GradeMax

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Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Thursday 7 November 2019

Morning (Time: 1 hour 15 minutes) | Paper Reference **WCH06/01**

Chemistry

Advanced

Unit 6: Chemistry Laboratory Skills II

Candidates must have: Scientific calculator

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 ▶

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P 5 8 3 0 1 A 0 1 1 6

Pearson

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

1 A pale green crystalline solid **A** contains two cations and one anion.

(a) When **A** 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 **A** that is identified by this test.

(1)

.....

(b) **A** dissolves in distilled water to form a very pale green solution **B**.

B reacts with aqueous sodium hydroxide to form a green precipitate, which turns into a brown solid **C**, on standing in air.

(i) Give the name or formula of the cation in **B** that is identified by this test.

(1)

.....

(ii) Identify, by name or formula, the brown solid **C**.

(1)

.....

(c) **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** that is identified by this test.

(1)

.....

(d) Suggest the **formula** of solid **A**. Do not include any water of crystallisation.

(1)

.....

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(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 **W**	Very smoky flame	**W** could be an alkene or ..... compound	(1)
(ii) Add a little **W** to bromine water and shake the mixture	Yellow solution turns into a colourless solution	**W** contains the ..... group	(1)
(iii) Heat **W** until it melts then add phosphorus(V) chloride	Steamy fumes form	**W** contains the ..... group	(1)
(iv) Heat **W** until it melts then add solid	Bubbles of carbon dioxide form	**W** contains the ..... group	(2)

(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 $C_6H_5^+$	(1)
(ii) A peak occurs at m/e = 103	The peak is due to an ion with the formula	(1)

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(c) The **low** resolution proton nmr spectrum of **W** has four peaks each with relative area 1 and two peaks each with relative area 2.

(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 isomers.

Use all the information in this question to deduce the structure of **one** of these isomers.

(2)

(Total for Question 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^3 of **X** was titrated with 0.0400 mol dm^{-3} acidified potassium manganate(VII).

The equation for the reaction is

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

The results of four titrations are shown.

Titration	Rough	1	2	3
Final burette reading / cm^3	21.10	41.30	19.85	20.10
Initial burette reading / cm^3	0.50	21.10	0.25	0.00
Titre / cm^3				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 (✓) in the appropriate boxes in the table.

(2)

Mean titre = ... cm^3

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(ii) Calculate the concentration, in mol dm^{-3}, of $V^{3+}(aq)$ ions in solution **X**.
Give your answer to **three** significant figures.

(3)

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

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

(1)

(b) **Method 2** used an electrochemical cell.

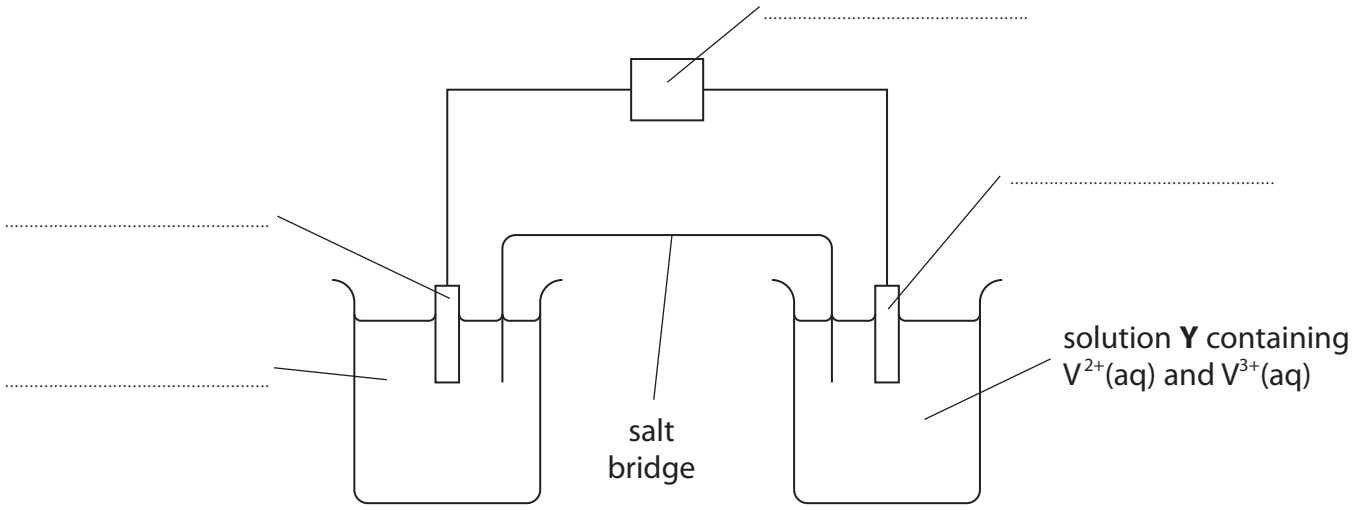
An electrochemical cell was made from the electrode systems represented by these half-equations:

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

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

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

Solution **Y** was made by mixing 50 cm^3 of an aqueous solution of V^{2+} ions with 50 cm^3 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)

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(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 = $-0.76\,V$.

