq) or KI(aq) / NaClO(aq)
2,4-dinitrophenylhydrazine (2,4-DNPH)
dilute sodium hydroxide solution
sodium hydrogencarbonate solution

(ii) Give a chemical test which gives a positive result for compounds **H**, **I** and **J** but not for compound **B**. [1]

Reagent(s) .....

Observation(s) .....

(iii) Give a chemical test which gives a positive result for compound **J** but not for compounds **B**, **H** and **I**. [1]

Reagent(s) .....

Observation(s) .....

(iv) Give a chemical test which gives a positive result for compound **H** but not for compounds **B**, **I** and **J**. [1]

Reagent(s) .....

Observation(s) .....

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