Surname	Centre Number	Candidate Number
First name(s)		2

wjec cbac

GCE A LEVEL

A410U30-1

O21-A410U30-1

eduqas
Part of WJEC

MONDAY, 18 OCTOBER 2021 – MORNING

CHEMISTRY – A level component 3
Chemistry in Practice

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**21**	
3.	**6**	
4.	**8**	
5.	**11**	
Total	**60**	

A410U301
01

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. Do not use gel pen or correction fluid. You may use 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 **Q.3**.

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

1. Ethanol and propan-1-ol are both liquids at room temperature.

(a) (i) Write the equation that represents the molar enthalpy change of combustion ($\Delta_c H$) of propan-1-ol. [2]

....

(ii) Describe how you would determine the enthalpy change of combustion of propan-1-ol.

State what measurements you would need to make and outline how you would use the results to calculate the enthalpy change of combustion in $kJ\,mol^{-1}$.

You may draw a diagram as part of your answer. [4]

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A410U301
03

(b) The results of experiments to measure the heat evolved when mixtures of ethanol and propan-1-ol were completely burned are shown below.

	Experiment					
	1	2	3	4	5	6
Number of moles of ethanol in the mixture	0.010	0.008	0.006	0.004	0.002	0.000
Number of moles of propan-1-ol in the mixture	0.000	0.002	0.004	0.006	0.008	0.010
Total number of moles in the mixture	0.010	0.010	0.010	0.010	0.010	0.010
Heat evolved / kJ	13.60	14.90	16.40	17.70	18.70	20.05

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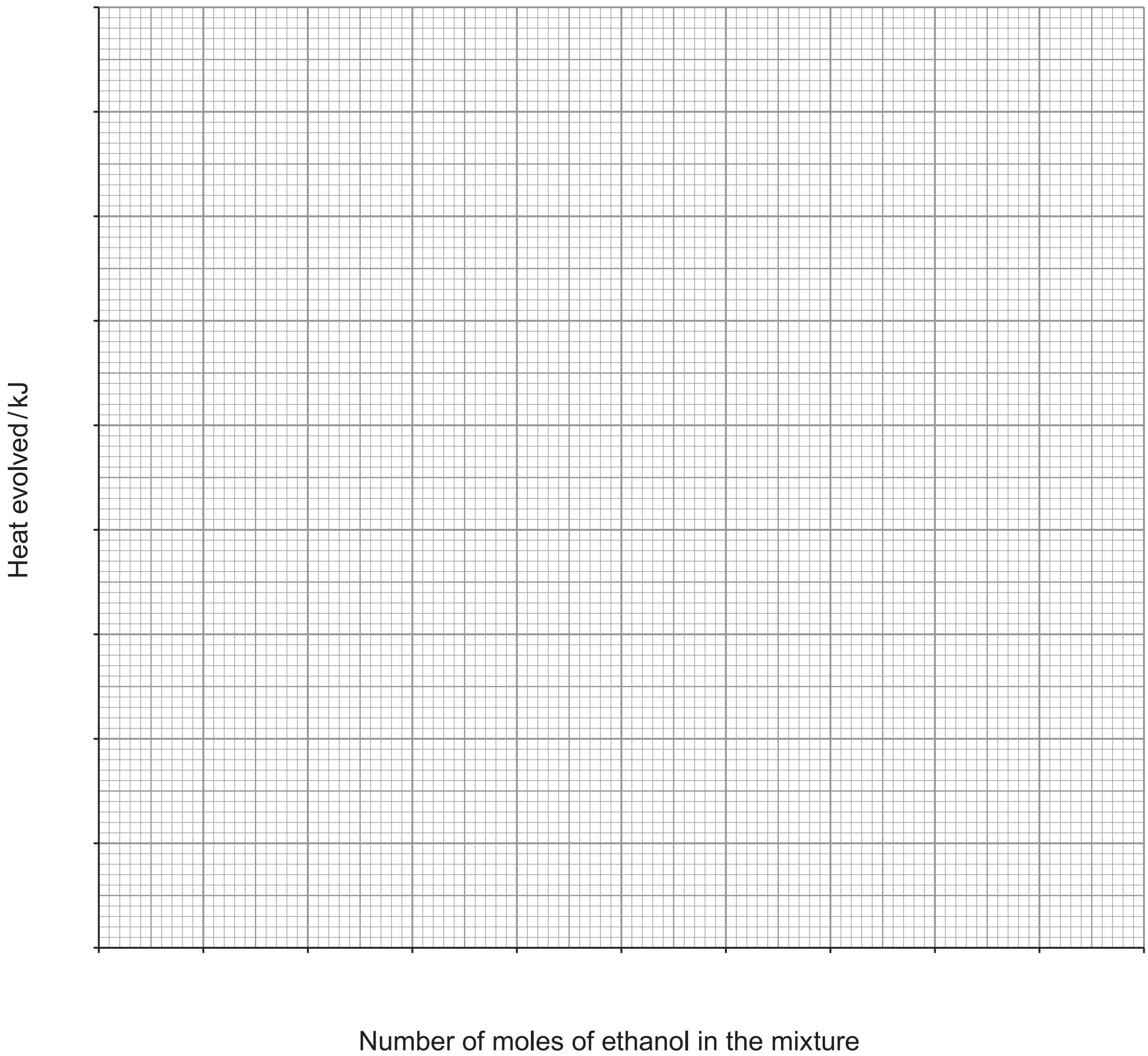
(i) Plot a graph of heat evolved against number of moles of ethanol in the mixture. [2]



