Surname	Centre Number	Candidate Number
First name(s)		2

GCE A LEVEL

1410U50-1E

S23-1410U50-1E

FRIDAY, 12 MAY 2023 – MORNING

CHEMISTRY – A2 unit 5
Practical Methods and Analysis Task

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**7**	
3.	**6**	
4.	**8**	
Total	**30**	

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01

ADDITIONAL MATERIALS

- A calculator, pencil and ruler;
- **Data Booklet** supplied by WJEC.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.
You may use a pencil for graphs and diagrams only.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet. 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.

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.

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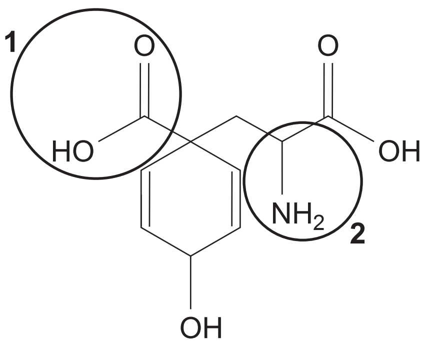
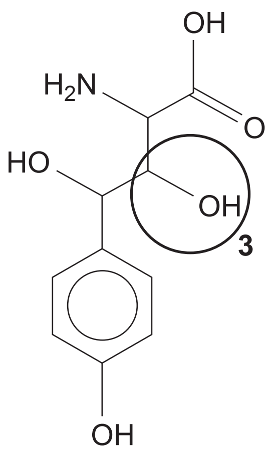
Answer **all** questions.

1. This question is about the chemistry of some of the many compounds which have the molecular formula $C_{10}H_{13}NO_5$. They all have a relative molecular mass of 227.

The skeletal formula of two compounds with this molecular formula are shown below.



Compound **A**



Compound **B**

(a) Name the homologous series for the functional groups shown as **1**, **2** and **3**. Include the term primary, secondary or tertiary if appropriate. [2]

1 ....

2 ....

3 ....

(b) (i) State **three** chemical tests that will give a positive result for both compound **A** and compound **B**. Give the reagent(s), essential reaction conditions and observations. [3]

	Reagent(s) and essential reaction conditions	Observation(s)
Test 1	....	....
Test 2	....	....
Test 3	....	....

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(ii) State a chemical test that will give a positive result for compound **B** but not for compound **A**. Give the reagent(s) and observation(s). [1]

Reagent(s): ....

....

Observation(s): ....

....

(c) Give the skeletal formula of the compound formed when 1 mole of compound **A** reacts with 2 moles of propanoyl chloride. [1]

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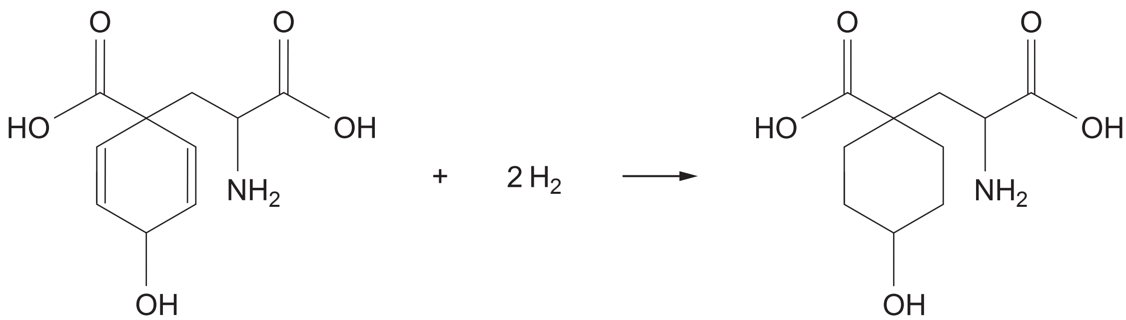
(d) The equation for the reaction of compound **A** with hydrogen in the presence of a nickel catalyst is shown below.



