Please check the examination details below	w before entering your candidate information  Other names
Pearson Edexcel nternational Advanced Level	re Number Candidate Number
<b>Thursday 7 Nov</b>	ember 2019
Morning (Time: 1 hour 15 minutes)	Paper Reference WCH06/01
Chemistry Advanced Unit 6: Chemistry Laborato	ry Skills II
Candidates must have: Scientific cald	<b>culator</b> Total Marks

# Instructions

- Use **black** ink or **black** 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.
- Check your answers if you have time at the end.

Turn over ▶







Answer ALL the questions. Write your answers in the spaces provided.	
A pale green crystalline solid <b>A</b> contains two cations and one anion.	
(a) When <b>A</b> is warmed with aqueous sodium hydroxide, a gas is evolved that turns damp red litmus paper blue.	
(i) Identify, by name or formula, the gas evolved.	(1)
(ii) Give the name or formula of the cation in $f A$ that is identified by this test.	(1)
(b) <b>A</b> dissolves in distilled water to form a very pale green solution <b>B</b> .	
${\bf B}$ reacts with aqueous sodium hydroxide to form a green precipitate, which turns into a brown solid ${\bf C}$ , on standing in air.	
(i) Give the name or formula of the cation in <b>B</b> that is identified by this test.	(1)
(ii) Identify, by name or formula, the brown solid <b>C</b> .	(1)
(c) <b>B</b> gives a white precipitate when aqueous barium chloride acidified with dilute hydrochloric acid is added.	
Give the name or formula of the anion in <b>B</b> that is identified by this test.	(1)
(d) Suggest the <b>formula</b> of solid <b>A</b> . Do not include any water of crystallisation.	(1)
	A pale green crystalline solid <b>A</b> contains two cations and one anion.  (a) When <b>A</b> is warmed with aqueous sodium hydroxide, a gas is evolved that turns damp red litmus paper blue.  (i) Identify, by name or formula, the gas evolved.  (ii) Give the name or formula of the cation in <b>A</b> that is identified by this test.  (b) <b>A</b> dissolves in distilled water to form a very pale green solution <b>B</b> . <b>B</b> reacts with aqueous sodium hydroxide to form a green precipitate, which turns into a brown solid <b>C</b> , on standing in air.  (i) Give the name or formula of the cation in <b>B</b> that is identified by this test.  (ii) Identify, by name or formula, the brown solid <b>C</b> .  (c) <b>B</b> gives a white precipitate when aqueous barium chloride acidified with dilute hydrochloric acid is added.  Give the name or formula of the anion in <b>B</b> that is identified by this test.

(e) A sample of 0.025 mol of solid **A** with a mass of 9.80 g is heated gently to remove the water of crystallisation and leave 0.025 mol of the anhydrous solid.

The mass of anhydrous solid is 7.10 g.

Calculate the number of moles of water of crystallisation combined with 1 mol of the anhydrous solid.

(2)

(Total for Question 1 = 8 marks)



- **2 W** is a white solid with the molecular formula  $C_9H_8O_2$ .
  - (a) A series of tests is carried out on **W**. Complete the table.

Test	Observation	Inference
(i) Ignite a sample of <b>W</b>	Very smoky flame	<b>W</b> could be an alkene
		or
		compound
(ii) Add a little <b>W</b> to bromine water and shake the mixture	Yellow solution turns into a colourless solution	<b>W</b> contains the
		group
(iii) Heat <b>W</b> until it melts then add phosphorus(V) chloride	Steamy fumes form	<b>W</b> contains the
		group
(iv) Heat <b>W</b> until it melts then add solid	Bubbles of carbon dioxide form	<b>W</b> contains the
		group

(b) Complete the table, which contains information about the mass spectrum of **W**.

