Surname	Centre Number	Candidate Number
First name(s)		2

GCE A LEVEL

A410U30-1

S25-A410U30-1

FRIDAY, 20 JUNE 2025 – MORNING

CHEMISTRY – A level component 3

Chemistry in Practice

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**19**	
3.	**19**	
4.	**11**	
Total	**60**	

A410U301
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 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 **Q3**(a).

JUN25A410U30101

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Examiner only

Answer **all** questions.

1. The following method was used to compare the rate of hydrolysis of 1-chlorobutane, 1-bromobutane and 1-iodobutane.

- Three test tubes containing a mixture of ethanol and acidified silver nitrate were placed in a 50 °C water bath
- Five drops of 1-chlorobutane were added to one of the test tubes and a stopwatch was started
- The time taken to form a precipitate was recorded
- The method was repeated with 1-bromobutane and 1-iodobutane

(a) (i) Record the colours of the precipitates formed in the table below. [1]

Halogenoalkane	Colour of precipitate	Time taken to form precipitate / s
1-chlorobutane	.....	606
1-bromobutane	.....	87
1-iodobutane	.....	52

(ii) I. Name the type of reaction mechanism for the hydrolysis of these halogenoalkanes. [1]

.....

II. Explain the trend in the rate of the reaction. [1]

.....

.....

.....

A410U301
03

Examiner only

(b) The following data was obtained for the alkaline hydrolysis of two different halogenoalkanes at 20 °C.

(i) Use the data in the tables to deduce the rate equation for both reactions.

Give your reasoning. [4]

$CH_3(CH_2)_3Cl$			
Experiment	Initial concentration / mol dm^{-3}		Initial rate / mol dm^{-3} s^{-1}
	$CH_3(CH_2)_3Cl$	OH^-	
A	0.18	0.22	5.94×10^{-6}
B	0.54	0.22	1.78×10^{-5}
C	0.18	0.44	1.19×10^{-5}
D	1.80		5.94×10^{-4}

rate = ...

$(CH_3)_3CCl$			
Experiment	Initial concentration / mol dm^{-3}		Initial rate / mol dm^{-3} s^{-1}
	$(CH_3)_3CCl$	OH^-	
E	0.15	0.15	6.75×10^{-6}
F	0.60	0.15	2.70×10^{-5}
G	0.45	0.45	2.03×10^{-5}

rate = ...

Examiner only

(ii) Deduce the concentration of OH^- in experiment **D**. [1]

Concentration = ... $mol\,dm^{-3}$

(iii) Calculate the value of the rate constant, *k*, for the alkaline hydrolysis of $CH_3(CH_2)_3Cl$. Give its unit. [3]

Value of *k* = ...

Unit .....

11

Examiner only

2. A student determined the purity of a sample of 1-bromobutane by two different methods.

The student started by dissolving 11.624 g of the 1-bromobutane sample in a mixture of ethanol and water in a conical flask. They added 100 cm^3 of 2.80 mol dm^{-3} sodium hydroxide solution (an excess). The mixture was swirled to ensure complete reaction.

$$C_4H_9Br + NaOH \longrightarrow C_4H_9OH + NaBr$$

The mixture was transferred quantitatively to a 250 cm^3 volumetric flask and the volume made up to the mark with deionised water.

The mixture was labelled as solution **X**.

Method 1: Titration

The student pipetted a 25.0 cm^3 sample of solution **X** into a conical flask and titrated it against 0.980 mol dm^{-3} hydrochloric acid. This was repeated and the following results were recorded.

	1	**2**	**3**	**4**
Final burette reading / cm^3	23.95	25.30	22.35	.....
Initial burette reading / cm^3	2.30	4.95	.....	3.50
Titre / cm^3	21.65	20.35	20.15	20.25

Method 2: Gravimetric analysis

The student added a 100 cm^3 sample of solution **X** to a beaker. Dilute nitric acid was added to neutralise hydroxide ions remaining from the preparation of the solution and preventing the formation of silver hydroxide.

Excess aqueous silver nitrate was added and the silver bromide precipitate formed was filtered, washed with deionised water, dried and weighed.

The mass of dry silver bromide formed was 6.294 g.

Examiner only

Analysis of results

Method 1: Titration

(a) Describe how the student should carry out **one** titration to determine accurately the volume of hydrochloric acid needed for complete reaction.

Assume that the hydrochloric acid is already in the burette. [4]

.....

.....

.....

.....

.....

.....

.....

.....

(b) Complete the results table opposite. Use the concordant results to calculate the mean titre. [2]

Mean titre = ... cm^3

(c) Suggest a possible reason why the reading for titration **1** was too high. [1]

.....

.....

A410U301
07

Turn over.

