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 23 January 2025

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, 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 8 4 5 7 A 0 1 1 6

Pearson

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

1 This question is about qualitative testing for ions.

(a) A student was given a solid sample of potassium sulfate, K_2SO_4.

(i) Describe how the student could use flame colour to confirm that the solid sample contains potassium ions.

Outline the experimental procedure, stating the colour of the flame produced.

(4)

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(ii) The student dissolved some of the solid sample in deionised water in a test tube.

To the test tube, the student added dilute hydrochloric acid followed by aqueous barium chloride. A precipitate was observed.

Give the colour of the precipitate and the **ionic** equation for its formation. Include state symbols.

(2)

Colour of precipitate

....

Ionic equation

(b) Another student was given a solution containing one type of cation and two types of anion.

(i) The student warmed some of the solution in a test tube, before adding aqueous sodium hydroxide and holding damp red litmus paper at the mouth of the tube.

From the results, the student identified the cation as the ammonium ion, NH_4^+.

Explain the student's inference.

(2)

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(ii) To another test tube of the solution, the student added silver nitrate solution. A pale yellow precipitate was observed.

The student then added an **excess** of dilute nitric acid. Effervescence was observed.

Some of the precipitate dissolved.

The student added an excess of **concentrated** ammonia solution to the remaining precipitate.

The precipitate dissolved to form a colourless solution.

Complete the table about the student's results.

(3)

Formula of gas evolved	
Formula of the precipitate that dissolved in dilute nitric acid	
Formula of the precipitate that dissolved in concentrated ammonia solution	

(Total for Question 1 = 11 marks)

2 A student used the reaction of magnesium with hydrochloric acid to determine the volume of 1 mol of hydrogen gas at room temperature and pressure (r.t.p.).

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

Procedure

Step **1** Weigh 0.030 g of magnesium ribbon.

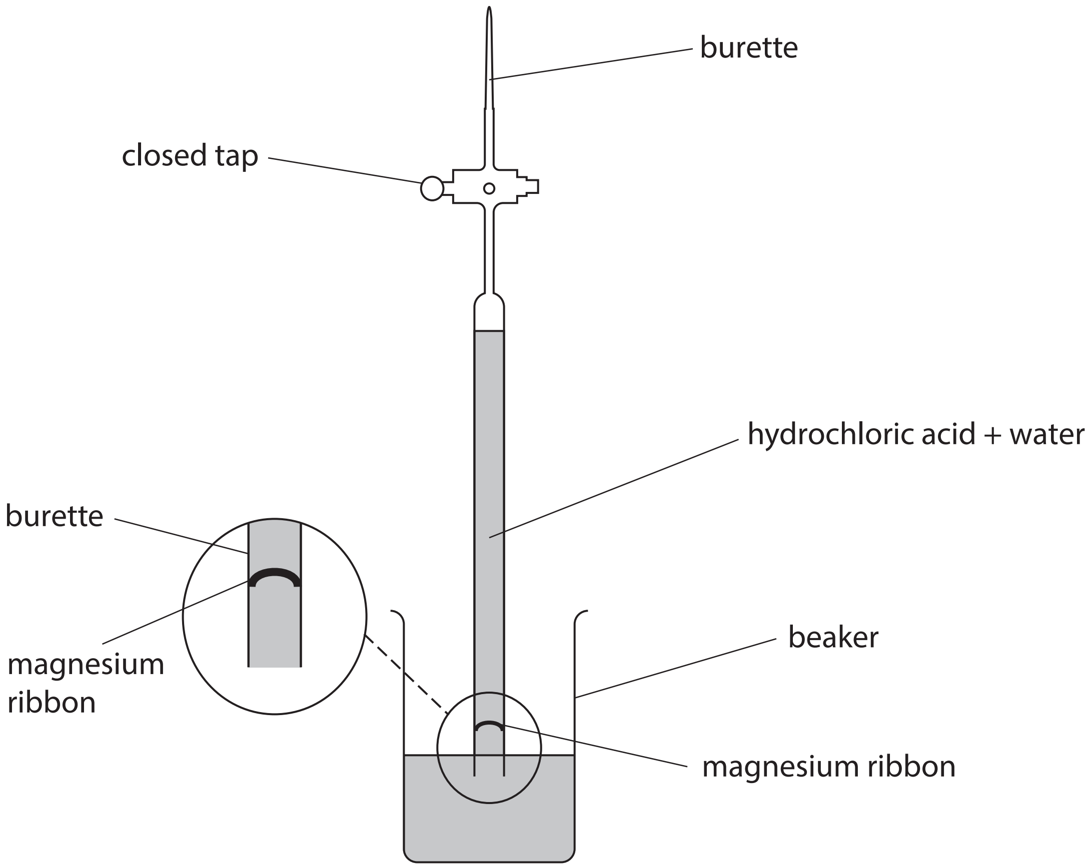
Step **2** Add approximately 25 cm^3 of 2.0 mol dm^{-3} hydrochloric acid into a burette and carefully add 25 cm^3 of water on top.

