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 24 May 2024

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.

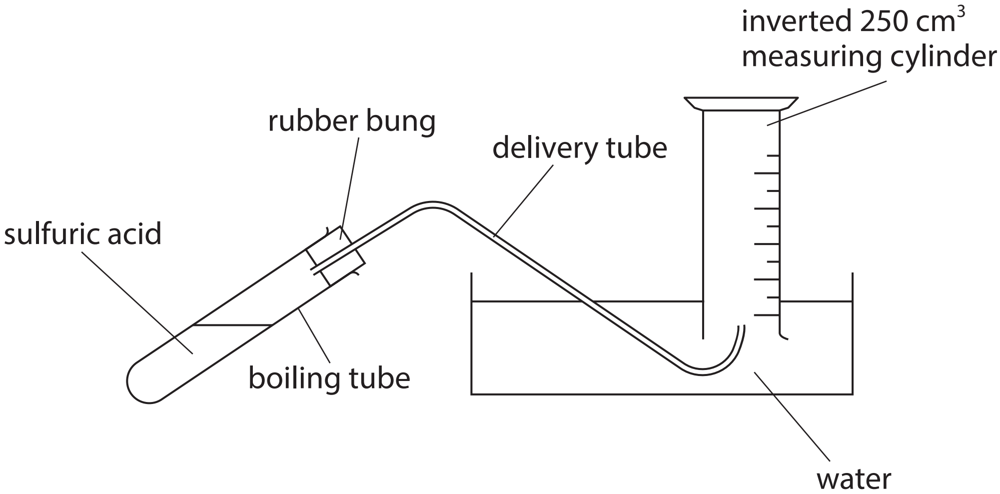
Turn over ▶

Pearson

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

1 This is a question about practical activities involving the collection of a gas.

(a) A student used the apparatus shown to collect the gas produced from the reaction between copper(II) carbonate and sulfuric acid.



The bung was removed and 0.650 g of copper(II) carbonate was added to 25.0 cm^3 of 2.00 mol dm^{-3} sulfuric acid (an excess) in the boiling tube.
The bung was quickly replaced and 120 cm^3 of carbon dioxide gas was collected in the measuring cylinder.
The equation for the reaction is shown.

$$CuCO_3(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l) + CO_2(g)$$

Calculate the molar volume of carbon dioxide gas, in $dm^3\,mol^{-1}$, from these data.
Give your answer to an appropriate number of significant figures.

(3)

P 7 5 7 8 0 A 0 2 1 6

(b) After the reaction, tests can be carried out on the mixture to show that the sulfuric acid was in excess.

(i) State the observation if a small volume of sodium hydrogencarbonate solution was added to show that the acid was in excess.

(1)

....

(ii) Describe a **different** test, and the positive observation, that could be carried out to show that the acid was in excess.

(2)

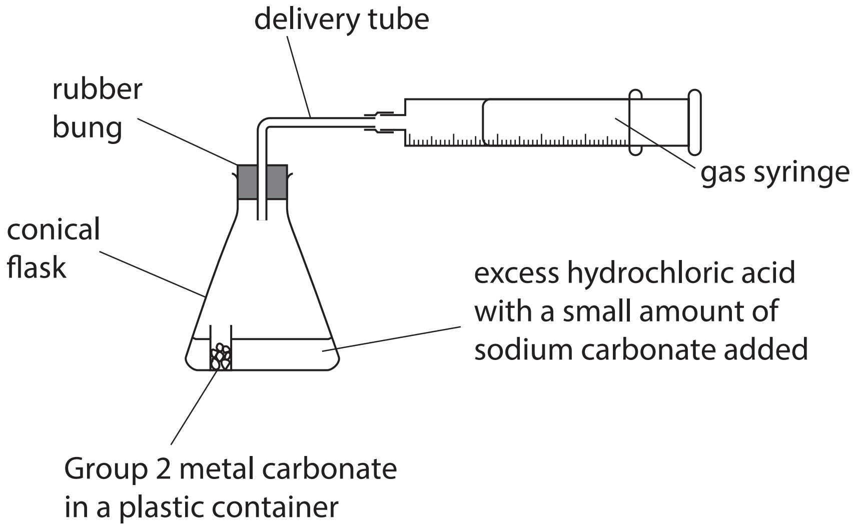
....

....

....

....

