



*Rewarding Learning*

General Certificate of Secondary Education  
2023–2024

Centre Number

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Candidate Number

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# Single Award Science: Chemistry

Unit 2

Higher Tier

<b>MV24</b>
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[GSA22]

THURSDAY 22 FEBRUARY 2024, MORNING

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## Time

1 hour, plus your additional time allowance.

## Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

**You must answer the questions in the spaces provided.**

**Do not write on blank pages.**

Complete in black ink only.

Answer all **seven** questions.

## Information for Candidates

The total mark for this paper is 60.

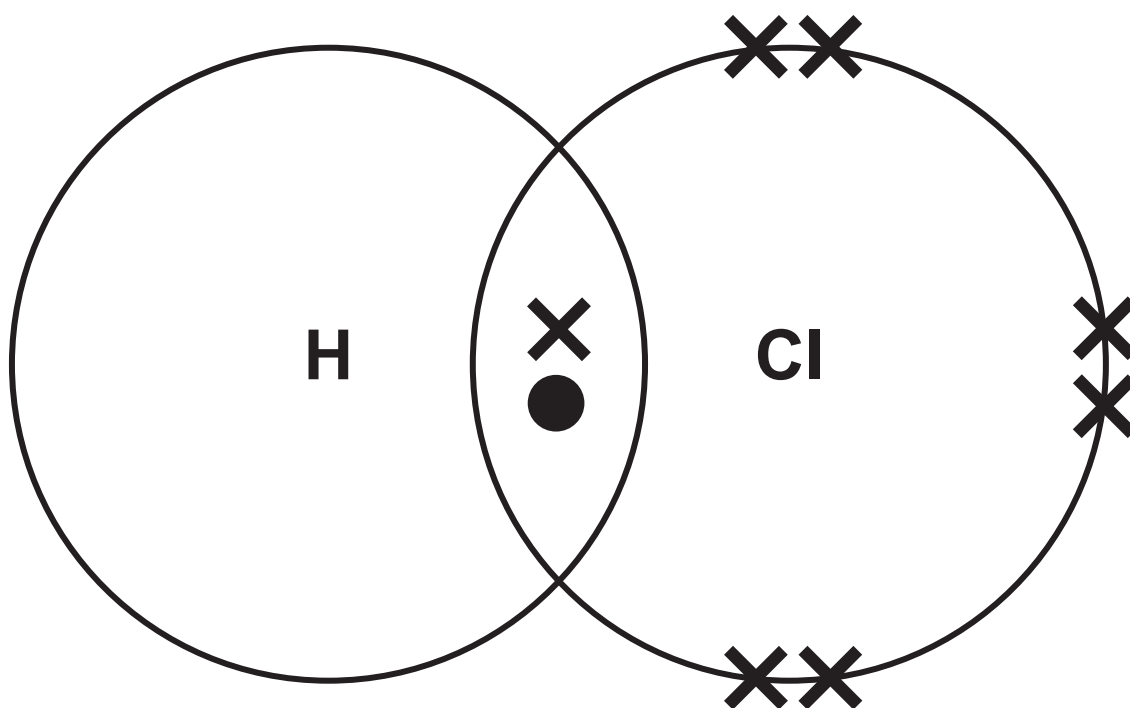
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question 3.

A Data Leaflet, which includes a Periodic Table of the Elements, is included for your use.

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**(Questions start overleaf)**

- 1 (a) Hydrogen reacts with chlorine to produce hydrogen chloride.  
The diagram below shows how hydrogen and chlorine bond by **sharing** one pair of electrons.



- (i) Name the **type** of chemical bonding that occurs between hydrogen and chlorine. [1 mark]
-

(ii) What is the formula for hydrogen chloride? [1 mark]

Circle your answer.

**H<sub>2</sub>Cl**

**HCl**

**HCl<sub>2</sub>**

(b) Ammonium chloride (NH<sub>4</sub>Cl) is another compound containing chlorine.

(i) How many **elements** are in ammonium chloride (NH<sub>4</sub>Cl)? [1 mark]

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(ii) How many **atoms** are represented by the formula NH<sub>4</sub>Cl? [1 mark]


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2 (a) Three metals (zinc, copper and lithium) were separately added to cold water and dilute acid. If a reaction occurred a ✓ was recorded and if no reaction occurred an ✗ was recorded.

The results are shown below.

