Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Thursday 18 January 2024

Afternoon (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.*
- 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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P 7 4 3 2 6 A 0 1 1 6

Pearson

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

1 A student carried out some tests on four aqueous solutions, labelled **A**, **B**, **C** and **D**. Each solution contained one cation and one anion.

(a) Complete the table.

	Test	Observation	Inference	
(i)	Dilute aqueous ammonia was added drop-by-drop to 4 cm^3 of **A** until there was no further change	A pale blue precipitate formed which dissolved to give a deep blue solution	The cation in **A** is	**(1)**
(ii)	Dilute aqueous ammonia was added drop-by-drop to 4 cm^3 of **B** until there was no further change	A white precipitate formed with the first few drops This precipitate dissolved in excess ammonia to give a colourless solution	The **formula** of the white precipitate is ..... The **formula** of the complex **ion** which forms in the colourless solution is	**(2)**
(iii)	Dilute aqueous sodium hydroxide was added drop-by-drop to 4 cm^3 of **C** until there was no further change	....	The cation in **C** is Fe^{3+}	**(2)**
(iv)	Dilute aqueous sodium hydroxide was added drop-by-drop to 4 cm^3 of **D** until there was no further change	An off-white precipitate formed which did not dissolve in excess but darkened when left to stand	The cation in **D** is	**(1)**

(v) Name the type of reaction which results in the darkening of the off-white precipitate in (a)(iv).

(1)

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(b) Adding dilute nitric acid followed by aqueous silver nitrate to **A** and **B** resulted in both forming precipitates.
The student was not certain, but suggested that the anion in **A** was the chloride ion and the anion in **B** was the bromide ion.

State why the student was not certain and outline a further test which could be carried out to confirm the presence of both these anions.

(3)

(c) The student tested for the anion in **C** by adding acidified barium nitrate solution and observed a white precipitate.

Give the **formula** of the compound in solution **C**.

(1)

(d) The student researched further tests for the anion present in **D**.
A test was found which involved the addition of sodium hydroxide solution followed by aluminium and then heating strongly.
Ammonia gas was given off.

Suggest a possible **anion** present in **D**.

(1)

(Total for Question 1 = 12 marks)

2 This question is about the identification of four different organic compounds, **W**, **X**, **Y** and **Z**. The molecules of each compound contain a total of **three** carbon atoms and only **one** functional group.

(a) A sample of **W** gave a positive result with Tollens' reagent.

Give the positive result and the displayed formula of **W**.

(2)

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.....

(b) A sample of **X** produced a sweet-smelling substance when warmed with ethanoic acid and a few drops of concentrated sulfuric acid.

(i) **Name** the **functional group** in **X** identified by this test.

(1)

.....

(ii) There are only two peaks in the ^{13}C NMR spectrum of **X**.

Draw the displayed formula of **X**, labelling the carbon environments.

(2)

(c) A sample of **Y** gave a positive result when warmed with an alkaline solution of iodine.

(i) Give **two** observations of a positive result from this test.

(2)

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(ii) Identify **Y** by name or formula.

(1)

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(d) A sample of **Z** produced bubbles when sodium carbonate solution was added.

Draw the **displayed** formula of **Z**, showing all the bonds.

(1)

(Total for Question 2 = 9 marks)

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3 A student was given a 0.0200 mol dm^{-3} solution of ammonium vanadate(V) and asked to prepare solutions containing vanadium ions in different oxidation states, and then to confirm the results.

The student decided to use the three different reducing agents shown.

zinc sulfur dioxide tin

(a) The student pipetted 25.0 cm^3 of the vanadate(V) solution into a flask and added about 60 cm^3 of 1 mol dm^{-3} sulfuric acid.

About 5 g of granulated zinc was added to the flask.

Cotton wool was used to stopper the flask, which was heated and gently boiled for 30 minutes.

(i) Suggest why only an approximate volume of sulfuric acid was used.

(1)

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(ii) The cotton wool helps to prevent the reoxidation of the vanadium and to allow the escape of hydrogen gas.

State why hydrogen gas was produced.
You may include an equation in your answer.

(1)

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(iii) Give a possible reason why the flask was heated.

(1)

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(iv) The student concluded that zinc had reduced the vanadium(V) to the vanadium(II) oxidation state.

Explain the sequence of colours that the student would have seen to reach this conclusion.
Link each colour to the vanadium oxidation state.

(3)

(b) The student was told that sulfur dioxide is toxic and that cylinders of the gas are not recommended for use in schools.
The student was advised to prepare it within the reaction mixture from sodium sulfate(IV) and hydrochloric acid.

(i) Suggest why sulfur dioxide is advised to be prepared in this way.

(1)

(ii) Write the equation for the generation of sulfur dioxide from the reaction between sodium sulfate(IV) (Na_2SO_3) and hydrochloric acid.
State symbols are not required.

