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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.

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**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)**

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

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

| Peak | Inference | |
|---|---|---|
| (i) A peak occurs at $m/e$ =<br>..... | 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<br>..... | (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)**

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**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)**

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

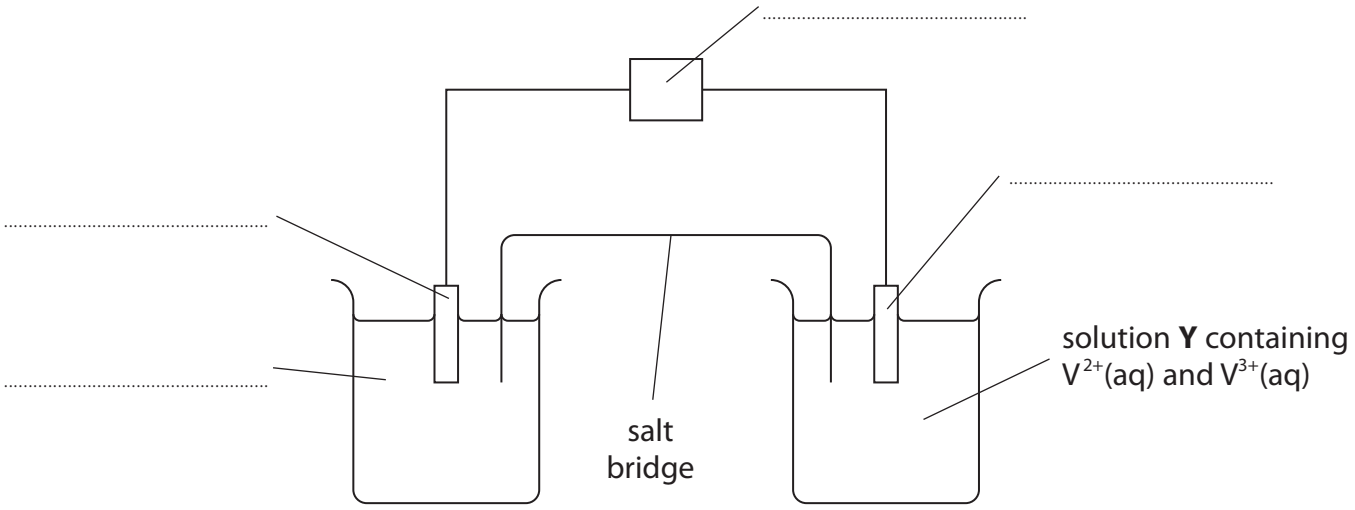
An electrochemical cell was made from the electrode systems represented by these half-equations:

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

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

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)**

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(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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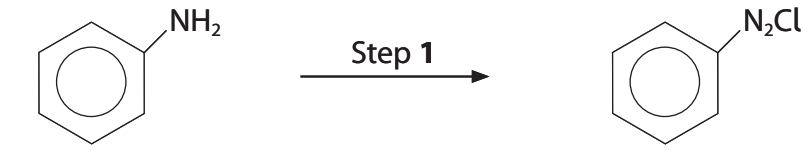
**(Total for Question 3 = 16 marks)**

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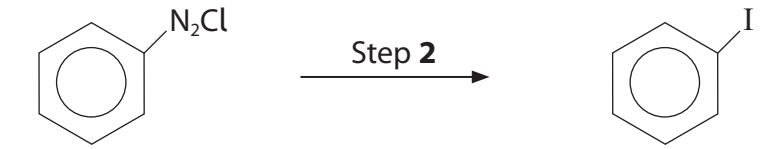
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**4** This question is about the preparation of iodobenzene from phenylamine, and its purification.
The preparation occurs in two steps.




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)**

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(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.

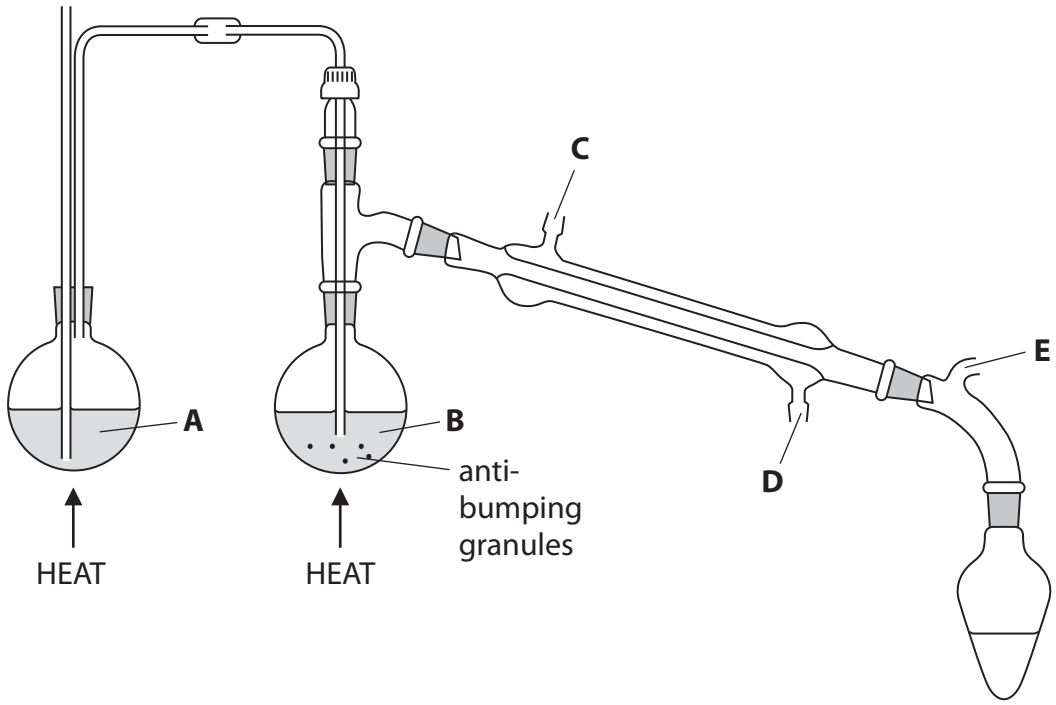
(i) Suggest a reason why the aqueous potassium iodide is added slowly.

**(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)**

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(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)**

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(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)**

.....

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(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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1.0 H hydrogen 1 | | | | | | | | | | (18) 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<br>atomic symbol<br>name<br>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

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 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 |

* Lanthanide series

* Actinide series

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