Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Friday 26 May 2023

Morning (Time: 1 hour 20 minutes)

Paper reference **WCH13/01**

Chemistry

International Advanced Subsidiary/Advanced Level
UNIT 3: Practical Skills in Chemistry I

You must have:
Scientific calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Pearson

Answer ALL the questions. Write your answers in the spaces provided.

1 This question is about two ionic compounds, **A** and **B**.

(a) Compound **A** is a white crystalline solid that contains one cation and one anion.

(i) A flame test was carried out on solid **A** and a pale green colour was observed.

Identify, by name or formula, the cation present in **A**.

(1)

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(ii) Aqueous silver nitrate, acidified with dilute nitric acid, was added to a sample of solid **A** dissolved in distilled water.

A yellow precipitate formed.

Identify, by name or formula, the anion present in **A**.

(1)

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(iii) Give the **formula** of **A**.

(1)

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(iv) The **anion** present in **A** can be shown by a **different** test on solid **A**.

Give a suitable different test with the expected result to show the identity of this **anion**.

(2)

Test	Expected result

(b) Solid **B** is ammonium sulfate.

(i) Give a test, with the expected result, to confirm the presence of the ammonium ion in **B**.

(2)

Test	Expected result

(ii) Give a test, with the expected result, to confirm the presence of the sulfate ion in **B**.

(3)

Test	Expected result

(iii) Write the **ionic** equation for the reaction taking place in (b)(ii). Include state symbols.

(1)

(Total for Question 1 = 11 marks)

2 Tests are carried out to identify two liquid organic compounds, **C** and **D**.

(a) A small amount of phosphorus(V) chloride, PCl_5, is added to separate 2 cm^3 samples of each compound.

Observations	
C	**D**
Misty fumes are given off	Misty fumes are given off

Identify, by name or formula, the misty fumes.

(1)

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(b) 2 cm^3 of aqueous sodium hydrogencarbonate, $NaHCO_3(aq)$, is added to separate 2 cm^3 samples of each compound.
Any gas given off is tested with limewater.

Observations	
C	**D**
Bubbles of a colourless gas Limewater turns cloudy	No change

Identify, by name or formula, the gas produced by compound **C**.

(1)

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(c) 2 cm^3 of Benedict's or Fehling's solution is added to separate 2 cm^3 samples of each compound. The test tubes are placed in a warm water bath.

Observations	
C	**D**
No change	Positive result

Give the expected observation for the positive result produced by liquid **D**.
Include the initial and final appearance of the contents of the test tube.

(2)

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(d) Both **C** and **D** have the molecular formula $C_3H_6O_2$.

(i) Deduce the structure of **C** and the **two** possible structures of **D**.
Use the molecular formula and the results from (a), (b) and (c).

(3)

Structure of **C**

Possible structure of **D**	Possible structure of **D**

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(ii) Some infrared data are given in the table.

Group	Wavenumber range / cm^{-1}
O—H stretching in alcohols	3750–3200
O—H stretching in carboxylic acids	3300–2500
C═O stretching in aldehydes	1740–1720
C═O stretching in ketones	1720–1700
C═O stretching in carboxylic acids	1725–1700
C—H stretching in aldehydes	2900–2820, 2775–2700
C—H stretching in alkanes	2962–2853

State the wavenumber range for one peak that would be present in the infrared spectra of **both C** and **D**, identifying the bond responsible for this peak.

(1)

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(iii) A student suggested that the structure of **D** could be identified using mass spectrometry because only one of the possible structures of **D** would have a peak at $m/z = 15$.

Identify which of the possible structures of **D** would be expected to give this peak. Justify your answer.

(2)

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(Total for Question 2 = 10 marks)

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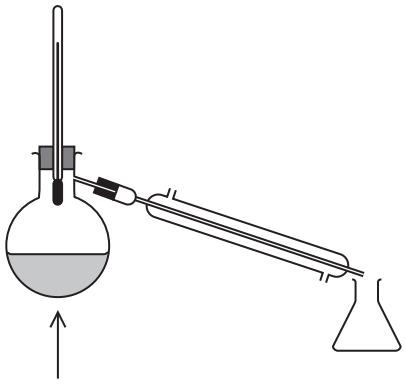
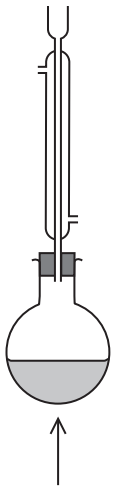
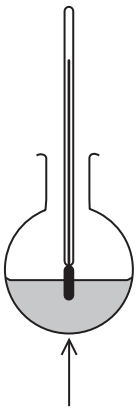
3 This question is about some reactions of butan-1-ol.