(ii) Describe the trend in the graph. [1]

....

....

A410U301
05

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(iii) Calculate the enthalpy change of combustion of propan-1-ol in $kJ\,mol^{-1}$. [1]

Enthalpy of combustion = ... $kJ\,mol^{-1}$

(iv) A mixture of ethanol and propan-1-ol containing a total of 0.010 mol produced 15.35 kJ of heat on combustion.

Calculate the mass of ethanol present in this mixture. [2]

Mass = ... g

(v) **On the grid on page 5**, sketch the graph that would be obtained if the propan-1-ol were replaced with butan-1-ol. [2]

14

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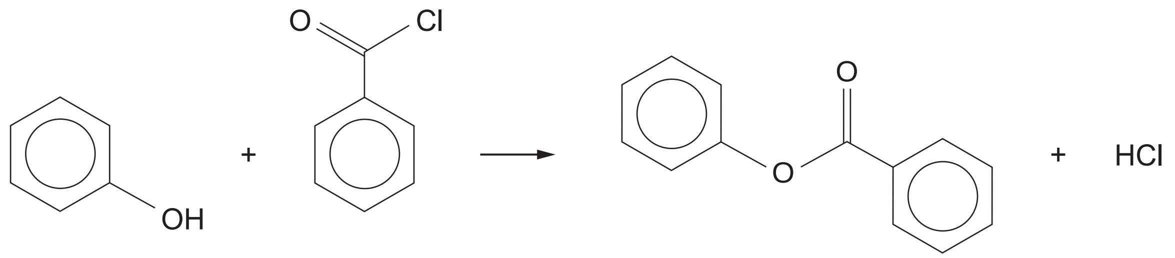
2. Phenyl benzoate can be prepared from phenol and benzoyl chloride as shown in the equation below.



phenyl benzoate

A sample of phenyl benzoate was prepared as follows.

Step	Procedure
1	28 cm^3 of 1.0 mol dm^{-3} sodium hydroxide and 1.5 g of phenol were added to a 50 cm^3 conical flask.
2	In a fume cupboard, 3.0 cm^3 of benzoyl chloride was added to the conical flask. A well-fitting cork was placed on top of the conical flask, and the flask shaken vigorously at intervals for 15 minutes. (The density of benzoyl chloride is 1.2 g cm^{-3}.)
3	The solid phenyl benzoate that formed was filtered and washed with deionised water to remove any water-soluble impurities.

(a) Suggest the purpose of the sodium hydroxide solution (step 1). [1]

....

....

(b) (i) Name another reagent that could have been used in place of benzoyl chloride (step 2) to prepare phenyl benzoate. [1]

....

(ii) Give an advantage of using benzoyl chloride in this reaction. [1]

....

....

A410U301
07

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(c) Phenyl benzoate is very much more soluble in hot ethanol than it is in cold ethanol.

Use this fact to outline how you would purify phenyl benzoate to obtain a pure dry product. [3]

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(d) After purification, 2.9 g of pure phenyl benzoate was isolated.

Show which of the reactants is in excess and hence calculate the percentage yield of this reaction. [4]

Percentage yield = ... %

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(e) State the names of **two** methods that could be used to show that a sample of phenyl benzoate is pure. [2]

Method 1

....

Method 2

....

