



*Rewarding Learning*

General Certificate of Secondary Education  
2018–2019

Centre Number

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Candidate Number

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# Single Award Science: Chemistry

Unit 2

Higher Tier



[GSA22]

\*GSA22\*

**THURSDAY 16 MAY 2019, MORNING**

## TIME

1 hour.

## 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 outside the boxed area on each page or on blank pages.**

Complete in black ink only. **Do not write with a gel pen.**

Answer **all seven** questions.

## INFORMATION FOR CANDIDATES

The total mark for this paper is 60.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question 3.

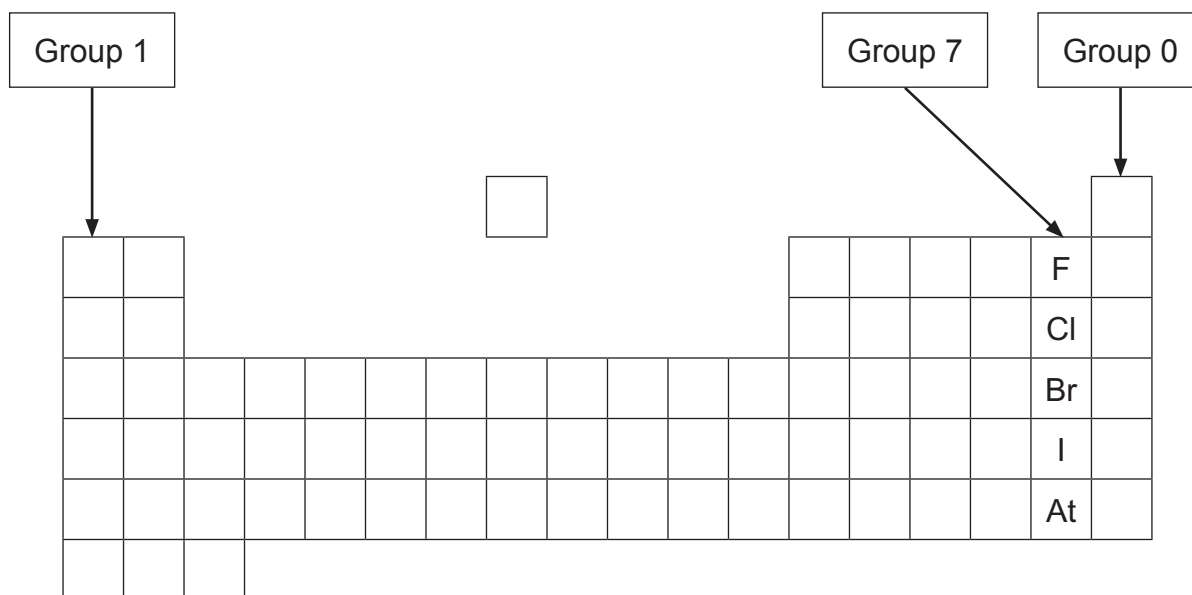
A Data Leaflet, which includes a Periodic Table of the Elements, is included for your use.

12326



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1 The diagram below represents the Periodic Table.



(a) What name is given to the elements in:

(i) Group 1? \_\_\_\_\_ [1]

(ii) Group 0? \_\_\_\_\_ [1]



- (b) Group 7 elements are called the halogens. The table below shows information about the first four halogens.

| Halogen  | Density/<br>g/cm <sup>3</sup> | Melting point/<br>°C | Boiling point/<br>°C |
|----------|-------------------------------|----------------------|----------------------|
| Fluorine | 0.0017                        | −220                 | −188                 |
| Chlorine | 0.0032                        | −102                 | −34                  |
| Bromine  | 3.1028                        | −7                   | 59                   |
| Iodine   | 4.9330                        | 114                  | 184                  |

- (i) State the trend in density shown in the table.

\_\_\_\_\_ [1]

- (ii) Astatine is below Iodine in Group 7 of the Periodic Table. Predict the melting point of astatine.

\_\_\_\_\_ °C [1]

[Turn over



2 (a) Describe how crude oil is formed.