(a) A group of students was required to oxidise butan-1-ol to butanoic acid.
The students suggested three different types of apparatus for this reaction.

		
Apparatus **E**	Apparatus **F**	Apparatus **G**

Their teacher told them they should use apparatus **F**.

(i) Explain why apparatus **E** is **not** suitable for the oxidation of butan-1-ol to butanoic acid.

(2)

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(ii) Give a **different** reason why apparatus **G** is also **not** suitable for the oxidation of butan-1-ol to butanoic acid.

(1)

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(iii) Explain why, in apparatus **F**, the water should flow in from the bottom of the condenser.

(2)

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(iv) State the reaction **mixture** that can be used to oxidise the butan-1-ol to butanoic acid.

(1)

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(v) Give the colour change observed in the flask during this oxidation.

(1)

From ..... to .....

(b) Butan-1-ol can also form the alkene but-1-ene in an elimination reaction.

(i) Name a suitable chemical reagent to carry out this elimination reaction.

(1)

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(ii) Give a chemical test, including the expected result, to confirm the presence of the C═C double bond in but-1-ene.

(2)

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(Total for Question 3 = 10 marks)

4 This question is about calcium and calcium hydroxide, $Ca(OH)_2$.

A student reacted calcium with water to determine a value for the molar volume of hydrogen at room temperature and pressure.

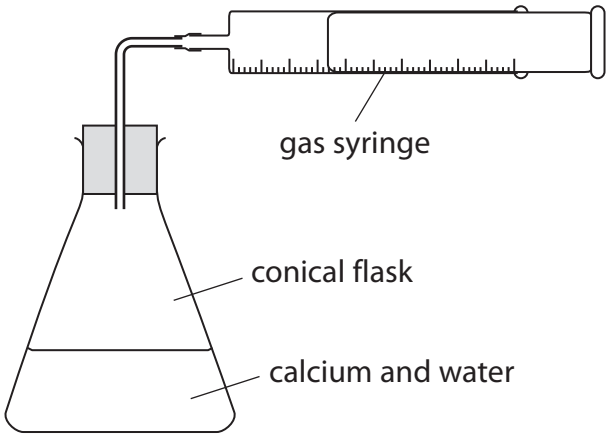
Procedure

Step **1** 200 cm^3 of distilled water (an excess) was transferred to a conical flask.

Step **2** A small piece of calcium metal was placed in a pre-weighed weighing boat. The boat was then reweighed.

Step **3** The calcium was dropped into the conical flask and a bung connected to a gas syringe was inserted.

Step **4** The volume of hydrogen collected was recorded.



Results

Mass of weighing boat / g	1.657
Mass of weighing boat and calcium / g	1.783
Volume of hydrogen collected / cm^3	72.0

The equation for the reaction in the conical flask is shown.

$$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$$

(a) (i) State **two** observations when this reaction takes place.

(2)

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(ii) Calculate the value for the molar volume of hydrogen under these conditions, using the student's results.

Give your answer to an appropriate number of significant figures and include units.

(4)

(b) A second student using this method obtained a value of 21.8 $dm^3 mol^{-1}$ for the molar volume of hydrogen.

(i) Calculate the percentage error in this student's value.
The data book value for the molar volume of hydrogen under these conditions is 23.9 $dm^3 mol^{-1}$.

(1)

(ii) Give **two** possible reasons why this student obtained a value below the data book value.
Assume the method was followed correctly and there were no measurement errors.

(2)

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(c) A third student carried out an experiment to determine the concentration of a saturated solution of calcium hydroxide, $Ca(OH)_2$, in water at room temperature.

$25.0\,cm^3$ of a saturated solution of calcium hydroxide was pipetted into a conical flask. Three drops of methyl orange indicator were added and the solution was titrated with $0.0400\,mol\,dm^{-3}$ hydrochloric acid.

The procedure was repeated until concordant titres were obtained.

The results are shown in the table.

Titration	1	2	3	4
Final burette reading / cm^3	26.85	31.25	34.55	27.15
Initial burette reading / cm^3	0.00	5.00	8.00	1.00
Titre / cm^3				
Concordant results (✓)				

(i) State the colour change observed in the conical flask at the end-point of the titration.

(2)

From ..... to .....

(ii) Complete the table and use the concordant results to calculate the mean titre.

(2)

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(iii) The reaction taking place in this titration is

$$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$$

Calculate the concentration of the calcium hydroxide solution in g dm^{-3}.

(4)

(d) Dissolving calcium hydroxide in water is an exothermic process.

Describe what you would see if the saturated solution of calcium hydroxide was heated from room temperature to 50 °C.
Justify your answer.

(2)

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(Total for Question 4 = 19 marks)

TOTAL FOR PAPER = 50 MARKS