Examiner only

(d) Calculate the percentage purity of the 1-bromobutane (M_r 137) based on the results of the titration. [4]

Percentage purity = ... %

Method 2: Gravimetric analysis

(e) Describe how the student could have checked that all the bromide ions had been precipitated as silver bromide. [2]

.....

.....

.....

(f) Calculate the percentage purity of the 1-bromobutane (M_r 137) based on the mass of dry silver bromide formed. [3]

Percentage purity = ... %

Examiner only

Evaluation of results

(g) Another student repeated the gravimetric analysis.

This student's percentage purity value was **slightly higher** than the value calculated in part (f).

When asked to consider why his value was higher, the student suggested the two reasons given below.

In both cases circle to show whether you agree or disagree that this could account for the higher percentage purity value.

Give your reasoning. [3]

'I did not dry the silver bromide sufficiently before weighing.'

Agree / Disagree

.....

.....

.....

'I did not add sufficient acid to solution **X** before adding the silver nitrate solution.'

Agree / Disagree

.....

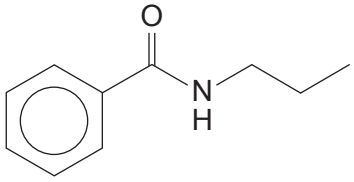
.....

.....

19

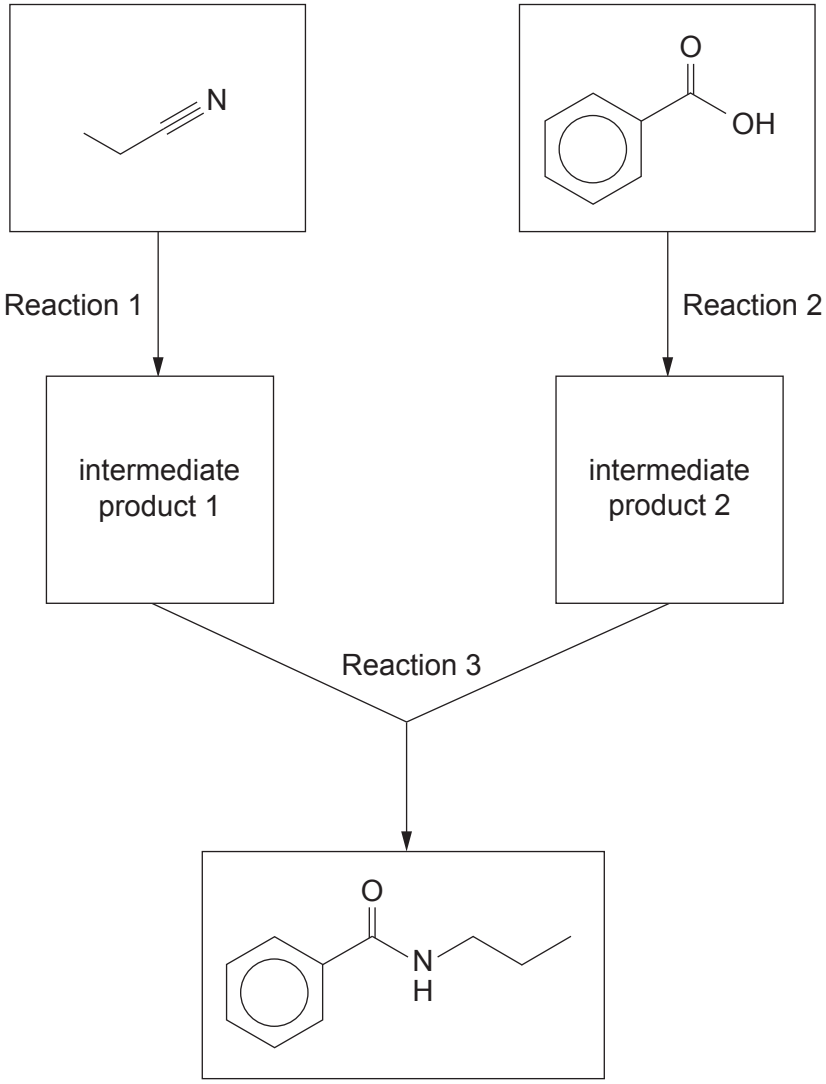
A410U301
09

3. N-propylbenzamide ($C_{10}H_{13}NO$) is a solid that is largely insoluble in cold water but is readily soluble in hot water.



(a) Summarise the steps in the reaction scheme for the preparation of N-propylbenzamide from propanenitrile and benzenecarboxylic acid.

No other organic compounds are available but you may use any inorganic reagents that are necessary.



Examiner only

In your answer, you should give

- the reagents and reaction conditions needed to make the intermediate products
- the structures of the intermediate products
- equations for all three reactions [6 QER]

Examiner only

(b) Outline how impure N-propylbenzamide could be purified. [3]

.....

.....

.....

.....

.....

.....