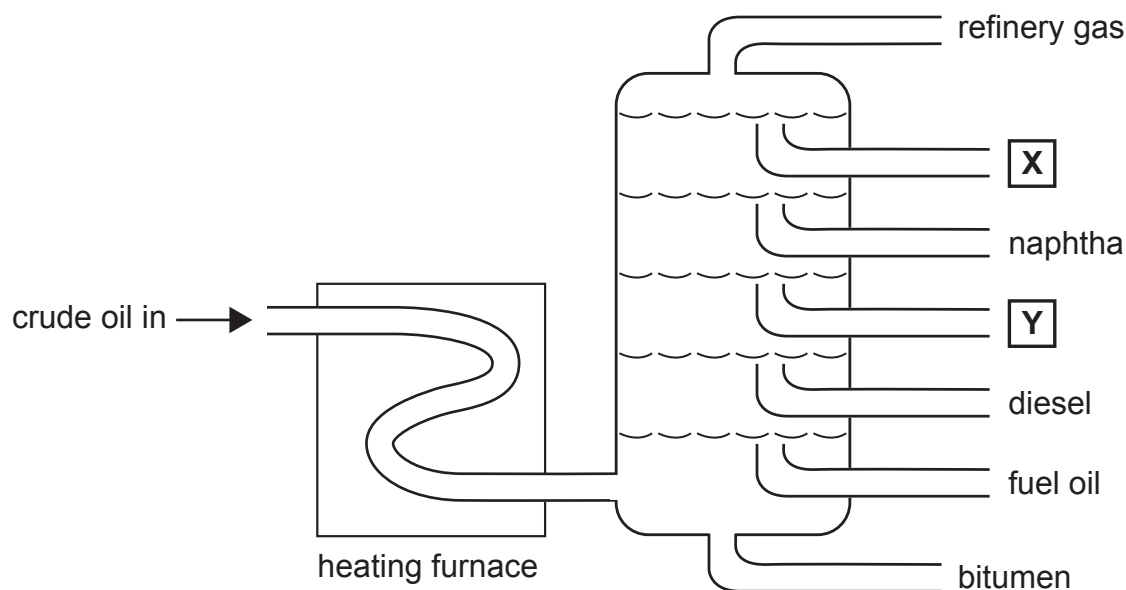
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[3]

(b) The diagram below shows part of the process used to separate crude oil into useful products (fractions).



(i) Name the process that is used to separate crude oil as shown in the diagram above.

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[1]

(ii) Name the fractions X and Y.

X \_\_\_\_\_

Y \_\_\_\_\_

[2]

(iii) Why is the crude oil heated?

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[1]



- (c) The table below gives information about some of the fractions obtained from crude oil.

| Fraction     | Boiling point range/°C | Number of carbon atoms in the alkane chain |
|--------------|------------------------|--------------------------------------------|
| refinery gas | –160 to 20             | 1–4                                        |
| naphtha      | 70 to 120              | 5–10                                       |
| diesel       | 170 to 230             | 14–20                                      |
| fuel oil     | 230 to 350             | 20–50                                      |

Use information in the table to answer the following questions.

- (i) Which fraction has the largest boiling point range?

\_\_\_\_\_ [1]

- (ii) Which fraction would the alkanes methane and ethane belong to?

\_\_\_\_\_ [1]

- (iii) Complete the sentence about the trend shown in the table.

As the number of carbon atoms in the alkane chain \_\_\_\_\_  
\_\_\_\_\_ [1]

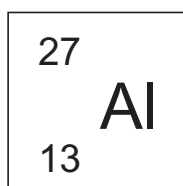
- (iv) An alkane has a boiling point of 175 °C. Which fraction does it belong to?

\_\_\_\_\_ [1]

[Turn over



**3** In the Periodic Table aluminium is shown using the following symbol:



Describe the structure of an aluminium atom.

Your answer should include:

- the numbers of protons, neutrons and electrons in an aluminium atom
- the location of the protons, neutrons and electrons in the atom
- the electronic configuration (structure) of an aluminium atom
- how aluminium's electronic configuration relates to its position (Group and Period) in the Periodic Table.

**In this question you will be assessed on your written communication skills including the use of specialist scientific terms.**

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[6]

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**(Questions continue overleaf)**

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**[Turn over**

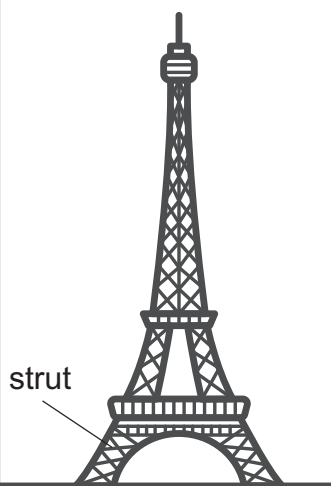


\*20GSA2207\*

4 Below is part of an article from a science magazine.

## A super-strong and lightweight new material.

Nanostructured ceramics could be used to build lighter, stronger airplanes and batteries.



