Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

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.
- **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 ▶

Pearson

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

1 An experiment is carried out to determine the enthalpy change for the reaction between zinc and copper(II) sulfate solution.

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Procedure

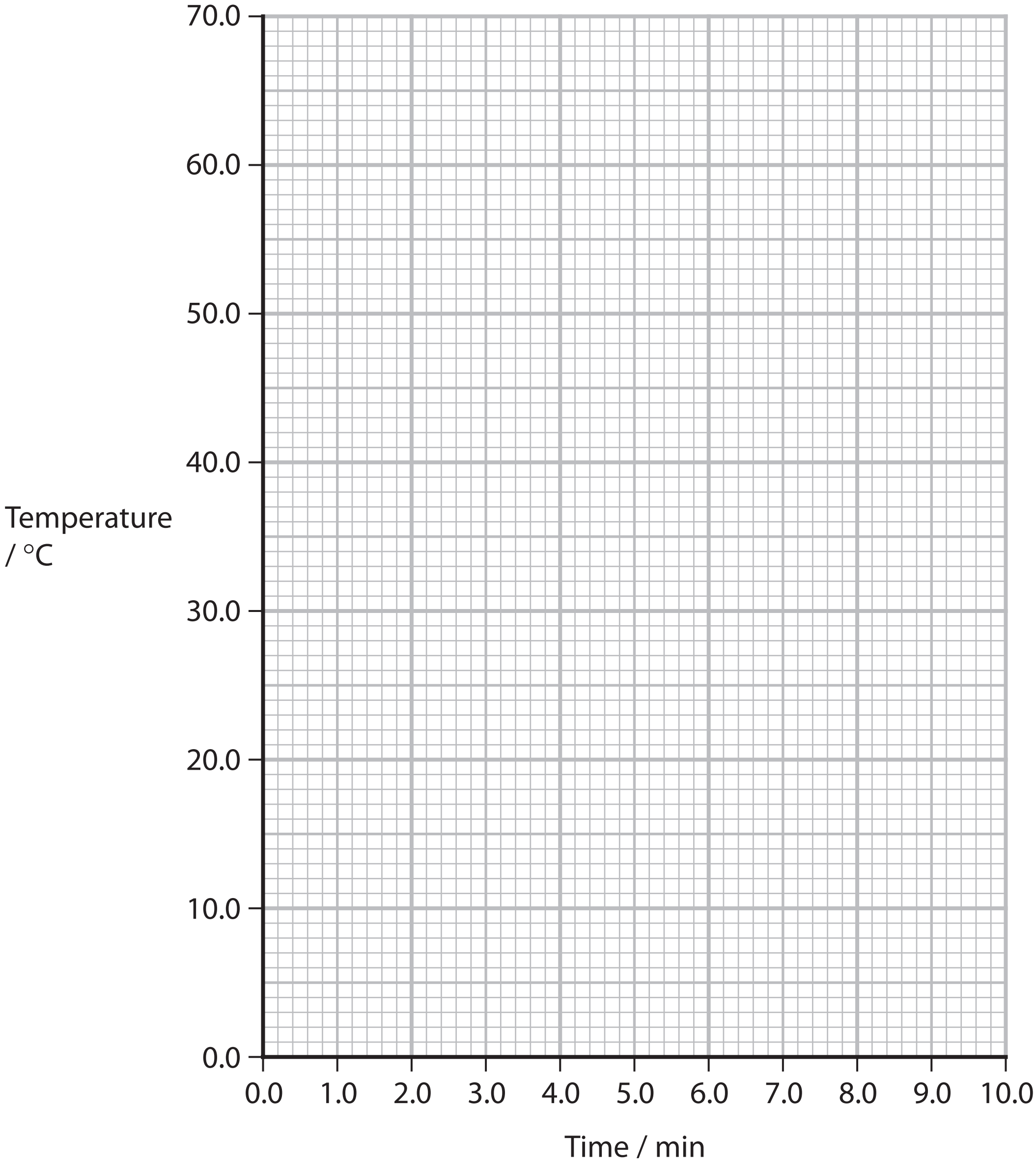
- weigh 4.50 g of zinc powder into a weighing bottle
- use a measuring cylinder to transfer 50.0 cm^3 of 1.00 mol dm^{-3} aqueous copper(II) sulfate into a polystyrene cup, held in a 250 cm^3 beaker
- stir the solution with a thermometer, record the temperature to the nearest 0.5 °C and start a timer
- continue to stir the solution, recording the temperature every minute
- at exactly 3.5 minutes, add the zinc powder to the aqueous copper(II) sulfate, stirring continuously
- record the temperature of the solution every minute from 4.0 to 9.0 minutes.