(c) Another student used the apparatus shown to collect the volume of gas produced from the reaction between a Group 2 metal carbonate and excess hydrochloric acid.



(i) Give **two** reasons why the second set of apparatus gives a more accurate measurement of the volume of gas given off.
Justify your answers.

(2)

....

....

....

....

....

....

(ii) The reaction of 0.320 g of the Group 2 metal carbonate resulted in 89.0 cm^3 of carbon dioxide gas being collected in the gas syringe.

$$MCO_3(s) + 2HCl(aq) \rightarrow MCl_2(aq) + H_2O(l) + CO_2(g)$$

Determine, by calculation, the identity of the Group 2 metal from these data.
You **must** show your working.
Assume a molar gas volume of 24 000 $cm^3 mol^{-1}$.

(3)

(Total for Question 1 = 11 marks)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

2 Bromoethane was prepared from the reaction of ethanol with sulfuric acid and potassium bromide.

$$C_2H_5OH + H_2SO_4 + KBr \rightarrow C_2H_5Br + KHSO_4 + H_2O$$

Procedure

Step **1** 10.0 cm^3 of ethanol was placed in a round-bottomed flask.

Step **2** 10.0 cm^3 of concentrated sulfuric acid was added carefully and gradually to the ethanol in the flask.

Step **3** 12.0 g of potassium bromide was added to the reaction mixture in the flask.

Step **4** The flask was set up for distillation and heated gently.

Step **5** Water, ethanol and bromoethane were collected in a small beaker.

Step **6** The bromoethane was purified.

Step **7** The bromoethane was dried.

(a) Suggest why the flask in Step **2** was frequently placed in a stream of cold running water as the sulfuric acid was gradually added.

(1)

....

....

(b) The potassium bromide used in Step **3** was initially lumpy and not a fine powder. State the apparatus that would be suitable for breaking up the lumps of potassium bromide into a powder.

(1)

....

(c) Explain why an orange colour was seen in the round-bottomed flask when it was first gently heated in Step **4**.

(2)

....

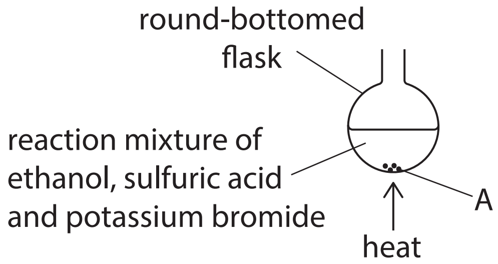
....

....

....

(d) Complete the labelled diagram of the distillation apparatus used in Step **4**.

(3)



(e) Identify the solid particles labelled **A** in the flask that have been added to promote smooth boiling.

(1)

....

(f) Bromoethane is very volatile.
Suggest what could be done with the small beaker, used in Step **5** to collect bromoethane, in order to prevent the loss of the bromoethane distillate.

(1)

....

....

....

(g) Describe how to use a separating funnel to remove the aqueous layer from the bromoethane collected in Step **6**.
[Densities: bromoethane = 1.47 g cm^{-3} water = 1.00 g cm^{-3}]

(2)

....

....

....

....

....

(h) State why the bromoethane would **not** be dried in Step **7** by placing in a warm oven.

(1)

....

....

(i) A small quantity of water is removed by the drying agent anhydrous calcium chloride.

Complete the equation by adding the formula of the product including its state symbol.

(1)

$$CaCl_2(s) + 2H_2O(l) \rightarrow \text{..............................}$$

(j) State a chemical test for the –OH group in ethanol and a chemical test for the –Br group in bromoethane. Include the expected positive observations.

(4)

–OH group in ethanol ....

....

....

–Br group in bromoethane ....

....

....

(Total for Question 2 = 17 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

3 The equilibrium between iodine(I) chloride, chlorine and iodine(III) chloride can be used to demonstrate the effects of changing conditions on a system at equilibrium.

