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Candidate surname					Other names				
Centre Number					Candidate Number				

Pearson Edexcel International Advanced Level

Friday 13 June 2025

Morning (Time: 1 hour 20 minutes)

Paper reference **WCH16/01**

Chemistry

International Advanced Level

UNIT 6: Practical Skills in Chemistry II

You must have:
Scientific calculator, ruler

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.*
- There is a Periodic Table on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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

1 A student carries out tests on two inorganic salts, **A** and **B**.

(a) Salt **A** contains one type of cation and one type of anion.

Complete the table for the tests on a sample of the solid salt **A**.

Test	Observations	Inference	
(i) Heat a small amount of solid A in a test tube, holding some cobalt chloride paper at the mouth of the test tube.	1 2	A is a hydrated salt.	(2)
(ii) Add excess aqueous sodium hydroxide to a solution of A and leave to stand in air.	A pale brown precipitate forms, which darkens on standing.	The formula of the cation in A is	(1)
(iii)	A white precipitate forms on adding a mixture of two solutions to a solution of A .	The formula of the anion in A is Cl^- .	(2)
.....	The white precipitate dissolves on adding an excess of another solution.		
Conclusion			
(iv) Give the formula of salt A , which has a molar mass of 197.9 g mol^{-1} .			(2)
.....			

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- (b) Salt **B** contains two types of cation and one type of anion.

Tests were carried out on separate samples of a solution of salt **B**.

Test 1

Excess dilute aqueous sodium hydroxide was added and the solution warmed. A green precipitate was observed. The precipitate turned brown on standing in air.

A piece of damp red litmus paper was held at the mouth of the test tube. The litmus paper turned blue.

Test 2

Acidified barium chloride solution was added.

A white precipitate was observed.

- (i) Write **ionic** equations to account for the following observations.
State symbols are **not** required.

(3)

Formation of **green** precipitate in Test 1

--

Formation of gas that turned the litmus paper blue in Test 1

--

Formation of white precipitate in Test 2

--

- (ii) The brown precipitate from Test 1 was dissolved in sulfuric acid.
A yellow-brown solution formed.

Give the **formula** of the **complex ion** present in the yellow-brown solution.

(1)

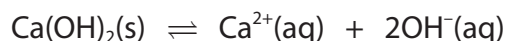
- (iii) State the **formula** of salt **B**.

(1)

(Total for Question 1 = 12 marks)



- 2 When excess calcium hydroxide is added to water, a reversible reaction occurs resulting in this equilibrium.



The equilibrium constant, K_c , for this reaction is

$$K_c = [\text{Ca}^{2+}(\text{aq})] [\text{OH}^{-}(\text{aq})]^2$$

A student carries out an experiment to determine the concentration of a saturated solution of calcium hydroxide, and the value of K_c .

Procedure

Step 1 Weigh approximately 2 g of powdered calcium hydroxide into a conical flask.

Step 2 Add about 100 cm³ of deionised water to the flask. Stopper the flask and shake for about a minute. Leave the stoppered flask for one day.

Step 3 Filter the contents of the flask.

Step 4 Titrate 25.0 cm³ portions of the filtrate with 0.100 mol dm⁻³ hydrochloric acid in the presence of a suitable indicator.

- (a) Give the reason why the conical flask is left for one day at the end of Step 2.

(1)

- (b) Give the name of a suitable indicator to use in Step 4, including the expected colour change at the end-point.

(2)

Name of indicator

Colour change from to



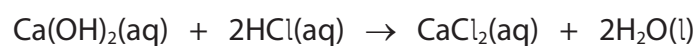
(c) Results from the titrations are shown.

Titration	1	2	3
Final burette reading / cm ³	9.95	19.50	28.95
Initial burette reading / cm ³	0.00	9.95	19.50
Titre of HCl(aq) / cm ³	9.95		

(i) Complete the table and calculate the mean titre in cm³.

(2)

(ii) The equation for the titration is shown.



A data book value for the concentration of a saturated solution of calcium hydroxide at 20 °C is 1.56 g dm⁻³.

Calculate the expected titre, using this information and that given in Step 4.

(4)

(iii) The solubility of calcium hydroxide decreases with increasing temperature.

Suggest why the mean titre from the experiment in (c)(i) does **not** agree with the expected titre from (c)(ii).

(1)

.....

.....

.....



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- (d) From the results of the experiment, the student determined the concentration of the saturated solution of calcium hydroxide to be $0.0190 \text{ mol dm}^{-3}$.

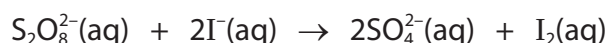
Calculate the value of K_c , including units, from the student's result.

$$K_c = [\text{Ca}^{2+}(\text{aq})] [\text{OH}^{-}(\text{aq})]^2 \quad (2)$$

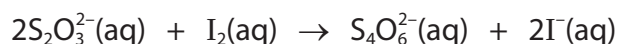
(Total for Question 2 = 12 marks)



- 3** A 'clock' reaction may be used to determine the activation energy for the reduction of peroxodisulfate(VI) ions, $\text{S}_2\text{O}_8^{2-}(\text{aq})$, by iodide ions, $\text{I}^-(\text{aq})$.



A small amount of thiosulfate ions, $\text{S}_2\text{O}_3^{2-}(\text{aq})$, is added to the reaction mixture, which also contains some starch indicator.