Step **3** Push the magnesium ribbon into the open end of the burette so that it stays in position.

Step **4** Quickly invert the burette. Clamp the burette vertically and take the burette reading.

Step **5** Wait for the magnesium to start reacting. Take the final burette reading after all the magnesium has reacted.

A diagram of the experiment is shown.



(a) Explain why the volume of hydrochloric acid added to the burette in Step **2** does not need to be exact.

You must include a calculation.

(3)

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(b) State why the magnesium does not start reacting as soon as the burette is inverted in Step **4**.

(1)

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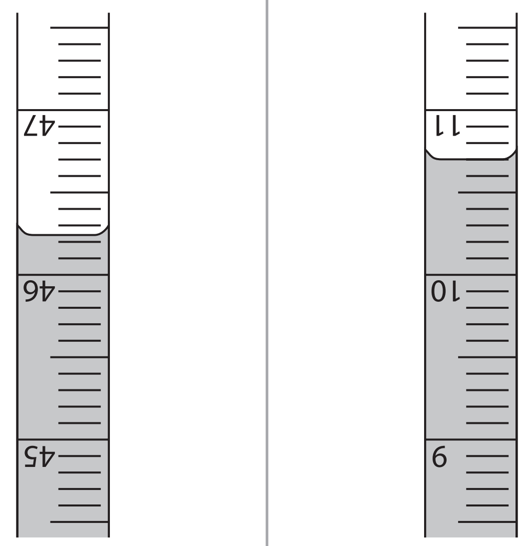
(c) The diagram shows the burette readings from Steps **4** and **5**.

Burette reading from Step **4**	Burette reading from Step **5**



Record the burette readings, and hence the volume of hydrogen gas produced in the experiment.

(2)

Burette reading in Step **4** / cm^3	
Burette reading in Step **5** / cm^3	
Volume of hydrogen gas / cm^3	

(d) Calculate the volume of 1 mol of hydrogen gas at r.t.p., in cm^3, using your answer to (c), the reaction equation and the mass of magnesium (0.030 g) used in the procedure.

(2)

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

(e) The magnesium ribbon used in Step **1** contained a magnesium oxide impurity of up to 2% by mass.

Explain whether this magnesium oxide impurity could account for any difference in your answer to (d) from the Data Book value of 24 000 cm^3.

No calculation is required.

(2)

(f) Two readings were taken to measure the mass of magnesium used in the experiment. The uncertainty in each reading was 0.0025 g.

(i) Calculate the percentage uncertainty in the mass of magnesium used in the experiment.

(1)

(ii) The student wanted to reduce the percentage uncertainty by using double the mass of magnesium.

Give the reason why the experiment outlined in the procedure could **not** be conducted successfully using double the mass of magnesium.

(1)

(Total for Question 2 = 12 marks)

3 The concentration of a solution of barium hydroxide can be determined using a standard solution of ethanedioic acid.

(a) State what is meant by the term **standard** solution.

(1)

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(b) Describe the preparation of 100.0 cm^3 of a 0.0500 mol dm^{-3} standard solution of ethanedioic acid, starting with crystals of ethanedioic acid dihydrate, $H_2C_2O_4 \cdot 2H_2O$.

Your answer should include details of the apparatus used and the mass of $H_2C_2O_4 \cdot 2H_2O$ required.

(6)

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(c) 25.0 cm^3 of 0.0500 mol dm^{-3} ethanedioic acid solution, $H_2C_2O_4(aq)$, was added to a conical flask and titrated with barium hydroxide solution, $Ba(OH)_2(aq)$, of an unknown concentration.

(i) Name the piece of apparatus that should be used to add the ethanedioic acid solution, $H_2C_2O_4(aq)$, to the conical flask.

(1)

....

(ii) The titration was carried out with a few drops of phenolphthalein indicator in the conical flask.

State the colour change observed at the end-point of the titration.

(2)

From .... to ....

(iii) The formation of a white precipitate was observed during the titration.

Suggest the identity of the white precipitate, by name or formula.

(1)

....

(iv) The titration was repeated, giving a mean titre of 31.55 cm^3.

Calculate the concentration of the barium hydroxide solution, $Ba(OH)_2(aq)$, in **g dm^{-3}**.

$Ba(OH)_2$ and $H_2C_2O_4$ react in a 1 : 1 ratio.

Give your answer to an appropriate number of significant figures.