	<b>zinc</b>	<b>copper</b>	<b>lithium</b>
cold water	✗	✗	✓
dilute acid	✓	✗	✓

- (i) Use this information to complete the reactivity series below by placing the metals zinc, copper and lithium in their correct positions. [1 mark]

sodium	<b>most reactive</b>  <b>least reactive</b>
magnesium	
aluminium	
iron	

A flame test can be used to identify metal ions.

- (ii) Name the metal ion that produces a yellow-orange flame. [1 mark]
-

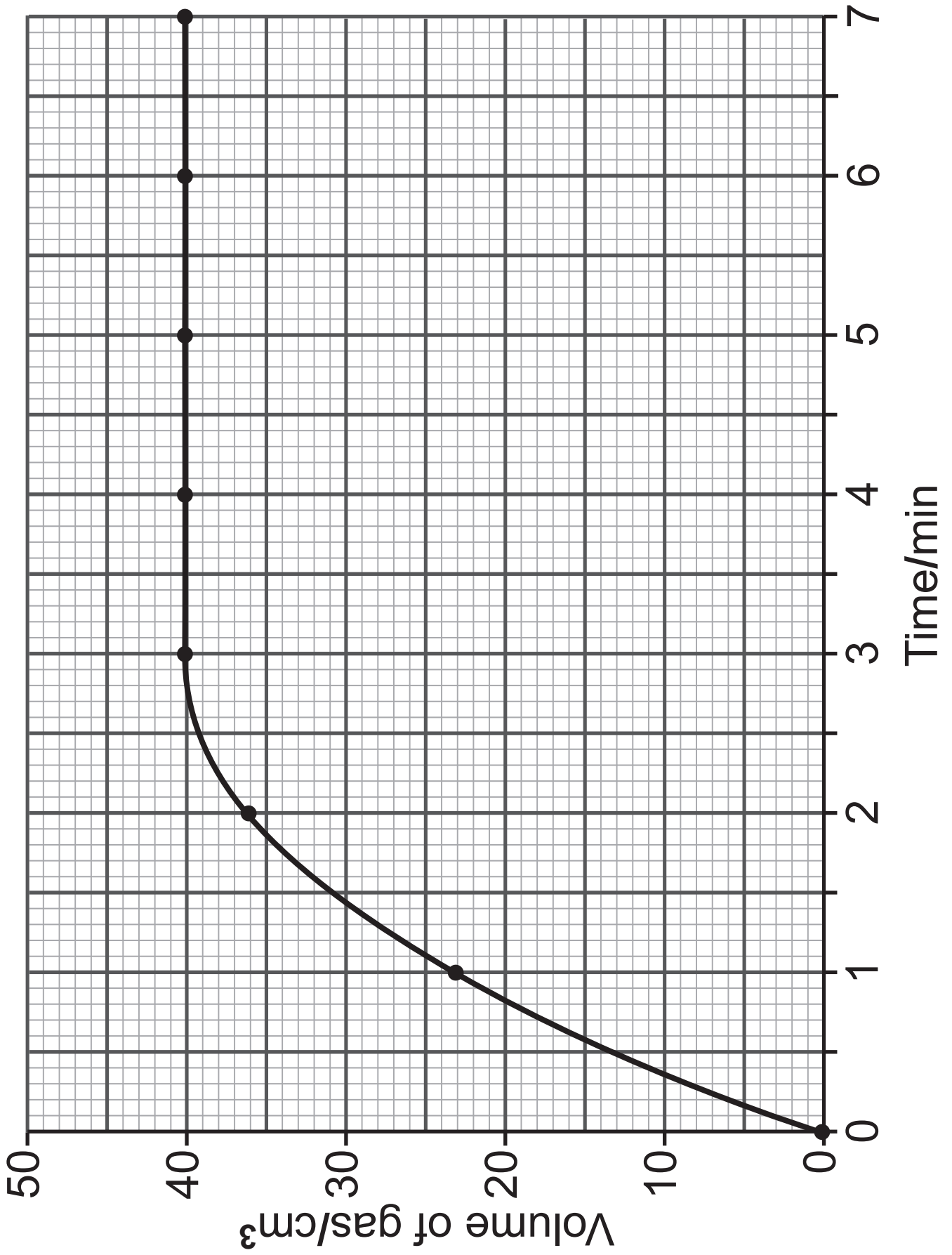
**(b)** Magnesium and an unknown metal **X**, were each reacted with excess dilute hydrochloric acid. The volume of hydrogen gas given off during each reaction was measured.