Compound **A** Compound **C**

Calculate the volume of hydrogen gas **in cm^3**, measured at 298 K and 1 atm pressure, needed to react with 54.0 g of compound **A**. [2]

volume = ... cm^3

9

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2. There are several different types of chemical reactions, and often more than one way of classifying them.
You are provided with solutions of the following reagents.

dilute nitric acid	chlorine	concentrated hydrochloric acid	1-chlorobutane
sodium iodide	silver nitrate	sodium hydroxide	copper(II) sulfate

(a) Identify which reagents, and outline the conditions, you would use to illustrate the different types of chemical reactions named in the table. The reagents chosen must give an observable result. [6]

	Reaction	Reagents and conditions	Observation(s)
1	Nucleophilic substitution		
2	Ligand exchange		
3	Displacement		

(b) Give the formula of the complex ion formed on ligand exchange. [1]

formula = ...

7

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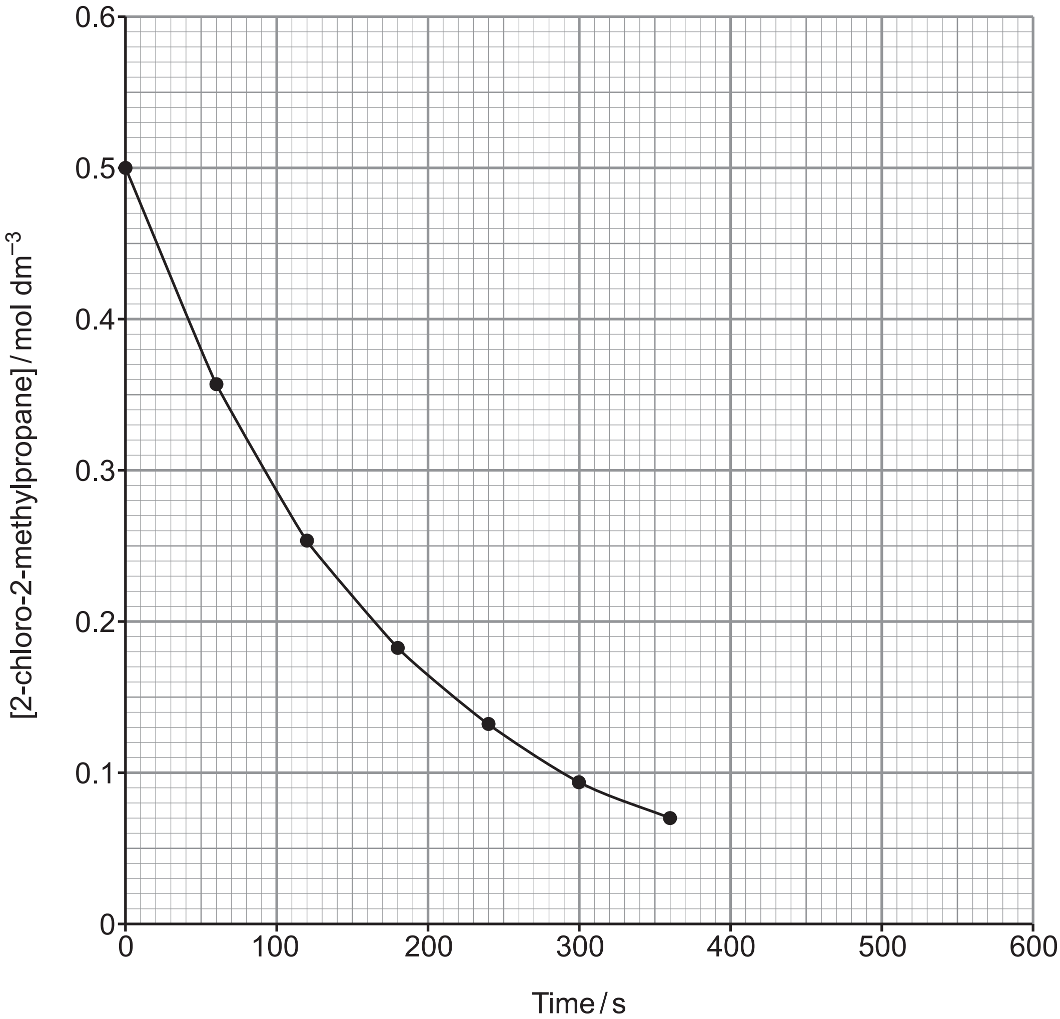
3. The equation for the hydrolysis of 2–chloro–2–methylpropane in an ethanol–water mixture is shown below.

$$(CH_3)_3CCl \quad + \quad H_2O \longrightarrow (CH_3)_3COH \quad + \quad HCl$$

Since the water concentration is effectively constant, the rate equation can be written as

$$\text{Rate} = k\,[(CH_3)_3CCl]^x$$

In an experiment designed to determine the order of the reaction with respect to 2–chloro–2–methylpropane the following data were obtained at a constant temperature.