(3)

(Total for Question 3 = 14 marks)

4 This question is about the preparation of 2-chloro-2-methylpropane from 2-methylpropan-2-ol and concentrated hydrochloric acid.

$$(CH_3)_3COH + HCl \rightarrow (CH_3)_3CCl + H_2O$$

Procedure

Step **1** Pour 9.0 cm^3 of 2-methylpropan-2-ol into a separating funnel.

Step **2** Add 20 cm^3 of concentrated hydrochloric acid to the separating funnel, about 3 cm^3 at a time.
Stopper and invert the funnel after each addition.

Step **3** Leave the separating funnel for about 20 minutes, shaking it gently at regular intervals. Allow the layers to separate.

Step **4** Discard the aqueous layer before washing the organic layer repeatedly with sodium hydrogencarbonate solution, releasing the pressure after each addition.

Step **5** Transfer the organic layer into a small, dry conical flask and add three spatula measures of anhydrous sodium sulfate, swirling the flask after each addition.

Step **6** Decant the organic liquid into a pear-shaped flask and distil the 2-chloro-2-methylpropane into a pre-weighed conical flask.

(a) Give **one** reason, relating to safety, why the hydrochloric acid is added to the separating funnel 3 cm^3 at a time, and not all at once, in Step **2**.

(1)

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....

....

(b) Draw a labelled diagram of the separating funnel at the end of Step **3**.

[Density of 2-chloro-2-methylpropane = 0.85 g cm^{-3}]

(2)

(c) Sodium hydrogencarbonate solution is added to remove acid impurities in Step **4**.

Give the reason why a stronger alkali, such as sodium hydroxide solution, should **not** be used for this purpose.

(1)

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(d) State the role of the sodium sulfate in Step **5**.

(1)

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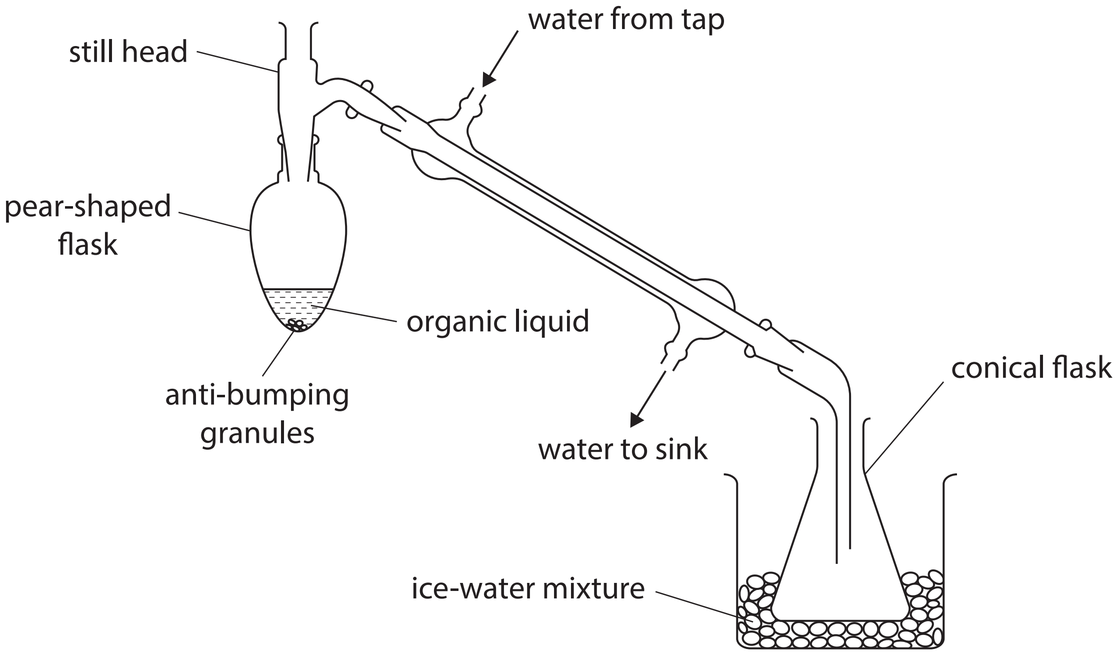
(e) Identify **two** changes that must be made to the apparatus shown before distilling in Step **6**, giving a reason for each change.

(4)



Change 1

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Reason 1

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Change 2

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Reason 2

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....

(f) Calculate the mass of 2-chloro-2-methylpropane produced in this procedure, if the percentage yield is 70%.

[Density of 2-methylpropan-2-ol = 0.78 g cm^{-3}]

[M_r of 2-methylpropan-2-ol = 74.0]

[M_r of 2-chloro-2-methylpropane = 92.5]

(4)

(Total for Question 4 = 13 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1.0
H
hydrogen
1

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (8) (18)
																	4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											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											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	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
* Actinide series	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