The results are shown below.

	Time/min	0	1	2	3	4	5	6	7
Volume of gas /cm <sup>3</sup>	Metal <b>X</b>	0	23	36	40	40	40	40	40
	Magnesium	0	14	25	33	37	40	40	40

- (i)** The results for metal **X** are plotted on the grid opposite.  
On the same grid, plot and draw the line graph for magnesium.  
[3 marks]





**(ii)** Describe fully the trend for metal **X**.  
[2 marks]

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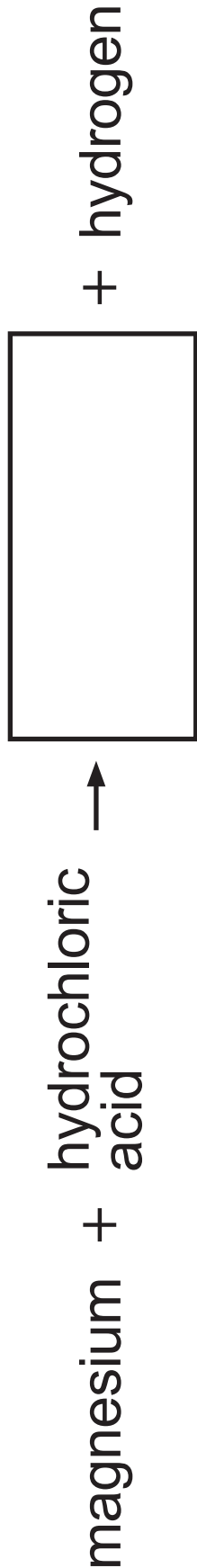
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**(iii)** A student concludes that metal **X** is more reactive than magnesium. How do the results show the student is correct? [1 mark]

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(iv) Complete the word equation below for the reaction of magnesium with hydrochloric acid. [1 mark]



**(v)** The student tested the gas produced with a lit splint. What would he observe? [1 mark]

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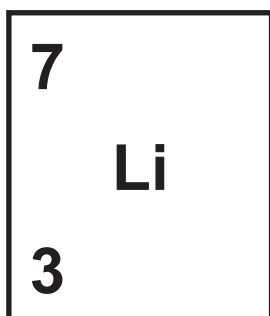
**(vi)** When magnesium is added to hydrochloric acid there is an increase in temperature. What name is given to a reaction that gives out heat? [1 mark]

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**(Questions continue overleaf)**

**3** The element lithium is represented on the Periodic Table as shown below.



With reference to the structure of a lithium atom, describe how a lithium ion is formed.

Your answer should include:

- the name, number and location of the three sub-atomic particles found in a lithium atom; and
- how a lithium ion forms from a lithium atom. [6 marks]



- 4 A wide variety of evidence can be collected from a crime scene including biological and digital evidence.



- (a) Give **one** example of digital evidence that could be collected from a crime scene. [1 mark]
- 

- (b) The role of nanomaterials in forensic science is rapidly developing. Nanomaterials have different properties compared to the same larger scale material. Gold is an example of this, it has a melting point of  $1064\text{ }^{\circ}\text{C}$  but nanoparticles of gold have a melting point of  $300\text{ }^{\circ}\text{C}$  and are dark red in colour.



Scientists are researching the use of gold nanoparticles to enhance images of residues left behind at crime scenes and when testing for the presence of drugs. This will help with the analysis of toxins from evidence such as hair, saliva and blood.

It is hoped that the use of nanomaterials will lead to faster detection of trace evidence and help provide conclusive evidence in a court of law.

Use this information and your knowledge to answer the following questions.

(i) What is meant by the term **trace evidence**? [1 mark]

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(ii) Give **one** piece of trace evidence named in the information above. [1 mark]

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(iii) Complete the following sentences.  
[1 mark]

Nanomaterials contain nanoparticles.  
Nanoparticles range in size from one  
to \_\_\_\_\_ nm.