Procedure

- Step 1** Prepare a water bath by heating a half-full beaker of water to approximately 50°C .
- Step 2** Using a burette, add 10.0 cm^3 of 0.020 mol dm^{-3} $\text{S}_2\text{O}_8^{2-}(\text{aq})$ ions into a boiling tube.
- Step 3** Into a second boiling tube, use separate burettes to add 5.0 cm^3 of 0.50 mol dm^{-3} $\text{I}^-(\text{aq})$ ions, 5.0 cm^3 of 0.010 mol dm^{-3} $\text{S}_2\text{O}_3^{2-}(\text{aq})$ ions, and 2.5 cm^3 of 0.2% starch solution.
- Step 4** Place both boiling tubes in the water bath and add a thermometer to each. When the temperatures of the two solutions are the same as the water bath, pour the contents of the second boiling tube into the first, stir and start a timer.
- Step 5** Stop the timer when the colour changes and record the time, t .
The reciprocal of the time, $1/t$, is proportional to the initial rate.
- Step 6** Repeat the experiment at several temperatures between 45°C and 25°C .

- (a) Explain why thiosulfate ions, $\text{S}_2\text{O}_3^{2-}(\text{aq})$, are added to the reaction mixture.

(2)



- (b) Explain why a burette, and not a measuring cylinder, is used to add the starch solution in Step 3, even though the concentration of starch indicator does not need to be exactly the same at each temperature.

(2)

.....

.....

.....

.....

.....

- (c) State the colour change in Step 5.

(2)

Colour change from to

- (d) Some results from the experiment are shown.

$T/^{\circ}\text{C}$	T/K	$(1/T)/\text{K}^{-1}$	Time, t/s	$(1/t)/\text{s}^{-1}$	$\ln(1/t)$
	322	0.00311	33	0.0303	-3.50
43			47	0.0213	-3.85
36	309	0.00324	72	0.0139	-4.28
31	304	0.00329			-4.60
25	298	0.00336	147	0.00680	

- (i) Complete the table.

(3)



- (ii) The experimental data was plotted on a graph of $\ln(1/t)$ against $1/T$, giving a straight line with gradient, $m = -6045 \text{ K}$.

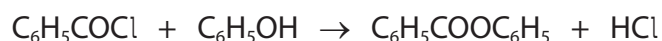
Calculate the activation energy, E_a , for this reaction, in kJ mol^{-1} , using this result.

$$\ln(1/t) = -\frac{E_a}{R} \times \frac{1}{T} + \text{constant} \quad R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1} \quad (1)$$

(Total for Question 3 = 10 marks)



- 4 This question is about the preparation and purification of a sample of phenyl benzoate, $\text{C}_6\text{H}_5\text{COOC}_6\text{H}_5$.



Procedure

- Step 1** Weigh 5.00 g of phenol, $\text{C}_6\text{H}_5\text{OH}$, into a conical flask and add 90 cm^3 of 2.0 mol dm^{-3} aqueous sodium hydroxide.
- Step 2** Working in a fume cupboard, add 9 cm^3 of benzoyl chloride, $\text{C}_6\text{H}_5\text{COCl}$, into the conical flask. Stopper the flask and shake for 15 minutes, carefully releasing the pressure every few minutes.
- Step 3** Cool the flask under cold running water before collecting the impure phenyl benzoate, $\text{C}_6\text{H}_5\text{COOC}_6\text{H}_5$, by suction filtration. Wash the crude product with water.
- Step 4** Recrystallise the crude product using ethanol.
- Step 5** Measure the melting temperature of the pure, dry crystals of phenyl benzoate.
- Some data relating to the organic compounds involved in the preparation are shown.

Compound	Hazard	M_r	Melting temperature / $^{\circ}\text{C}$
Phenol	Corrosive. Toxic by inhalation and skin absorption.	94.0	41
Benzoyl chloride	Corrosive. Toxic by inhalation and skin absorption.	140.5	-1
Phenyl benzoate	Irritating to the skin and eyes.	198.0	71

- (a) State the main safety precaution, other than wearing safety spectacles and a laboratory coat, that should be taken when weighing the phenol in Step 1.

(1)

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(b) Give **one** reason why Step **2** must be performed in a fume cupboard.

(1)

(c) Deduce why the volume of benzoyl chloride added in Step **2** does **not** need to be exact.
Include a calculation in your answer.

[Density of benzoyl chloride = 1.21 g cm^{-3}]

(4)

(d) Give **two** reasons why the crude product is washed with **water** in Step **3**.

(2)



(e) The recrystallisation in Step 4 was carried out using this method:

- transfer the crude product to a boiling tube and cover in ethanol
- place the boiling tube in a water bath at 60°C
- add ethanol until the solid completely dissolves after stirring
- cool the solution in an ice-water bath until crystals appear
- filter the crystals by suction filtration
- wash the crystals with **cold** ethanol.

(i) The boiling temperature of ethanol is 78°C .

Suggest why the crystals are dissolved in ethanol at 60°C , even though this is lower than the boiling temperature of ethanol.

(1)

(ii) Explain why the crystals are **washed** with **cold** ethanol.

(2)



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- (f) Draw a **labelled** diagram of the apparatus that could be used to measure the melting temperature of phenyl benzoate in Step 5.
You should assume that electrical equipment for measuring the melting temperature is **not** available.

(3)

- (g) Calculate the mass of phenyl benzoate that can be prepared from 5.00 g of phenol if the overall yield, by mass, is 65.0%.

(2)

(Total for Question 4 = 16 marks)

TOTAL FOR PAPER = 50 MARKS



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The Periodic Table of Elements

[illegible]

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series

* Actinide series