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Traditional ceramics are strong but also heavy, so they can't be used as building materials. When traditional ceramics break, they shatter like glass.

A new type of ceramic material, made up of nano-sized tubes crisscrossed like the struts of a tiny Eiffel Tower, is one of the strongest and lightest substances ever made.

Experiments showed that by changing the thickness of the tube walls, it is possible to control how the material breaks.

When the walls are thick, the ceramic shatters under pressure as expected. But tubes with thinner walls, just 10 nanometres thick, fold when compressed and then recover their shape.

Article: 'Biotechnology – A Super-Strong and Lightweight New Material' by Katherine Bourzac from MIT's Technology Review.  
© Massachusetts Institute of Technology.; MIT Alumni/ae Association.

(a) What size is a nanoparticle?

\_\_\_\_\_ m [1]

(b) Use information from the article to answer the following questions.

(i) Give **two** properties of the new thinner walled ceramic nano-material described above.

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

2. \_\_\_\_\_ [2]

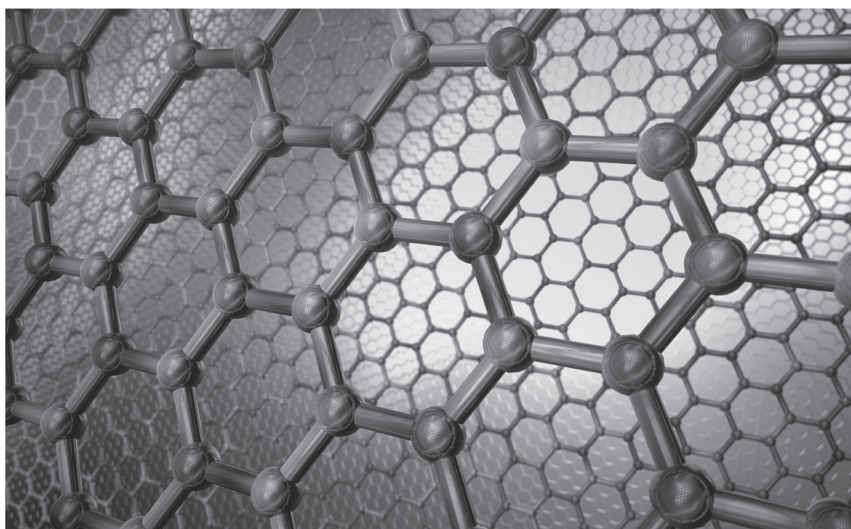
(ii) Which property of the new ceramic nano-material means it can be described as a smart material?

\_\_\_\_\_

\_\_\_\_\_ [1]



(c) Graphene is another new material that is made from carbon.



© Ian Cuming / Ikon Images / Science Photo Library

(i) Describe the structure of graphene.

\_\_\_\_\_  
\_\_\_\_\_ [1]

(ii) Give **one** use of graphene and state the property that makes it suitable for this use.

Use: \_\_\_\_\_

Property: \_\_\_\_\_ [2]

[Turn over



- 5 (a) The apparatus shown below was set up to measure the rate of reaction between 2.5 g of marble chips (calcium carbonate) and 50 cm<sup>3</sup> of hydrochloric acid. The acid was in excess.