(1)

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(c) After using tin as the reducing agent, the student carried out a titration with acidified potassium manganate(VII) to find out how far the vanadium had been reduced.

(i) State a suitable method to remove the unreacted tin.

(1)

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(ii) Information about the experiment is shown.

- 25.0 cm^3 of 0.0200 mol dm^{-3} ammonium vanadate(V) was reduced by tin
- 20.00 cm^3 of 0.0100 mol dm^{-3} potassium manganate(VII) was required to oxidise the vanadium back to its original oxidation state
- the manganate(VII) half-equation is
  $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

Deduce the vanadium ion oxidation state after the reduction by tin.
You must show your working.

(4)

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(iii) Explain the effect on the titre of leaving the tin in the reaction mixture.

(2)

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(Total for Question 3 = 15 marks)

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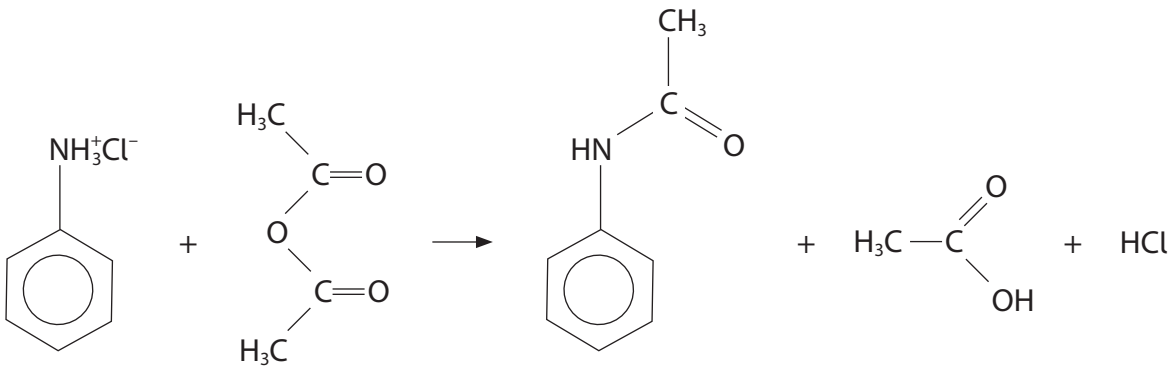
4 This question is about the preparation of phenylethanamide by the reaction between phenylammonium chloride and ethanoic anhydride.



Data

Compound	Molar mass / g mol^{-1}	Density of liquid / g cm^{-3}	Melting temperature / °C
phenylammonium chloride	129.5	–	196–198
ethanoic anhydride	102.0	1.08	–
phenylethanamide	135.0	–	113–115

Outline procedure

Step **1** Dissolve 1.0 g of phenylammonium chloride in 30 cm^3 of deionised water in a conical flask.

Step **2** Dissolve 6.0 g of sodium ethanoate in 25 cm^3 of deionised water in a separate conical flask.

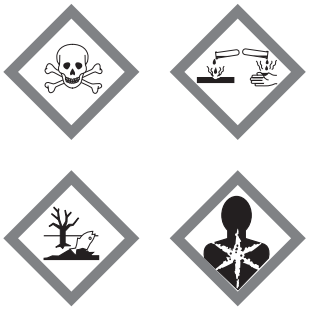
Step **3** Carefully add 2.0 cm^3 of ethanoic anhydride to the phenylammonium chloride solution and stir until all the ethanoic anhydride has dissolved. Then add the solution of sodium ethanoate and continue to stir for a further 3 minutes.

Step **4** Collect the impure sample of phenylethanamide by filtration under reduced pressure.

Step **5** Recrystallise the phenylethanamide using deionised water.

Step **6** Determine the melting temperature of the crystals of phenylethanamide.

(a) The use of phenylammonium chloride is preferred to the use of phenylamine in this preparation.

Compound	State at room temperature	Hazard symbols
phenylamine	liquid	
phenylammonium chloride	solid	

Suggest, by referring to **both** columns of data in the table, **two** reasons why it is preferable to use phenylammonium chloride.

(2)

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(b) Show, by calculation, that ethanoic anhydride is in excess in this preparation.

(3)

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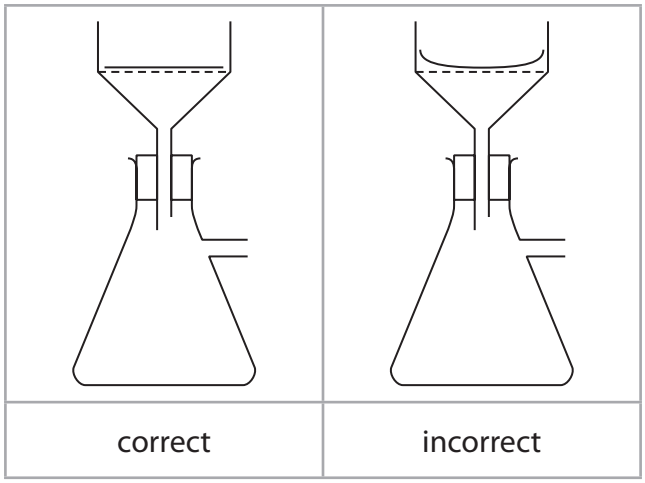
(c) In Step **4**, a Büchner flask and funnel were used for suction filtration.