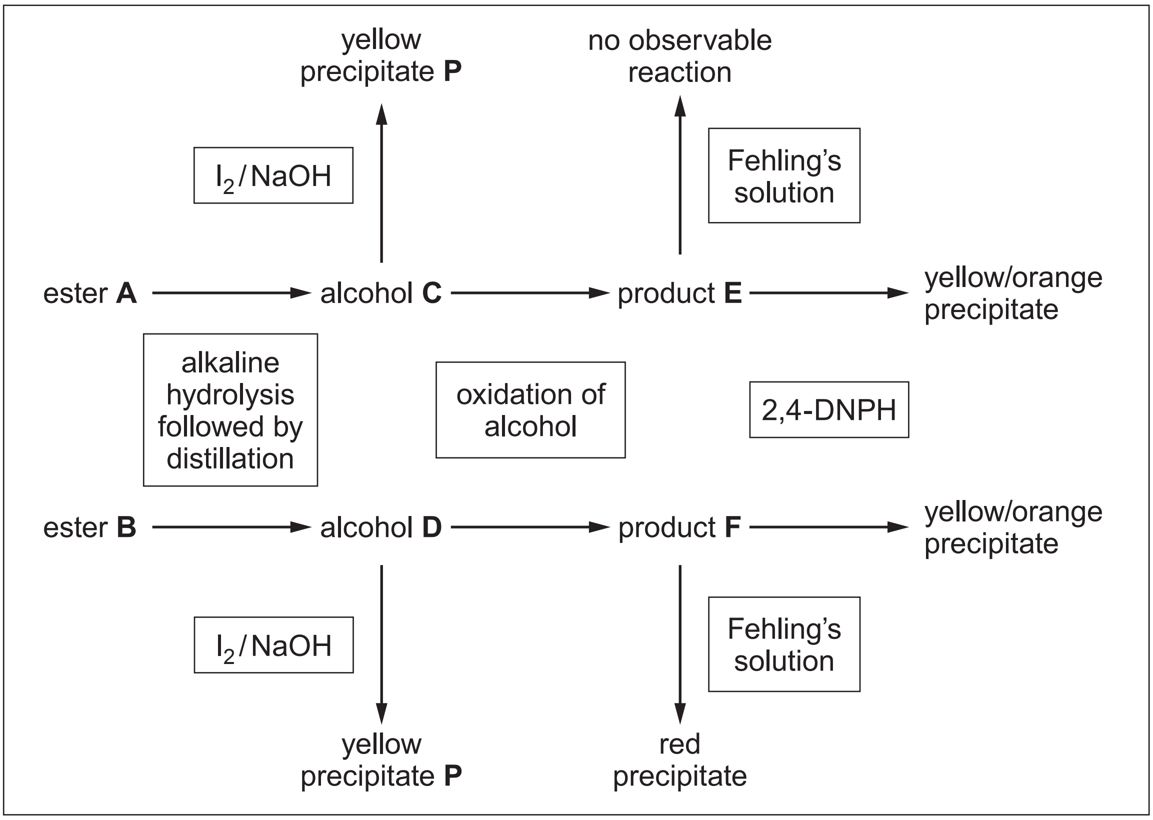
A410U301
09

(f) Two esters, **A** and **B**, of molecular formula $C_4H_8O_2$, were separately refluxed with aqueous sodium hydroxide and then the reaction mixtures distilled.

The alcohols formed in each reaction, **C** and **D** respectively, both gave a yellow precipitate, **P**, with an alkaline solution of iodine.

On oxidation, **C** and **D** formed **E** and **F** respectively. Both **E** and **F** gave a yellow/orange precipitate with 2,4-dinitrophenylhydrazine (2,4-DNPH). However, only **F** gave a red precipitate on heating with Fehling's solution.

These reactions and observations are summarised below.



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(i) Give the formula of yellow precipitate **P**.

Draw the structure of the grouping present in **C** and **D**, identified by the formation of this yellow precipitate with an alkaline solution of iodine. [2]

Formula of **P** ....

Grouping

(ii) State the reagent(s) necessary for the oxidation of **C** and **D** in the laboratory. Give the expected observation(s) as the reaction proceeds. [2]

Reagent(s) ....

Observation(s) ....

(iii) Name the functional group in compound **F**, identified by the positive test with Fehling's solution. [1]

....

(iv) Draw the structures of all four esters with the molecular formula $C_4H_8O_2$.

Identify and label esters **A** and **B**. [4]

21

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3. A student is asked to identify the contents of six test tubes containing aqueous solutions of the following six inorganic compounds.

barium nitrate	**potassium iodide**	**aluminium sulfate**
sodium hydroxide	**iron(II) nitrate**	**lead(II) nitrate**

One of the solutions has a pale green colour. No two test tubes contain the same compound.