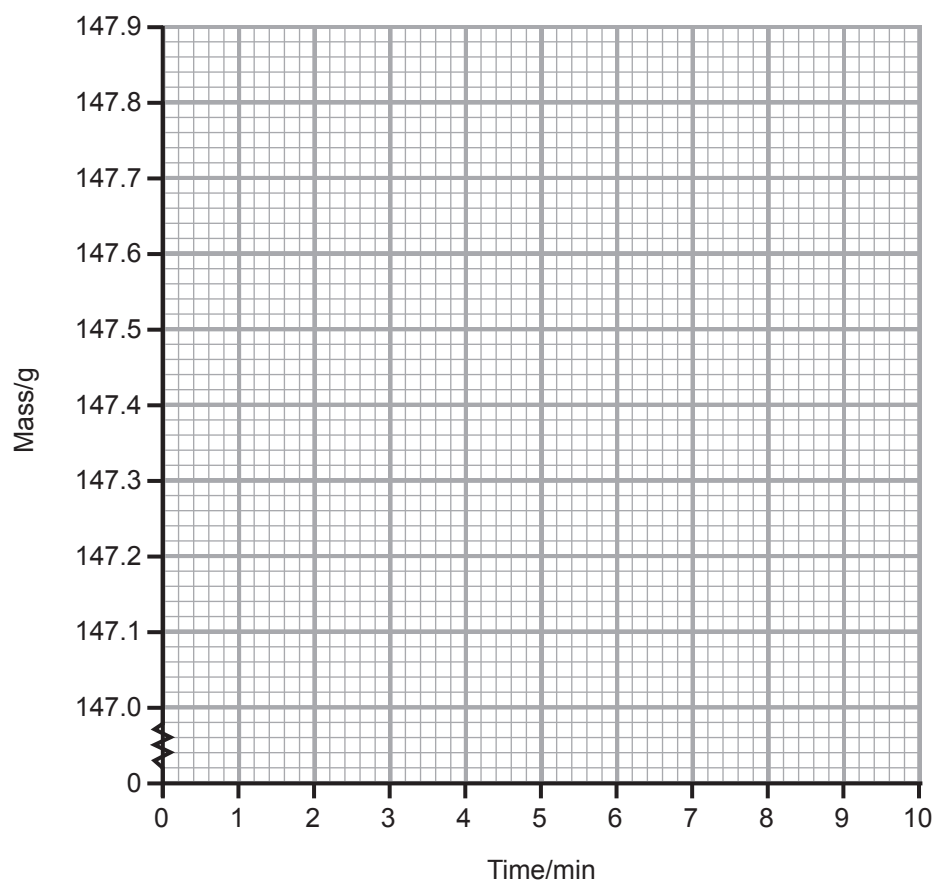
© Riccardo\_Mojana / iStock / Thinkstock

The mass of the flask and its contents were recorded every 2 minutes for ten minutes. The results are shown below.

| Time/min                     | 0      | 2      | 4      | 6      | 8      | 10     |
|------------------------------|--------|--------|--------|--------|--------|--------|
| Mass of flask and contents/g | 147.90 | 147.40 | 147.20 | 147.10 | 147.05 | 147.02 |



(i) Use the grid below to plot and draw a line graph of these results.



(ii) Calculate the total loss of mass during this experiment.

\_\_\_\_\_ g [1]

(iii) During which time period was the rate of this reaction faster: **0 – 2 minutes** or **8 – 10 minutes**? Use your graph to explain your answer.

\_\_\_\_\_  
\_\_\_\_\_ [1]

(b) Explain why the mass of the flask and contents decreased during this experiment.

\_\_\_\_\_  
\_\_\_\_\_ [1]

[Turn over]



(c) If this experiment was repeated at a **higher** temperature, with all other factors remaining the same. What change, if any, would you expect to happen to:

(i) the rate of the reaction?

\_\_\_\_\_ [1]

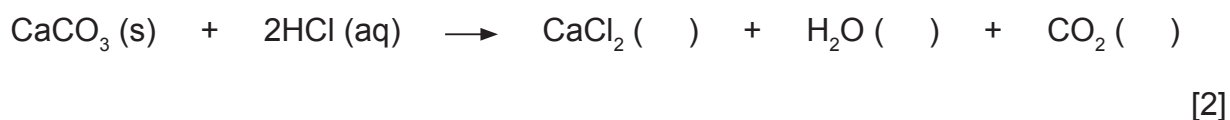
(ii) the total mass lost during the experiment?

\_\_\_\_\_ [1]

(d) The experiment was repeated with **less** concentrated acid and all other factors remained the same. What effect, if any, will this have on the rate of the reaction? Explain your answer in terms of particles.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]

(e) Complete the balanced symbol equation below for this reaction by adding the state symbols for the products.