(iv) Give **one** advantage of using  
nanomaterials in forensic science.  
[1 mark]

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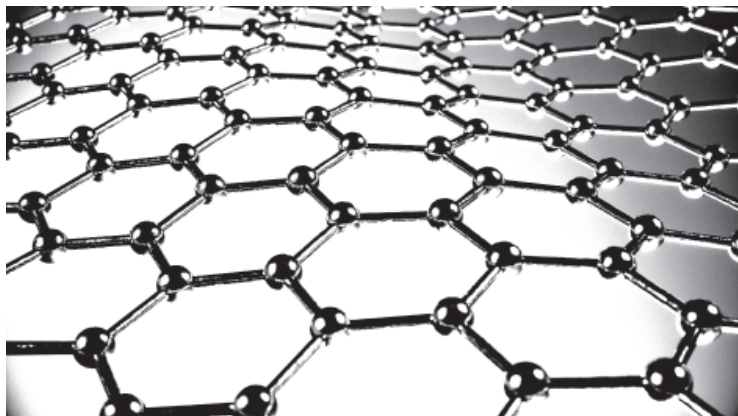
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(v) Give **one** difference in the  
properties of gold when it is used in  
nanomaterials and when it is used in  
larger scale materials. [1 mark]

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(c) Graphene is another useful nanomaterial known for its high strength and electrical conductivity.



(i) Describe the structure of graphene.  
[2 marks]

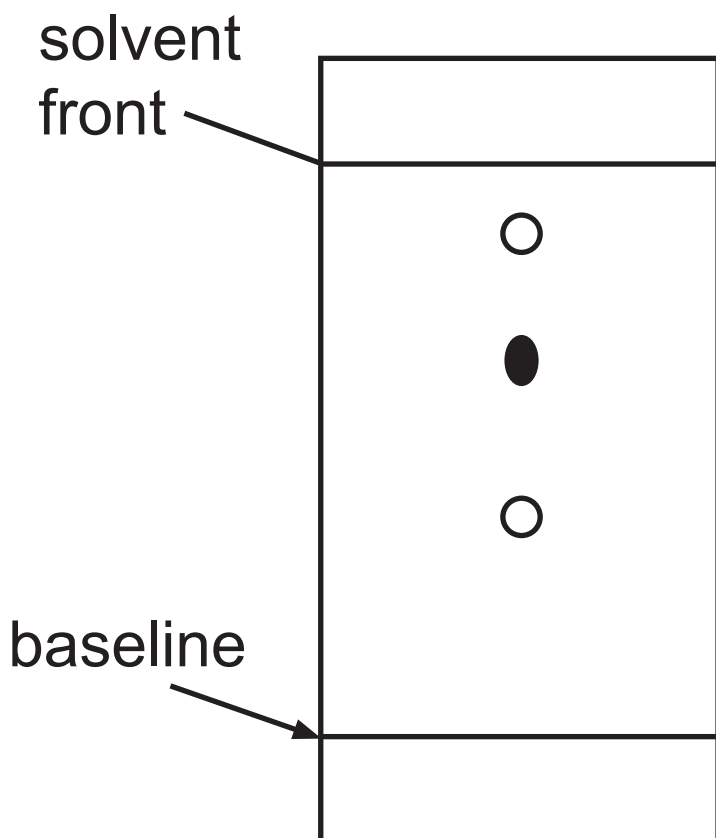
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(ii) Give **one** use of graphene.  
[1 mark]

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- 5 A student used chromatography to separate the dyes in black ink. The results are shown below.



- (a) Describe how the student set up the experiment to get these results.  
[3 marks]