The results are shown.

Time / min	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
Temperature / °C	21.5	22.5	22.0	22.0	60.5	63.0	60.5	58.5	57.0	55.5

(a) (i) Plot a graph of temperature against time on the grid.

(1)



(ii) Use the graph to determine the maximum temperature change, ΔT, in this experiment. You **must** show your working on the graph.

(3)

ΔT = ... °C

(iii) State why using a series of measurements gives a more accurate temperature change than taking the initial and highest temperatures.

(1)

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(b) (i) Show by calculation that the zinc powder is in excess.

(2)

(ii) Calculate the energy transferred in the reaction, in joules.

Assume that the specific heat capacity of the solution is $4.2\,J\,g^{-1}\,°C^{-1}$.

(1)

(iii) State a second assumption, other than the specific heat capacity of the solution, that you have made in your calculation in (b)(ii).

(1)

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(iv) Calculate the enthalpy change of the reaction, using your answers to (b)(i) and (b)(ii).

(2)

(c) Identify **two** improvements in the experimental procedure that would improve the accuracy of the result, other than repeating the experiment. Justify your answers.

(2)

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(Total for Question 1 = 13 marks)

2 The hydrogencarbonate of an unknown Group 1 metal, $MHCO_3$, is a white solid. Two students carried out a titration experiment using hydrochloric acid.

The results were used to determine a value for the relative formula mass, M_r, of $MHCO_3$ and thus obtain a value for the relative atomic mass, A_r, of M.

Both students made solutions containing 2.00 g of $MHCO_3$.

The **first** student made a 250.0 cm^3 standard solution.

The **second** student made a solution by placing the $MHCO_3$ in a beaker, dissolving the solid in a little deionised water, and then filling the beaker to the 250 cm^3 mark.

Both students titrated 25.0 cm^3 portions of their solution using hydrochloric acid with a concentration of 0.150 $mol\,dm^{-3}$. They used the same method and equipment.

The students repeated their titrations until they achieved concordant titres.

The **first** student obtained a mean titre of 13.35 cm^3.

(a) Calculate the value for the A_r of the metal M from the data of the **first** student.

$MHCO_3$ and HCl react in a 1 : 1 ratio.

You must show your working. Give your answer to **two** decimal places.

(4)

(b) **Both** students calculated values of the relative atomic mass of M.
Using their calculations and the total percentage uncertainty of their experiments, they deduced that M was potassium.

The value for A_r calculated by the second student was 37.52.

(i) Calculate the experimental error for the **second** student.

[A_r of potassium = 39.1]

(1)

(ii) The **second** student calculated the A_r value of M to be 37.52 with a total percentage uncertainty of 4.5 %.

Comment on the value of 37.52 obtained by this student by calculating the range of values of A_r.

(3)

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(iii) The **first** student suggested that the burette was the biggest source of experimental uncertainty.

Explain how the percentage uncertainty of the burette reading could be reduced without changing the apparatus or simply repeating the experiment.

(2)

(iv) The **second** student was told that using a beaker to prepare their standard solution was incorrect.

Describe the steps the student should take to make a standard solution as accurately as possible.
Assume that the student is supplied with 2.00 g of $MHCO_3$ in a weighing bottle and the usual laboratory glassware.

(4)

(c) The solution formed from the reaction between $MHCO_3$ and HCl can be evaporated to give a white solid, MCl.

(i) State the test the students might use on the white solid to show that M was potassium. Include the expected result.

(2)

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(ii) Describe a test and the expected result to confirm the presence of the chloride ion in the white solid.