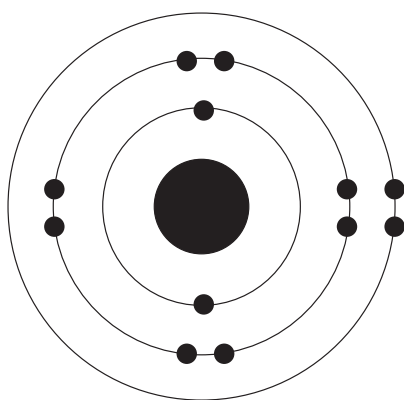
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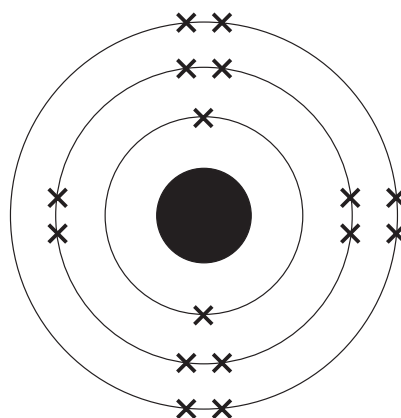
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- 6 (a) The diagrams below show the electronic configuration of a magnesium atom and a sulfur atom.

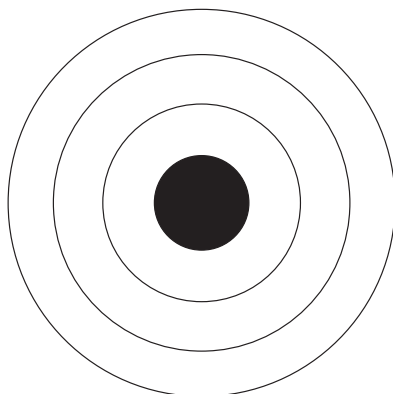


magnesium

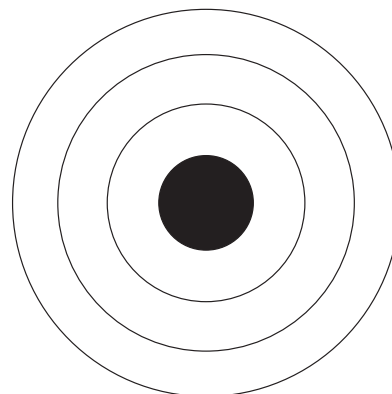


sulfur

- (i) Complete the dot and cross diagrams below for the ions of magnesium and sulfur.



magnesium ion



sulfur ion

[2]

- (ii) Give the formula of a magnesium ion.

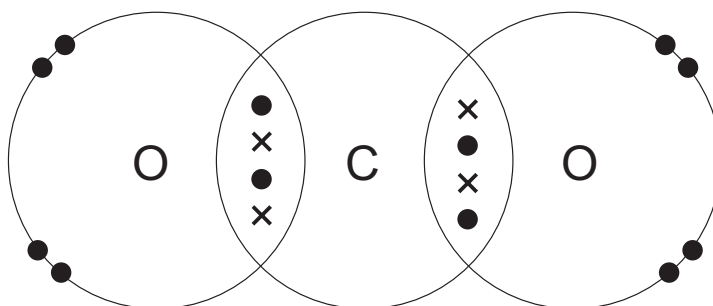
\_\_\_\_\_ [1]

- (iii) Name the compound formed when magnesium and sulfur react.

\_\_\_\_\_ [1]



- (b) Carbon reacts with oxygen to form carbon dioxide. The dot and cross diagram below shows the outer electrons in a molecule of carbon dioxide.



- (i) Name the **type** of bonding shown in carbon dioxide.

\_\_\_\_\_ [1]

- (ii) How many lone pairs of electrons are shown in the diagram?

\_\_\_\_\_ [1]

- (iii) Name another compound that has the same type of bonding as carbon dioxide.

\_\_\_\_\_ [1]

- (c) Name the solution that is used to test for carbon dioxide.

\_\_\_\_\_ [1]

- (d) Increasing levels of carbon dioxide in the atmosphere can lead to climate change.

State **one** effect on the Earth of climate change.