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(a) Use the graph to:

(i) determine the rate of reaction, in $mol\,dm^{-3}\,s^{-1}$, when the concentration of 2–chloro–2–methylpropane is $0.200\,mol\,dm^{-3}$.

Show clearly on your graph, how you determined your answer. [2]

rate = ... $mol\,dm^{-3}\,s^{-1}$

(ii) show that the reaction is first order with respect to 2-chloro-2-methylpropane. [2]

....

....

....

....

(b) Find the value of the rate constant, k, and state its units. [2]

value of k = ...

units = ...

6

4. Ammonia is very soluble in water, and to a lesser extent in other solvents such as trichloromethane.
Water and trichloromethane **do not mix**.

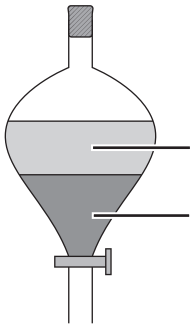
When ammonia is shaken with a mixture of these two solvents, the ammonia dissolves in both solvents and an equilibrium is established.

$$NH_3\text{(organic layer)} \rightleftharpoons NH_3\text{(aqueous layer)}$$

Under these conditions and at equilibrium, the equilibrium constant K_c is given as

$$K_c = \frac{[NH_3\text{ (aqueous layer)}]}{[NH_3\text{ (organic layer)}]}$$

An experiment was carried out to determine the equilibrium constant K_c.

	Method
Step 1	Using a measuring cylinder, 100 cm^3 of trichloromethane and 100 cm^3 of ammonia solution (1.00 mol dm^{-3}) were added into a separating funnel. The separating funnel was stoppered and inverted several times, ensuring that any pressure was released.
Step 2	The separating funnel was allowed to stand at a constant temperature of 298 K for 24 hours. Two layers were formed as shown below. 
Step 3	The aqueous and organic layers were separated into two separate beakers.
Step 4	Using a volumetric pipette, 25.0 cm^3 of the organic layer was transferred into a conical flask and 3 drops of methyl orange indicator were added. The sample was then titrated against hydrochloric acid of concentration 0.100 mol dm^{-3}, swirling the flask vigorously between additions of the hydrochloric acid. $NH_3 + HCl \longrightarrow NH_4Cl$
Step 5	Step 4 was repeated twice to obtain concordant results. The mean volume of hydrochloric acid of concentration 0.100 mol dm^{-3} needed to neutralise the ammonia was found to be 9.50 cm^3.

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Since there are equal volumes of both the organic and aqueous layers, the ratio of the concentration of ammonia in both solvents is equivalent to the ratio of moles of ammonia in both solvents.

The equilibrium constant can therefore be simplified to

$$K_c = \frac{\text{number of moles of } NH_3 \text{ (aqueous layer)}}{\text{number of moles of } NH_3 \text{ (organic layer)}}$$

(a) Calculate the value of K_c for the equilibrium. [3]

K_c = ...

(b) Explain why it is not necessary to titrate both the organic **and** aqueous layers. [1]

....

....

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(c) Another student attempts a titration of the aqueous layer using 0.100 mol dm^{-3} HCl but their experiment is unsuccessful.

Explain why it is unsuccessful and suggest a change that would allow the experiment to be successful.

Include data to support your answer. [2]

....

....

....

(d) The stock aqueous ammonia had a concentration of 8.00 mol dm^{-3}.

A science technician diluted the 8.00 mol dm^{-3} aqueous ammonia to make 2 dm^3 of aqueous ammonia of concentration 1.00 mol dm^{-3} ready for use in this experiment.

Outline how the Science technician diluted the 8.00 mol dm^{-3} aqueous ammonia ready for use in this experiment. [2]

....

....

....

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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