(3)

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(Total for Question 2 = 19 marks)

3 Cyclohexene, C_6H_{10}, was prepared by dehydrating cyclohexanol, $C_6H_{11}OH$, using concentrated phosphoric(V) acid, H_3PO_4.

$$C_6H_{11}OH(l) \rightarrow C_6H_{10}(l) + H_2O(l)$$

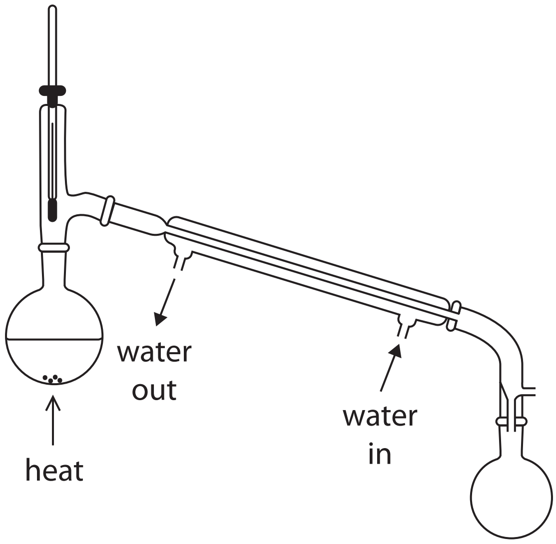
Procedure

Step **1** Approximately 12 cm^3 of cyclohexanol was measured into a small flask.

Step **2** 5 cm^3 of concentrated phosphoric(V) acid was added slowly to the flask with cooling and swirling.

Step **3** Some anti-bumping granules were added to the mixture.

Step **4** The flask was set up for distillation, using the apparatus shown, and the distillate was collected between 80 °C and 90 °C.



Step **5** The distillate was transferred to a separating funnel and washed with an aqueous solution of sodium carbonate.

Step **6** The crude organic product was separated from the mixture, placed in a clean separating funnel and washed with deionised water.

Step **7** The organic layer was separated and dried using a suitable drying agent.

Step **8** The dried organic layer was distilled, over a narrow range of temperature, to give pure cyclohexene.

Substance	Boiling temperature / °C	Density / $g\,cm^{-3}$
Cyclohexanol	162	0.96
Cyclohexene	83	0.81
Water	100	1.00

(a) Give the most suitable piece of apparatus for measuring the cyclohexanol in Step **1**.

(1)

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(b) Explain why adding phosphoric(V) acid slowly, with cooling and swirling, in Step **2** results in a higher yield of cyclohexene.

(2)

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(c) In Step **3** anti-bumping granules are present to promote smooth boiling in the mixture.

Give a reason, other than damage to equipment, why bumping should be avoided.

(1)

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(d) Explain why, in Step **4**, the distillate is collected in a temperature range of 80 °C to 90 °C.

(2)

Substance	Boiling temperature / °C
Cyclohexanol	162
Cyclohexene	83
Water	100

(e) (i) State what is removed by washing the mixture with sodium carbonate solution in Step **5**.
Include an **ionic** equation for the reaction.
State symbols are not required.

(2)

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(ii) After the washing in Step **5**, the separating funnel contains two layers.

Draw a diagram of the separating funnel, labelling its contents.

(2)

Substance	Density / $g\,cm^{-3}$
Cyclohexanol	0.96
Cyclohexene	0.81
Water	1.00

(iii) Suggest what might be removed by washing the product with deionised water in Step **6**.

(1)

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(f) Identify from the list shown **one** substance that could be used as a drying agent in Step **7** of this procedure. Justify your choice.

(2)

$C_2H_5OH(l)$	$Ca(OH)_2(s)$	$CuSO_4.5H_2O(s)$
$H_2SO_4(l)$	$MgSO_4(s)$	$Na_2SO_4.10H_2O(s)$

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(g) Chemical tests may be used to show whether or not reactants and products are present during the course of the procedure.

(i) State a chemical test and the expected observation for a C=C double bond.

(2)

(ii) State a chemical test and the expected observation for an –OH group.

(2)

(iii) State whether or not the test in (g)(ii) could be used on the organic product to show if cyclohexanol remains when Step **5** is complete.
Justify your answer.

(1)

(Total for Question 3 = 18 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 (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)
							1.0 **H** hydrogen 1										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