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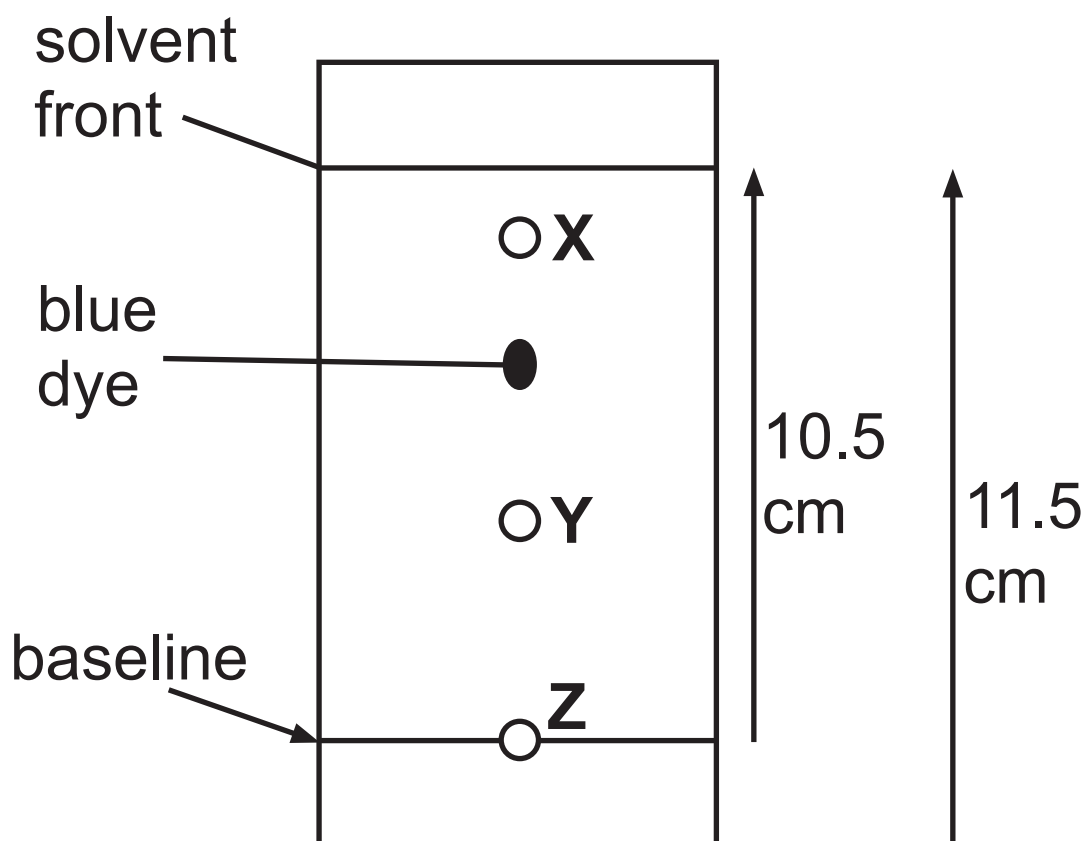
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**(b)** In chromatography the solvent is called the mobile phase. What term is used to describe the chromatography paper?  
[1 mark]

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(c) Black ink contains a mixture of dyes including red and blue. The diagram below shows the position of the blue dye in the chromatogram.



(i) The red dye is **less** soluble than the blue dye. At which position, **X**, **Y** or **Z** would you expect to see the red dye?  
[1 mark]

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(ii) The blue dye travelled a distance of 7.9 cm.

Use the formula:

$$R_f = \frac{\text{distance travelled by dye}}{\text{distance travelled by solvent}}$$

to calculate the  $R_f$  value for the blue dye.

Give your answer to **one** decimal place. [3 marks]

(Show your working out.)

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- 6 (a) Given below are the melting points and boiling points of some alkanes.

Alkane	Molecular formula	Melting point/°C	Boiling point/°C
methane	CH <sub>4</sub>	-182	-161
ethane	C <sub>2</sub> H <sub>6</sub>	-183	-88
propane	C <sub>3</sub> H <sub>8</sub>	-188	-42
butane	C <sub>4</sub> H <sub>10</sub>	-138	-1

Use this information and your knowledge to answer the following questions.

- (i) In what state are these alkanes at room temperature (20 °C)?  
[1 mark]
- 

- (ii) Which of these alkanes has the lowest melting point? [1 mark]
-



(iii) Complete the following sentence.  
[1 mark]

As the number of carbon atoms  
increases, the boiling point  
\_\_\_\_\_.

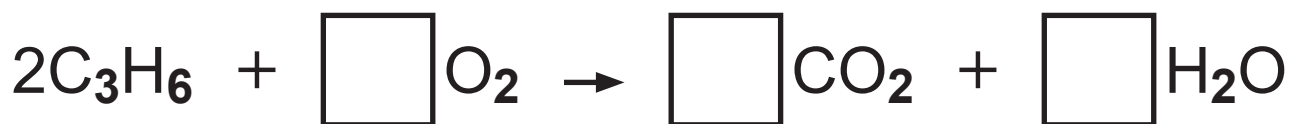
(iv) Pentane is an alkane with five carbon  
atoms. Predict the **boiling point** of  
pentane. [1 mark]

\_\_\_\_\_ °C

**(b)** Complete the table below about alkenes.  
[3 marks]

Alkene	Molecular formula	Structural formula
ethene		$  \begin{array}{c}  \text{H} \quad \text{H} \\    \quad   \\  \text{C} = \text{C} \\    \quad   \\  \text{H} \quad \text{H}  \end{array}  $
propene	$\text{C}_3\text{H}_6$	
	$\text{C}_4\text{H}_8$	$  \begin{array}{cccc}  \text{H} & \text{H} & \text{H} & \text{H} \\    &   &   &   \\  \text{C} = \text{C} & - & \text{C} & - & \text{C} & - & \text{H} \\    & &   & &   \\  \text{H} & & \text{H} & & \text{H}  \end{array}  $

(c) Shown below is the symbol equation for the complete combustion of propene. Complete the balancing of this equation. [2 marks]



(d) Polypropene can be made from propene molecules.