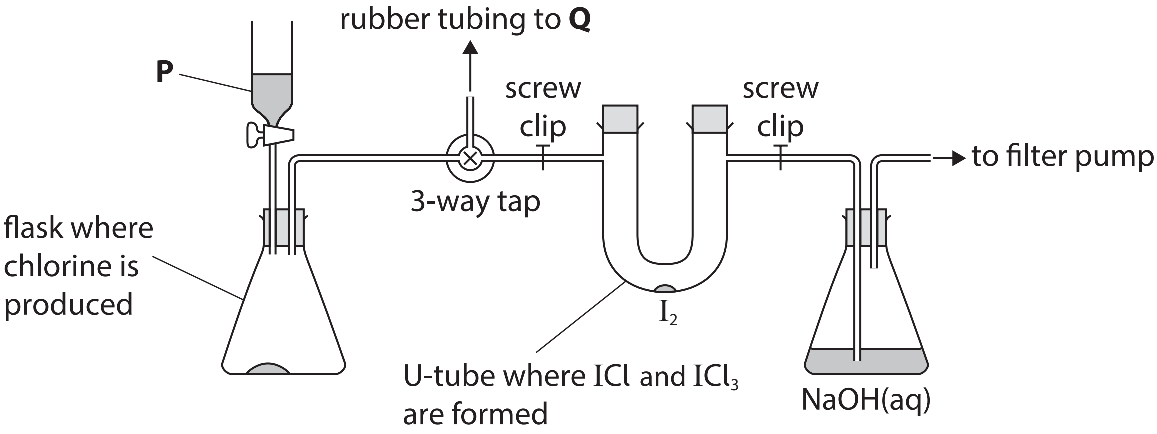
Iodine(I) chloride is formed by passing chlorine over iodine in a U-tube.
The equation for this is shown.

$$I_2 + Cl_2 \rightarrow 2ICl$$

A further reaction then occurs between the iodine(I) chloride and chlorine which results in the equilibrium shown.

$$\underset{\text{brown}}{ICl(l)} + \underset{\text{pale green}}{Cl_2(g)} \rightleftharpoons \underset{\text{yellow}}{ICl_3(s)} \qquad \Delta H = -106\,\text{kJ mol}^{-1}$$

The apparatus shown can be used to set up and then to demonstrate how the system at equilibrium responds to changing conditions.



(a) The addition of more liquid **P** to the flask on the left produces more chlorine gas.

(i) Explain the observations you would make as the amount of chlorine gas in the U-tube increases.

(3)

....

....

....

....

(ii) The 3-way tap can be used to prevent more chlorine gas from entering the equilibrium system.

Identify **Q** and state why it is necessary.

(2)

(b) Explain what you could do to the U-tube to result in more brown liquid being observed.

(2)

(c) The sodium hydroxide solution absorbs excess chlorine.

Write the equation for the reaction between cold, dilute sodium hydroxide and chlorine.
State symbols are not required.

(2)

(Total for Question 3 = 9 marks)

4 An experiment was carried out to determine the enthalpy change of neutralisation for the reaction between sulfuric acid and sodium hydroxide.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

Procedure

Step **1** 25.0 cm^3 of 1.25 mol dm^{-3} sulfuric acid was placed in a polystyrene cup. The polystyrene cup was then placed in a beaker. A thermometer was used to measure the temperature of the acid and a clock was started.

Step **2** The temperature of the sulfuric acid was measured every 30 seconds for 2½ minutes.

Step **3** 50.0 cm^3 of 1.25 mol dm^{-3} sodium hydroxide solution was added to the acid in the polystyrene cup at 3 minutes and the mixture was constantly stirred.

Step **4** The temperature of the mixture in the polystyrene cup was measured at 3½ minutes and then every 30 seconds until the clock reached 10 minutes.

(a) Give the reason why the polystyrene cup in Step **1** was placed in a beaker.

(1)

....

....

(b) State the purpose of measuring the temperature every 30 seconds for 2½ minutes in Step **2**.

(1)

....

....

(c) Explain why the temperature was not measured at 3 minutes.

(2)