Peak	Inference	
(i) A peak occurs at $m/e =$	The peak is due to C <sub>6</sub> H <sub>5</sub>	(1)
(ii) A peak occurs at $m/e = 103$	The peak is due to an ion with the formula	(1)

(c) The <b>low</b> resolution proton nmr spectrum of <b>W</b> has four peaks each with relative area 1 and two peaks each with relative area 2.	
(i) State the number of proton environments in <b>W</b> .	
(i) State the number of proton environments in w.	(1)
(ii) State what can be deduced from the relative peak areas.	(1)
(d) W exists as two geometric isomore	
<ul><li>(d) W exists as two geometric isomers.</li><li>Use all the information in this question to deduce the structure of one of the</li></ul>	
	(2)
	: 11 marks)

- **3** A student used two methods to determine the concentration of vanadium(III) ions in an aqueous solution **X**.
  - (a) Method 1 used a titration procedure.

10.0 cm<sup>3</sup> of **X** was titrated with 0.0400 mol dm<sup>-3</sup> acidified potassium manganate(VII).

The equation for the reaction is

$$5V^{3+}(aq) + 2MnO_4^{-}(aq) + 2H_2O(I) \rightarrow 5VO_2^{+}(aq) + 2Mn^{2+}(aq) + 4H^{+}(aq)$$

The results of four titrations are shown.

Titration	Rough	1	2	3
Final burette reading/cm³	21.10	41.30	19.85	20.10
Initial burette reading/cm³	0.50	21.10	0.25	0.00
Titre/cm <sup>3</sup>				20.10
Titres used to calculate mean				

(i) Complete the table and calculate the mean titre. Show which titres you have used in your calculation by putting a tick ( $\checkmark$ ) in the appropriate boxes in the table.

(2)

Mean titre = ..... cm<sup>3</sup>



(ii) Calculate the concentration, in mol dm<sup>-3</sup>, of V<sup>3+</sup>(aq) ions in solution **X**. Give your answer to **three** significant figures.

(3)

(iii) Each burette reading was accurate to  $\pm 0.05 \, \text{cm}^3$ .

Calculate the percentage uncertainty in the titre value for Titration 3.

(1)



(b) Method 2 used an electrochemical cell.

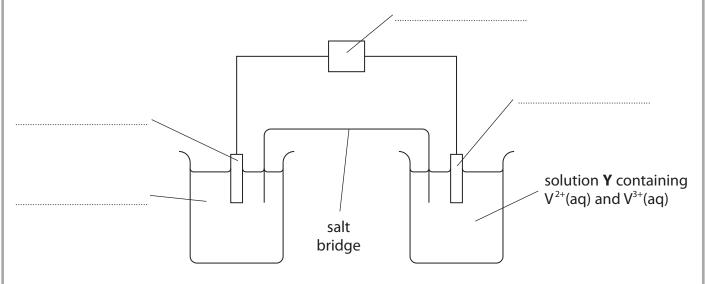
An electrochemical cell was made from the electrode systems represented by these half-equations:

$$Zn^{2+}(aq) + 2e^{-} \rightleftharpoons Zn(s)$$

$$V^{3+}(aq) + e^- \rightleftharpoons V^{2+}(aq)$$

The  $E_{cell}$  value was measured using the apparatus shown.

Solution **Y** was made by mixing 50 cm<sup>3</sup> of an aqueous solution of V<sup>2+</sup> ions with 50 cm<sup>3</sup> of the same solution **X** as used in **Method 1**.



(i) Complete the diagram by adding labels on the dotted lines provided. Conditions are not required.

(4)

(ii) The salt bridge consisted of a strip of filter paper soaked in a saturated solution of potassium nitrate.

Give a reason why potassium hydroxide solution should **not** be used for the salt bridge.

(1)



(iii) In this cell, the zinc half-cell was at standard temperature and concentration. When the cell reaction occurred, the zinc was oxidised and  $E_{cell} = +0.44$  V.

Write the overall equation for the cell reaction. State symbols are not required.

(1)

(iv) The standard electrode potential,  $E^{\ominus}$ , for the  $Zn^{2+}(aq)|Zn(s)$  half-cell = -0.76V.

The  $V^{3+}(aq) | V^{2+}(aq)$  half-cell was **not** at standard concentration in this experiment.

Calculate the electrode potential, E, for the  $V^{3+}(aq)|V^{2+}(aq)$  half-cell in this experiment.