(i) Name the **type** of reaction that produces polypropene. [1 mark]

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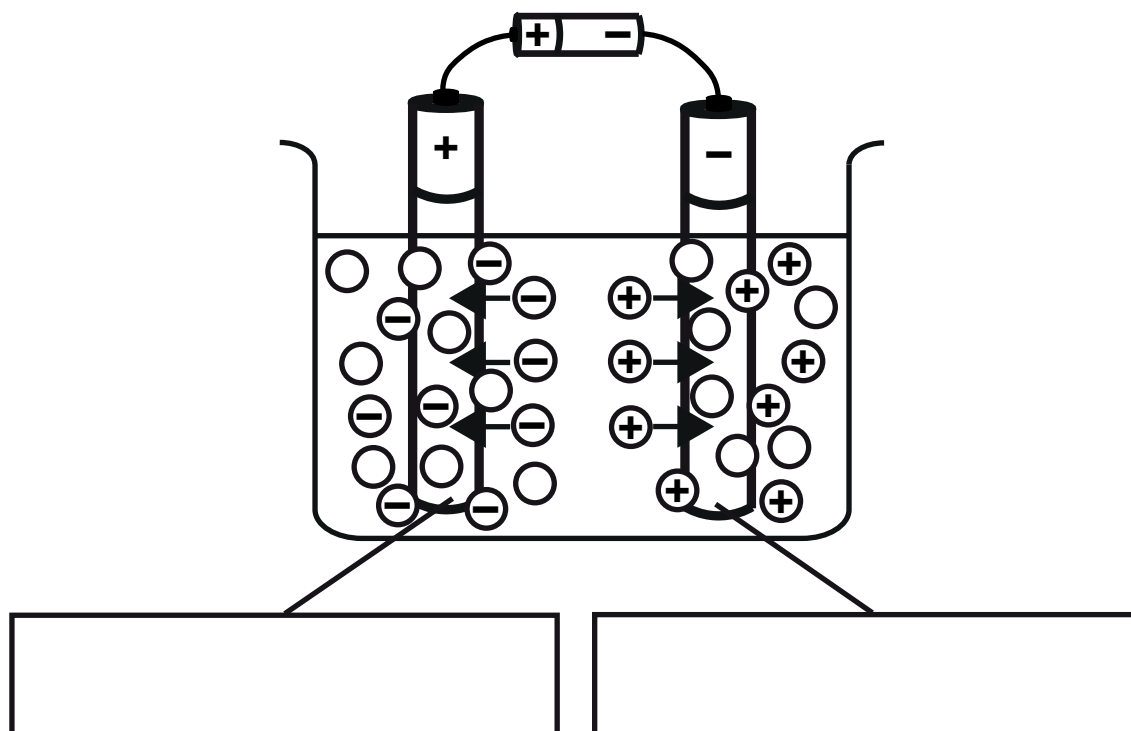
(ii) Describe, with reference to bonds, what happens during this process. [2 marks]

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- 7 (a) The apparatus shown below can be used to carry out simple electrolysis.



- (i) In the boxes, on the diagram above, add the names of the **two** electrodes.  
[1 mark]

- (ii) Give **two** properties of graphite that make it suitable for use as electrodes.  
[2 marks]

1. \_\_\_\_\_
2. \_\_\_\_\_

**(b)** What name is given to a liquid that conducts electricity? [1 mark]

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**(c)** Aluminium metal is extracted from molten aluminium oxide using electrolysis.

**(i)** Explain fully why the aluminium oxide must be molten. [2 marks]

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**(ii)** Give **one** reason, other than cost, why it is important to recycle materials such as aluminium. [1 mark]

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**(iii)** Write the half equation to show the formation of oxygen ( $O_2$ ) at the positive electrode. [2 marks]



**(iv)** Explain why the positive graphite electrode needs replaced at regular intervals. [1 mark]

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**This is the end of the  
question paper**

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Question Number	Marks
1	
2	
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<b>Total Marks</b>	
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