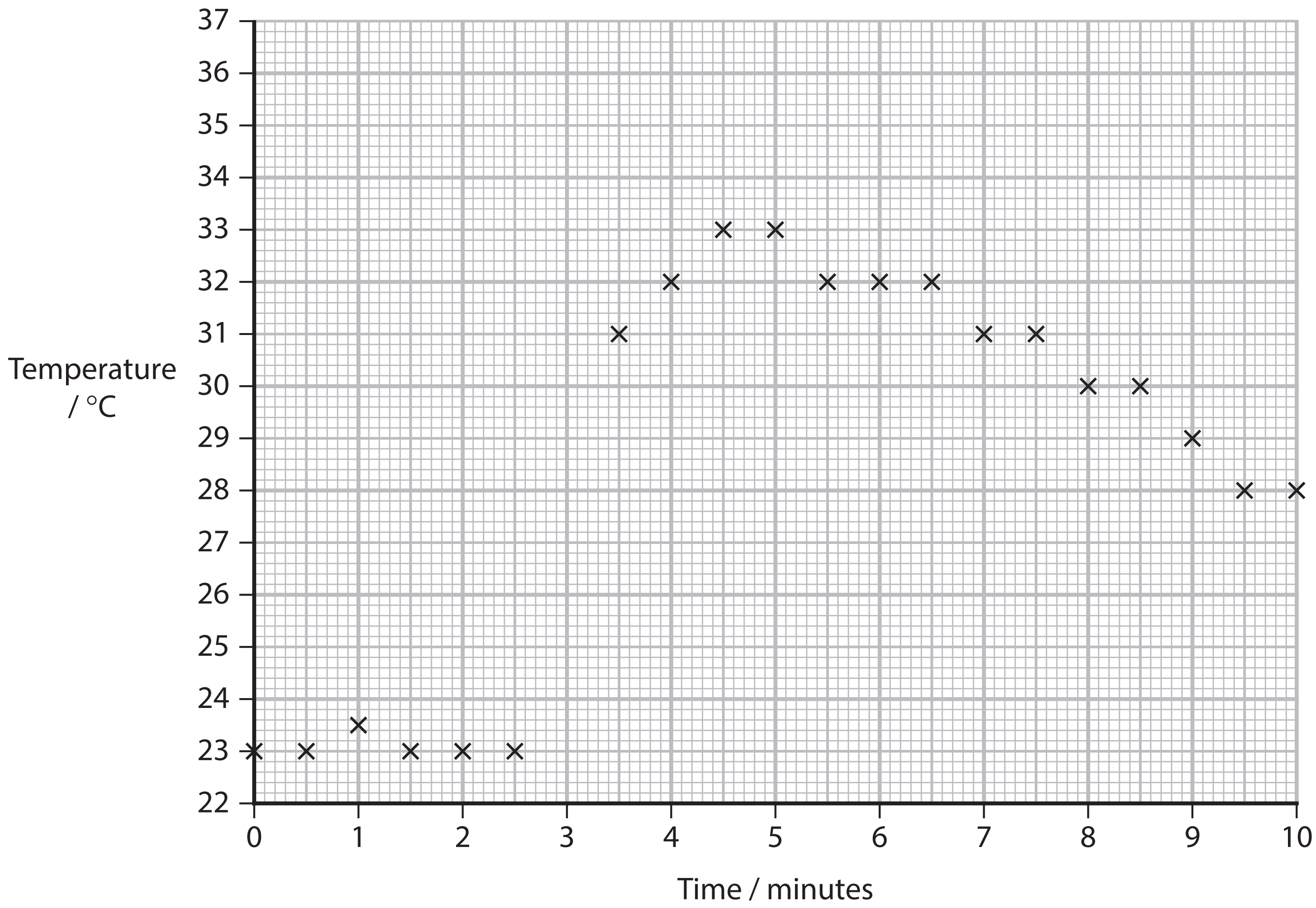
....

....

....

....

(d) The data from the experiment are shown on the graph.



(i) Determine the maximum temperature change, ΔT, for this reaction, using the graph.
You **must** show your working on the graph.

(2)

....

(ii) Explain why the temperature decreases over time after 5 minutes.

(2)

....

....

....

....

(iii) Give a possible reason why the temperature does not appear to change at various times, such as 5½ to 6½ minutes.

(1)

....

....

(iv) State why the data will not result in the **standard** molar enthalpy change of neutralisation being calculated.

(1)

....

....

(e) When calculating the enthalpy change of neutralisation, the two expressions shown are used.

energy transferred = mass × specific heat capacity × temperature change

enthalpy change = energy transferred ÷ moles

(i) Explain why it may or may not be valid to assume that the specific heat capacity of water is suitable to be used for this reaction.

(2)

....

....

....

....

(ii) State why the number of moles of sodium hydroxide and **not** the number of moles of sulfuric acid is used in the calculation for this experiment.

(1)

....

....

(Total for Question 4 = 13 marks)

TOTAL FOR PAPER = 50 MARKS

BLANK PAGE

BLANK PAGE

The Periodic Table of Elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0 (8)
							1.0 **H** hydrogen 1										*(18)* 4.0 **He** helium 2
(1)	*(2)*											*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	
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	*(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	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