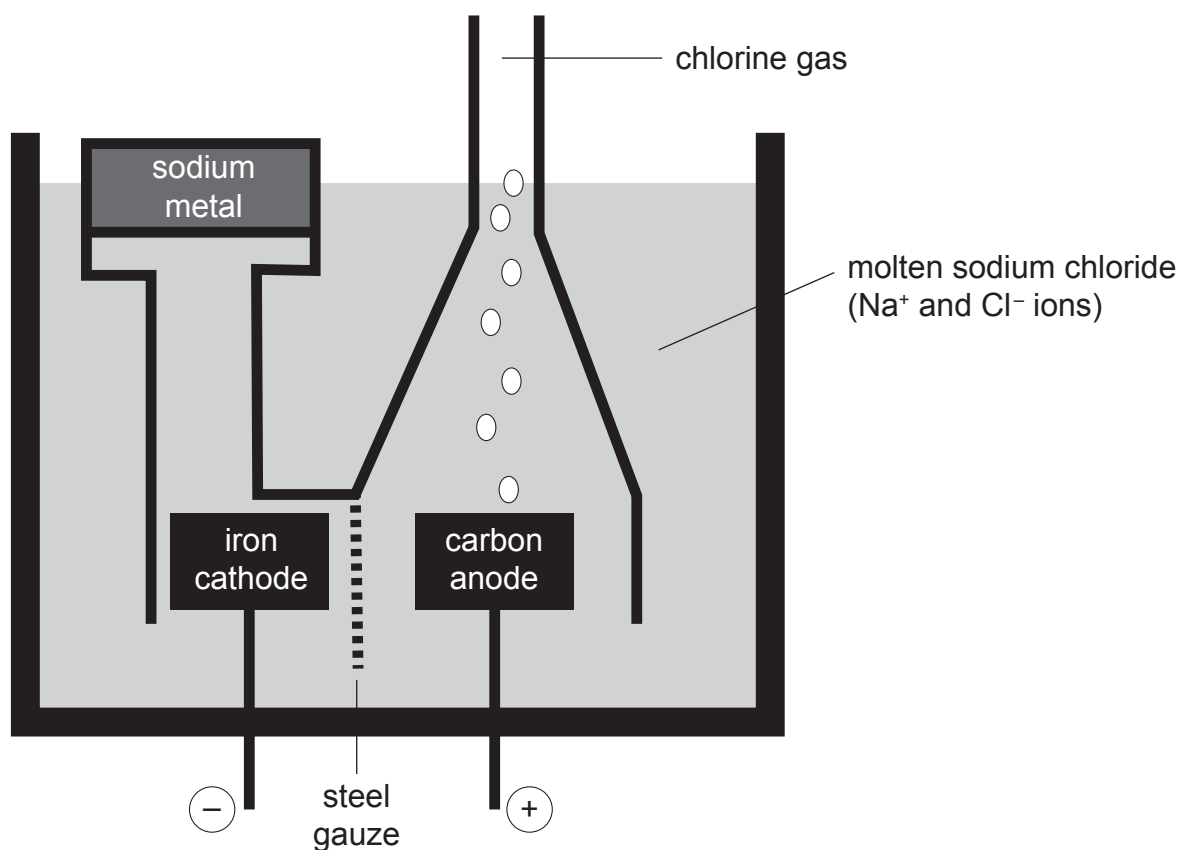
\_\_\_\_\_

\_\_\_\_\_ [1]

[Turn over



- 7 Both aluminium and sodium can be extracted using electrolysis. Sodium can be extracted from molten sodium chloride. In this process a carbon anode and an iron cathode are used. Molten sodium forms at the cathode and floats to the surface. Chlorine gas is formed at the anode.



(a) What is meant by the term **electrolysis**?

\_\_\_\_\_  
\_\_\_\_\_ [2]

(b) State **two** properties that carbon and iron must have to be useful as electrodes in this electrolysis.

1. \_\_\_\_\_
2. \_\_\_\_\_ [2]



During the electrolysis of molten aluminium oxide, aluminium is formed at the cathode when the aluminium ions gain three electrons.

- (c) Suggest how **sodium** is formed at the cathode during the electrolysis of molten sodium chloride.

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[2]

- (d) Sodium can react with water to produce hydrogen gas.

- (i) Describe the test for hydrogen gas.

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[2]

- (ii) Complete the balanced symbol equation for the hydrogen gas test.