(1)

(v) The **standard** electrode potential,  $E^{\ominus}$ , for the  $V^{3+}(aq) | V^{2+}(aq)$  half-cell = -0.26V. Solution **Y** was 1 mol dm<sup>-3</sup> with respect to  $V^{2+}(aq)$ .

For the half-cell in this experiment, the electrode potential is given by

$$E = E^{\oplus} + 0.059 \log [V^{3+}(aq)]$$

Use this, and your answer to (b)(iv), to calculate the concentration of  $V^{3+}(aq)$  in solution **Y**. You **must** show your working.

(2)



(Total for Q	uestion 3 = 16 marks)
Explain my these the values were amerena	(1)
Explain why these two values were different.	
obtained in (b)(v).	•
(c) The concentration of $V^{3+}(aq)$ obtained in (a)(ii) was approximate	ly double that

**4** This question is about the preparation of iodobenzene from phenylamine, and its purification. The preparation occurs in two steps.

phenylamine

benzenediazonium chloride

iodobenzene

Some data about phenylamine and iodobenzene are given in the table.

Compound	Molar mass /g mol <sup>-1</sup>	Density /g cm <sup>-3</sup>	Boiling temperature / °C
Phenylamine	93.0	1.02	184
lodobenzene	203.9	1.83	188

(a) In Step **1** of the preparation, phenylamine is converted into benzenediazonium chloride. Give the reagents and condition for Step **1**.

(2)

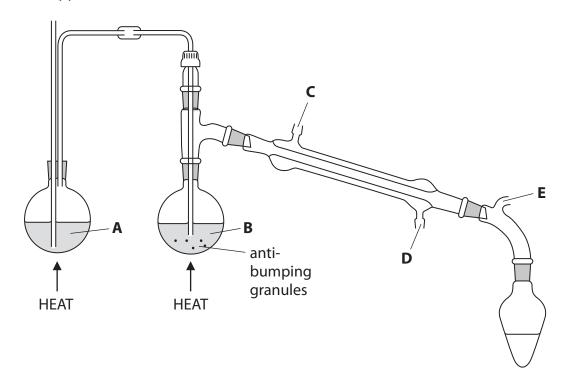
(b) In Step 2 of the preparation, aqueous potassium iodide is added slowly to the reaction mixture from Step 1.

The mixture is left to stand for 10 minutes and then it is heated for 20 minutes. The iodobenzene formed is steam distilled from the mixture.

(i) Suggest a reason why the aqueous potassium iodide is added slowly.

(1)

(ii) The apparatus used for steam distillation is shown.



Complete the labelling of the diagram, A, B, C and D.

$\boldsymbol{\wedge}$	 	 • • • • •														
R																
D	 															

C ......

D ......



(iii) State the purpose of the part of the apparatus labelled <b>E</b> .	(1)
(iv) The distillate collected contains iodobenzene and water.  Describe how iodobenzene is obtained from the distillate.  [Refer to the data given at the start of Question 4]	(2)
(v) The iodobenzene obtained from the distillate is a cloudy liquid.  Name a substance that should be added to make the liquid clear.	(1)
(vi) The clear liquid is distilled to obtain pure iodobenzene.  Give a suitable temperature <b>range</b> for collecting the pure iodobenzene.  [Refer to the data given at the start of Question 4]	
	(1)

(c) This preparation and purification process has an expected yield of 70%.

Calculate the **volume** of phenylamine needed to produce 25.0 cm<sup>3</sup> of iodobenzene.

[Refer to the data given at the start of Question 4]

(4)

(Total for Question 4 = 15 marks)

**TOTAL FOR PAPER = 50 MARKS** 

14

# **BLANK PAGE**



# The Periodic Table of Elements

0 (8)