Devise a scheme whereby each of the unlabelled solutions could be positively identified.

No other reagents are available.

You should include the **observations** for any reactions that enable you to identify each of the solutions. Explain your reasoning. [6 QER]

6

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4. There are very many different quantitative techniques in chemistry, and these quantitative techniques are used to determine 'how much' of a component is present in a sample.

This question looks at two different quantitative techniques you have studied during your A level Chemistry course.

(a) A student was given a sample of hydrated calcium sulfate, $CaSO_4.xH_2O$

(i) Outline an experimental procedure that she could carry out to find the value of x. [3]

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(ii) Having used a suitable experimental procedure, the student calculated that $x = 2$ and that the formula of the hydrated calcium sulfate is therefore $CaSO_4.2H_2O$.

She used an initial mass of 5.20 g of the hydrated calcium sulfate.

She made another measurement in order to find that $x = 2$. Calculate the value of this measurement. [2]

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(b) An experiment was carried out to identify the element **M** in the salt $\mathbf{M}_2SO_4$.

A 1.59 g sample of the pure compound $\mathbf{M}_2SO_4$ was dissolved in water and treated with an excess of aqueous calcium chloride. All the sulfate ions were precipitated as hydrated calcium sulfate. The precipitate was filtered, washed with a small volume of deionised water and dried.

The dry hydrated calcium sulfate, $CaSO_4.2H_2O$, was found to weigh 2.49 g.

Determine the relative atomic mass of element **M** and hence its identity.

You **must** show clearly how you obtained your answer. [3]

....

....

Element **M** ....

8

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5. A student determined the percentage purity of a sample of lead(IV) oxide as follows.

Step	Method
1	1.18 g of the impure lead(IV) oxide, solid **W**, was placed in a conical flask, and 4 g (an excess) of potassium iodide and 80 cm^3 of 1.00 $mol\,dm^{-3}$ hydrochloric acid added. The conical flask was stoppered and shaken well to ensure that all the lead(IV) oxide had reacted. The solution turned brown due to the formation of iodine. $PbO_2(s) + 4H^+(aq) + 2I^-(aq) \longrightarrow Pb^{2+}(aq) + 2H_2O(l) + I_2(aq)$
2	The solution in the conical flask was poured into a 200 cm^3 volumetric flask using a funnel. The conical flask and the funnel were rinsed with deionised water and the washings transferred into the volumetric flask. The solution was made up to the mark with deionised water. The flask was shaken well to ensure the solution formed was homogeneous. The solution was labelled as solution **X**.
3	25.0 cm^3 of solution **X** was pipetted into a conical flask and titrated against 0.0510 $mol\,dm^{-3}$ sodium thiosulfate solution. When the colour of the iodine in the flask started to fade, an appropriate indicator was added and the titration continued to the end-point. The equation for the reaction of sodium thiosulfate solution with iodine is as follows. $2S_2O_3^{2-}(aq) + I_2(aq) \longrightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$
4	Step 3 was repeated until concordant results were obtained. The mean volume of sodium thiosulfate used was 21.95 cm^3.

(a) Write the ion / electron half-equation for the oxidation of iodide ions to form iodine. [1]

....

(b) Use the equation for the overall reaction in step 1 to write the ion / electron half-equation for the reduction of lead(IV) oxide in acid conditions to form lead(II) ions. [1]

....

Examiner only

(c) Identify an appropriate indicator that could be used in step 3, and give the colour change at the end-point. [1]

Indicator ....

Colour change at the end-point ....

(d) (i) Calculate the number of moles of sodium thiosulfate used in the titration of 25.0 cm^3 of solution **X**, and hence the number of moles of iodine formed in step 1. [1]

Moles of iodine = ... mol

(ii) Calculate the percentage by mass of lead(IV) oxide in the solid sample **W**. [2]

Percentage by mass = ... %

(e) The balance used in weighing the lead(IV) oxide has an uncertainty for each reading of ±0.005 g.

Calculate the maximum percentage error.
Show your working. [1]

Percentage error = ... %

Examiner only

(f) The thermal decomposition of lead(IV) oxide at 600 °C produces lead(II) oxide and oxygen.

(i) Give the equation for the thermal decomposition of lead(IV) oxide. [1]

....

(ii) 0.123 dm^3 of oxygen gas was produced on heating a sample of pure lead(IV) oxide. Calculate the mass of lead(IV) oxide used.

Assume that the volume of gas was measured at 600 °C and 1 atm pressure. [3]

Mass = ... g

11

END OF PAPER

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

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