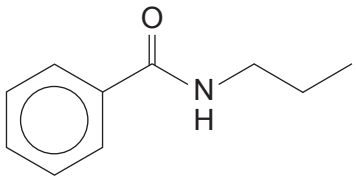
(c) In a typical reaction, 172.6 g of benzenecarboxylic acid is converted to N-propylbenzamide.

If the percentage yield for the conversion is 52.6%, calculate the mass of N-propylbenzamide formed. [2]

Mass of N-propylbenzamide = ... g

Examiner only

(d) Complete the equation for the alkaline hydrolysis of N-propylbenzamide. [1]

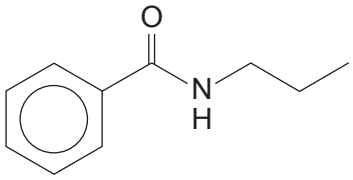


+ NaOH

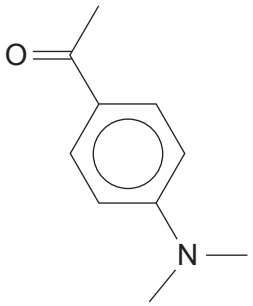
+

Examiner only

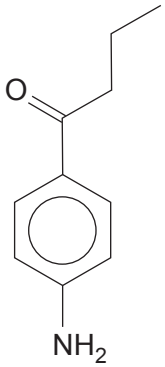
(e) $C_{10}H_{13}NO$ has a number of different isomers. Four of them are shown below.



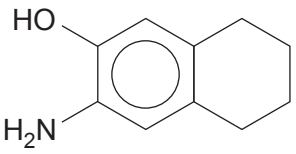
N-propylbenzamide



compound **K**



compound **L**



compound **M**

(i) State a chemical test that will give a positive result for compounds **K** and **L** but not for N-propylbenzamide or compound **M**. [1]

Reagent(s) .....

Observation .....

(ii) State a chemical test that will give a positive result for compounds **L** and **M** but not for N-propylbenzamide or compound **K**. [1]

Reagent(s) .....

Observation .....

Examiner only

(iii) State a chemical test that will give a positive result for compound **M** but not for N-propylbenzamide or compounds **K** or **L**. [1]

Reagent(s) .....

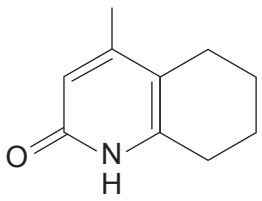
Observation .....

(iv) State a chemical test that will give a positive result for compound **K** but not for N-propylbenzamide or compounds **M** or **L**. [1]

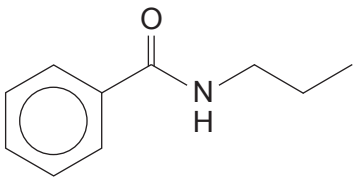
Reagent(s) .....

Observation .....

(f) Compound **N** is another isomer of formula $C_{10}H_{13}NO$.



compound **N**



N-propylbenzamide

Describe the similarities and differences in the infrared absorption spectra of compound **N** and N-propylbenzamide. Give the relevant bonds and their wavenumbers.

Refer to **both** compounds when considering the similarities and differences. [3]

.....

.....

.....

.....

19

Examiner only

4. Azurite is a deep blue copper-containing mineral. For many centuries, finely ground rock containing azurite has been used as a pigment to prepare a range of blue-coloured paints.

A student was told that azurite is a mixture of copper(II) carbonate and copper(II) hydroxide, with the formula $Cu_{\mathbf{a}}(CO_3)_{\mathbf{b}}(OH)_{\mathbf{c}}$.

The student performed a series of experiments to determine the exact formula of azurite.

Experiment		Result
1	0.080 mol of azurite was added to an excess of nitric acid. The solution was made up to 500 cm^3 and labelled as solution **W**.	A volume of 3.87 dm^3 of gas was released at 21 °C and 1 atm pressure.
2	An excess of potassium iodide was added to 25.0 cm^3 of solution **W**.	The iodine formed required 17.60 cm^3 of sodium thiosulfate of concentration 0.682 mol dm^{-3} for complete reaction.

(a) Use the data from experiment 1 to calculate the value of **b**, the number of carbonate ions in each formula unit. [3]

b = ...

Examiner only

(b) In experiment 2, aqueous copper(II) ions react with iodide ions.

(i) Give the ionic equation for the reaction of copper(II) ions with iodide ions. [1]

.....

(ii) Show that the value of **a**, the number of copper(II) ions in each formula unit, is 3. [3]

(c) 55.3% of the mass of each formula unit is due to copper ions.

Use this information and the value of **a** given in part (b)(ii) to calculate the relative formula mass (M_r) of azurite. [1]

M_r = ...

Examiner only

(d) Use **all** the information to find the formula of azurite. [3]

Formula .....

11

END OF PAPER

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

Examiner only

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

Examiner only