9

2

									_				_								
(18) 4.0 <b>He</b> helium 2	20.2 <b>Ne</b>	10	39.9	Ar	18	83.8	Ā	krypton	36	131.3	Xe	xenon	1000	[777] <b>D</b> 2	radon	86		ted			
(77)	19.0 <b>F</b>	6	35.5	chlorine	17	79.9	B	bromine	35	126.9	Ι	iodine	2 2	[2]	AL	85		een repor			17,
(16)	16.0	8 8	32.1	Sulfur	16	79.0	Se	selenium	34	127.6	<u>P</u>	tellurium	2002	[707]	<b>S</b> polonium	84		116 have b	ticated		,
(15)	14.0 N	7 7	31.0	<b>P</b> ohosphorus	15	74.9	As	arsenic	33	121.8	Sb	antimony	5 6	0.702	bismuth	83		nbers 112-	but not fully authenticated		4
(14)	12.0 <b>C</b>	6	28.1	Silicon		72.6	Ge	germanium	32	118.7	Sn	ti C	20.7	7. /07	ead pe	82		atomic nun	but not fu		,,,
(13)	10.8 <b>B</b>	5	27.0	Al	13	69.7	Ga	Ε	31	114.8	п	indium	1,7	†.†. <b>F</b>	<b>II</b>	81		Elements with atomic numbers 112-116 have been reported			1,,,
					(12)	65.4	Zu	zinc	30	112.4	В	cadmium	9 20	200.0	mercury	80		Elem			***
					(11)	63.5	J	copper	56	107.9	Ag	silver	1 1	). · · · · · · · · · · · · · · · · · · ·	<b>P</b> log	79	[272]	Rg	oentgenium 111		7.1
					(10)	58.7	ï	nickel	28	106.4	Pd	palladium	40,	2	P.L.	78	[271]	Ds	farmstadtium r		127
(6)							ပိ	cobalt	27	102.9	뫈	rhodium	5 5	172.2	iridium	77	[368]	Mt	meitnerium damstadtium 109 110		7.2
1.0 <b>H</b> hydrogen 1						55.8	Fe	iron	76	101.1	Ru	ruthenium	1 6	7.00	Sminm C	76	[277]		hassium 1		7.10
						54.9	Wn	nanganese	25	[86]	ပ	molybdenum technetium ruthenium	407.0	7.001	rhenium	75	[564]	Bh	bohrium 107		[7, 17]
Key	nass <b>ool</b>	umber			(9)	52.0	ე	vanadium chromium manganese	24	95.9	Wo	molybdenum	102 0	0.50	tungsten	74	[392]	Sg	seaborgium 106		,,,,
	relative atomic mass atomic symbol	atomic (proton) number			(2)	50.9	>	vanadium	23	92.9	<del>Q</del>	niobium r	1 00		tantalum	73	[797]	В	dubnium 105		,,,
	relativ <b>ator</b>	atomic			(4)	47.9	ï	Ē	22	91.2	Zr	zirconium	170 5	1,0,7	hafnium	72	[261]		rutherfordium 104		4,1
					(3)	45.0	Sc	scandium	21	88.9	>	yttrium	120.0	130.7	Lar	57	[227]		actinium 89	ľ	
(2)	9.0 <b>Be</b>	4	24.3	Mg	12	40.1	Ca	_	70	97.6	Sr	strontium	127.2	٠,٧٥	<b>Da</b>		[526]		radium 88		
(1)	6.9 <b>Li</b>		23.0	Na		39.1	¥	potassium	19	85.5	&	rubidium 27	122.0	22.3	caesium	55	[223]	ቷ	francium 87		
																				•	

\* Lanthanide series

\* Actinide series

**Lu** lutetium lawrencium [257] 173 **Yb** ytterbium nobelium [254] **No Tm** thulium mendelevium 169 [256] ÞΨ 101 167 **Er** erbium fermium [253] Fm 89 165 Ho holmium 67 einsteinium [254] 66 163 **Dy** dysprosium californium [251] ರ 86 99 [245] **BK**berkelium 159 **Tb** terbium 65 46 157 **Gd** gadolinium anium [247] Ë 96 64 **Eu** europium Pu Am plutonium americium 152 [243] 63 Samarium 150 [242] 94 62 Np neptunium promethium [147] Pm [237] 61 93 Nd neodymium uranium 144 238 9 92 aseodymium otactinium **P** 4 [231] Ъ 29 6 **H Ce** cerium 232 28 8