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For Examiner's  
use only

| Question<br>Number | Marks |
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| 1                  |       |
| 2                  |       |
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| 5                  |       |
| 6                  |       |
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Examiner Number

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## SYMBOLS OF SELECTED IONS

### Positive ions

| Name          | Symbol           |
|---------------|------------------|
| Ammonium      | $\text{NH}_4^+$  |
| Chromium(III) | $\text{Cr}^{3+}$ |
| Copper(II)    | $\text{Cu}^{2+}$ |
| Iron(II)      | $\text{Fe}^{2+}$ |
| Iron(III)     | $\text{Fe}^{3+}$ |
| Lead(II)      | $\text{Pb}^{2+}$ |
| Silver        | $\text{Ag}^+$    |
| Zinc          | $\text{Zn}^{2+}$ |

### Negative ions

| Name              | Symbol                             |
|-------------------|------------------------------------|
| Butanoate         | $\text{C}_3\text{H}_7\text{COO}^-$ |
| Carbonate         | $\text{CO}_3^{2-}$                 |
| Dichromate        | $\text{Cr}_2\text{O}_7^{2-}$       |
| Ethanoate         | $\text{CH}_3\text{COO}^-$          |
| Hydrogencarbonate | $\text{HCO}_3^-$                   |
| Hydroxide         | $\text{OH}^-$                      |
| Methanoate        | $\text{HCOO}^-$                    |
| Nitrate           | $\text{NO}_3^-$                    |
| Propanoate        | $\text{C}_2\text{H}_5\text{COO}^-$ |
| Sulfate           | $\text{SO}_4^{2-}$                 |
| Sulfite           | $\text{SO}_3^{2-}$                 |

## Data Leaflet

### Including the Periodic Table of the Elements

For the use of candidates taking  
Science: Chemistry,  
Science: Double Award  
or Science: Single Award

Copies must be free from notes or additions of any  
kind. No other type of data booklet or information  
sheet is authorised for use in the examinations

### SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

| Soluble                                                                                        |
|------------------------------------------------------------------------------------------------|
| All sodium, potassium and ammonium salts                                                       |
| All nitrates                                                                                   |
| Most chlorides, bromides and iodides<br>EXCEPT silver and lead chlorides, bromides and iodides |
| Most sulfates EXCEPT lead and barium sulfates<br>Calcium sulfate is slightly soluble           |
| Insoluble                                                                                      |
| Most carbonates<br>EXCEPT sodium, potassium and ammonium carbonates                            |
| Most hydroxides<br>EXCEPT sodium, potassium and ammonium hydroxides                            |
| Most oxides<br>EXCEPT sodium, potassium and calcium oxides which react with water              |

# gcse examinations chemistry

# Group

|   |   |          |   |
|---|---|----------|---|
| 1 | H | Hydrogen | 1 |
|---|---|----------|---|



|                                   |                                        |                                     |                                      |                                     |                                     |                                      |                                     |                                       |                                       |                                    |                                        |                                     |                                       |
|-----------------------------------|----------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|----------------------------------------|-------------------------------------|---------------------------------------|
| 140<br><b>Ce</b><br>Cerium<br>58  | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 145<br><b>Pm</b><br>Promethium<br>61 | 150<br><b>Sm</b><br>Samarium<br>62  | 152<br><b>Eu</b><br>Europium<br>63  | 157<br><b>Gd</b><br>Gadolinium<br>64 | 159<br><b>Tb</b><br>Terbium<br>65   | 162<br><b>Dy</b><br>Dysprosium<br>66  | 165<br><b>Ho</b><br>Holmium<br>67     | 167<br><b>Er</b><br>Erbium<br>68   | 169<br><b>Tm</b><br>Thulium<br>69      | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71    |
| 232<br><b>Th</b><br>Thorium<br>90 | 231<br><b>Pa</b><br>Protactinium<br>91 | 238<br><b>U</b><br>Uranium<br>92    | 237<br><b>Np</b><br>Neptunium<br>93  | 242<br><b>Pu</b><br>Plutonium<br>94 | 243<br><b>Am</b><br>Americium<br>95 | 247<br><b>Cm</b><br>Curium<br>96     | 245<br><b>Bk</b><br>Berkelium<br>97 | 251<br><b>Cf</b><br>Californium<br>98 | 254<br><b>Es</b><br>Einsteinium<br>99 | 253<br><b>Fm</b><br>Fermium<br>100 | 256<br><b>Md</b><br>Mendelevium<br>101 | 254<br><b>No</b><br>Nobelium<br>102 | 257<br><b>Lr</b><br>Lawrencium<br>103 |