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 = $-0.26\,V$.

Solution **Y** was 1 mol dm^{-3} with respect to $V^{2+}(aq)$.

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

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

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)

(c) The concentration of $V^{3+}(aq)$ obtained in (a)(ii) was approximately double that obtained in (b)(v).

Explain why these two values were different.

(1)

.....

.....

.....

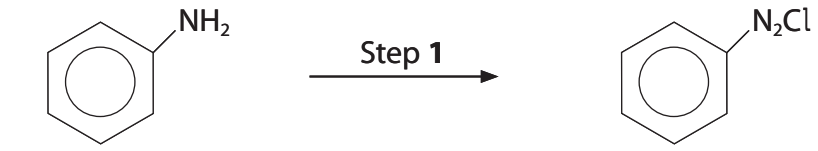
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(Total for Question 3 = 16 marks)

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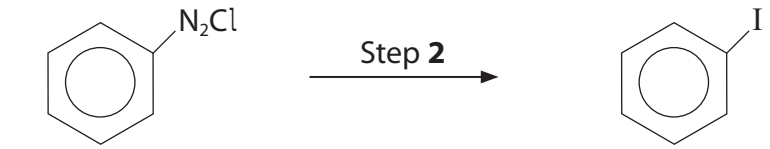
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4 This question is about the preparation of iodobenzene from phenylamine, and its purification.
The preparation occurs in two steps.



phenylamine

benzenediazonium chloride



iodobenzene

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

Compound	Molar mass / g mol^{-1}	Density / g cm^{-3}	Boiling temperature / °C
Phenylamine	93.0	1.02	184
Iodobenzene	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.

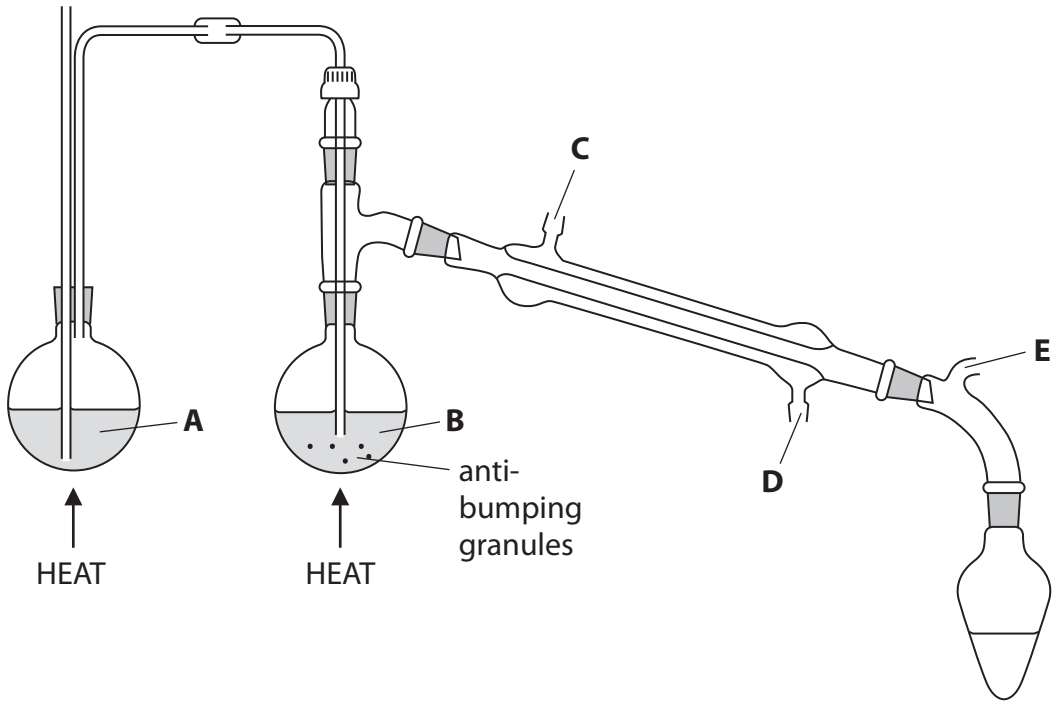
(i) Suggest a reason why the aqueous potassium iodide is added slowly.

(1)

.....

.....

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



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

(3)

A .....

B .....

C .....

D .....

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(iii) State the purpose of the part of the apparatus labelled **E**.

(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 **range** 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^3 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

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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	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

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