(i) The filter paper used should fit in the funnel and lie flat on the base of the Büchner funnel rather than curl up the sides of the funnel.



correct	incorrect

Explain why it is important to place the filter paper in this way.

(2)

(ii) Explain why the solid collected in Step **4** is washed with **a small volume** of **cold** water.

(2)

(d) In Step **5** the recrystallisation of phenylethanamide involves hot filtration. State the purpose of this filtration.

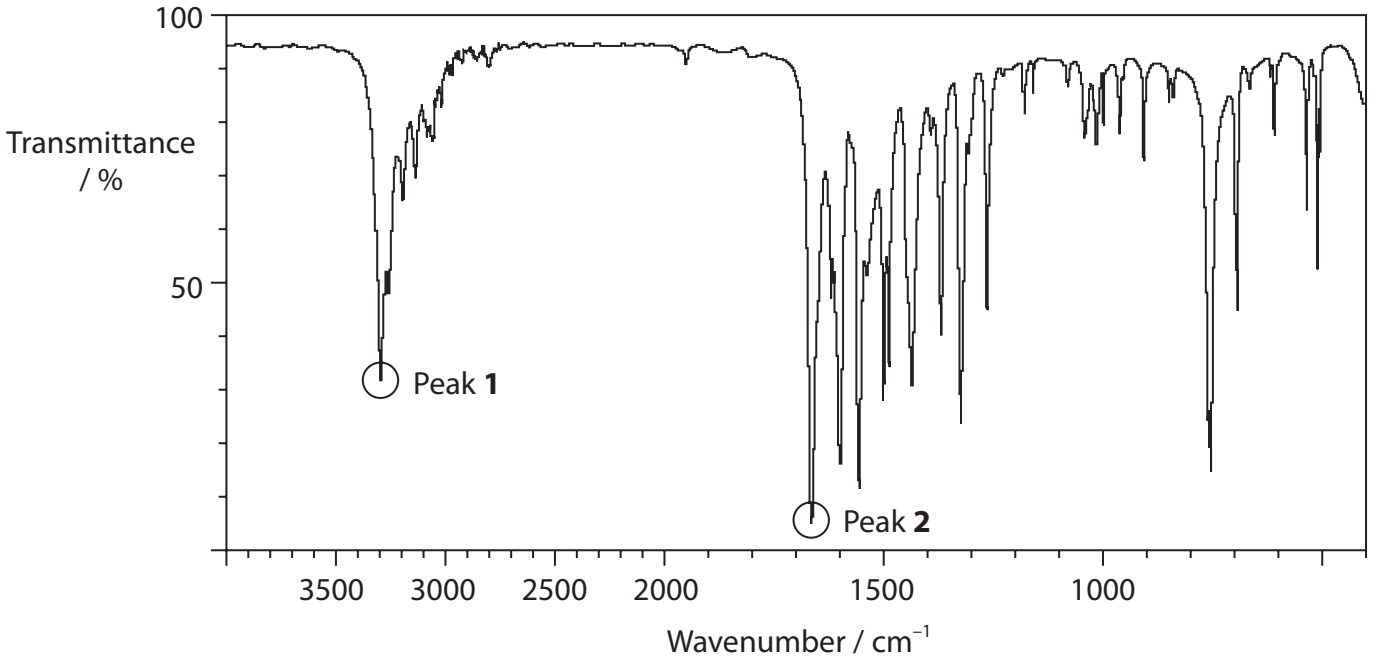
(1)

(e) Give the **two** effects of impurities on the melting temperature range of phenylethanamide.

(1)

(f) An infrared spectrum of phenylethanamide and an infrared spectrum of phenylamine were obtained.

One of these two spectra is shown with two peaks circled.



Infrared data for some organic functional groups are shown.

Group	Wavenumber range / cm^{-1}
N—H stretching vibrations	
Amine	3500–3300
Amide	3500–3140
C═O stretching vibrations	
Amides	1700–1630
Carboxylic acid, anhydrides	1850–1800 and 1790–1740
Ketones, alkyl	1720–1700

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Explain why Peak **1** cannot be used to identify the spectrum as being produced by phenylethanamide but Peak **2** can.
Include reference to the infrared data in your answer.

(3)

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(Total for Question 4 = 14 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

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

* Lanthanide series

* Actinide series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103