



Rewarding Learning

General Certificate of Secondary Education
2021–2022

Centre Number

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Candidate Number

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Single Award Science: Chemistry

Unit 2

Higher Tier



[GSA22]

GSA22

TUESDAY 23 NOVEMBER, 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 nine** 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 9.

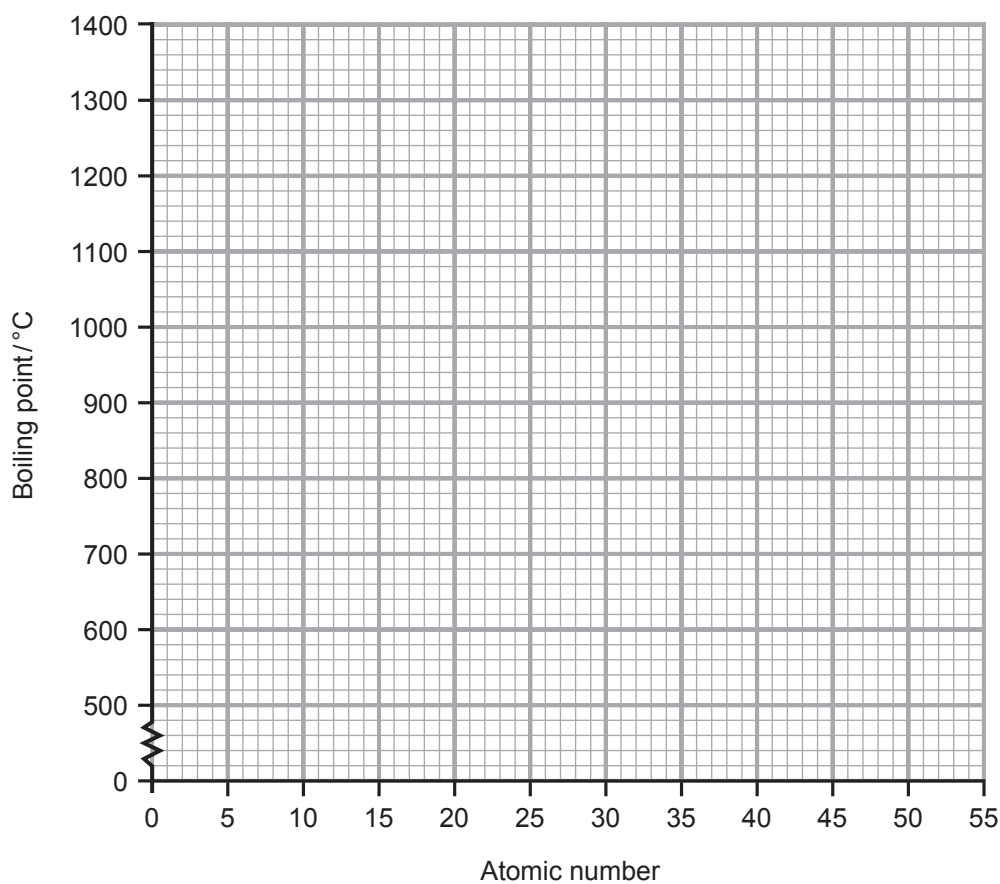
A Data Leaflet, which includes a Periodic Table of the Elements, is included for your use.



- 1 (a) The table below gives some information about the first five Group 1 elements.

Element	Atomic number	Boiling point/°C
lithium	3	1350
sodium	11	890
potassium	19	760
rubidium	37	680
caesium	55	670

- (i) On the grid below plot and draw a line graph for this information.



[3]



(ii) Describe the trend shown by this information.

_____ [1]

(b) Given below are some observations for the reactions of the first five Group 1 elements with water.

Element	Observations
lithium	gas produced, floats, produces some heat
sodium	heat produced, melts into a ball, gas produced, floats and moves rapidly on surface
potassium	burns with a lilac flame, heat produced, gas produced, floats, moves around and can explode
rubidium	sinks, produces heat, melts, gas produced, disappears with an explosion
caesium	gas and heat produced causing an instant explosion

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

(i) Apart from producing a gas, give **one** other observation common to all these reactions.

_____ [1]

(ii) Complete the following sentence.

As you go down Group 1, from lithium to caesium, the speed of the reaction of the metal with water _____ . [1]

(iii) Complete the word equation below.

potassium + water $\longrightarrow$ hydrogen +

[1]

[Turn over



(iv) Describe the test for hydrogen gas.

[2]

(c) Some chemical reactions release energy and cause their surroundings to heat up.

(i) What name is given to reactions that produce heat?

[1]

Patrick wanted to compare the amount of heat produced when iron reacts with acid to the amount produced when magnesium reacts with acid.

(ii) Give **one** way Patrick can make sure the investigation will be valid (a fair test).

[1]

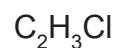
(iii) Describe fully what Patrick needs to measure to be able to compare the amount of heat produced in each reaction.

[2]



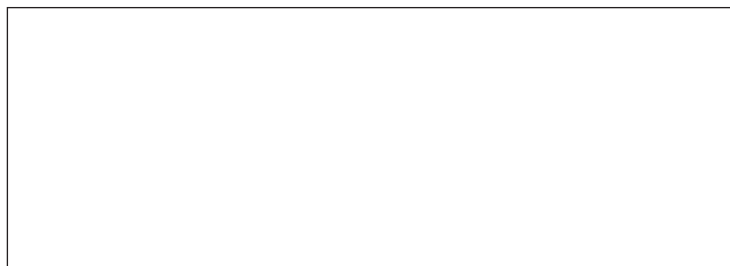
2 (a) The chemical formulae of four carbon compounds are given below.

(i) Circle the compound that is **not** a hydrocarbon.



[1]

(ii) In the box below draw the structural formula of butane (C_4H_{10}).



[1]

(iii) In what state is butane (C_4H_{10}) at room temperature?

_____ [1]

(b) Another carbon compound is ethanol ($\text{C}_2\text{H}_5\text{OH}$).

(i) How many elements are present in $\text{C}_2\text{H}_5\text{OH}$? _____ [1]

(ii) How many atoms are represented by the formula $\text{C}_2\text{H}_5\text{OH}$? _____ [1]

[Turn over]



- 3 The table below shows some information about the elements in Period 2 of the Periodic Table.

Name of element	Lithium	Beryllium	Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon
symbol	Li	Be	B	C	N	O	F	Ne
atomic number	3	4	5	6	7	8	9	10
atomic mass	7	9	11	12	14	16	19	20
melting point/°C	180	1287	2076	3500	−210	−219	−220	−249
boiling point/°C	1350	2970	3927	4827	−196	−183	−188	−246
metallic character	metal	metal	semi-metal	non-metal	non-metal	non-metal	non-metal	non-metal

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

- (a) Calculate the number of neutrons in an atom of lithium.

_____ [1]

- (b) Name the element which is a noble gas.

_____ [1]

- (c) Name the element that has the **lowest** melting point.

_____ [1]

- (d) Describe the trend in metallic character of the elements in Period 2.

_____ [1]



Lithium reacts with oxygen to form the compound lithium oxide.

(e) What is the chemical formula of lithium oxide?

Circle your answer.



[1]

[Turn over]



4 Aluminium is extracted from aluminium oxide by electrolysis.

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

[1]

The photograph below shows part of the National Grid which carries electricity to all parts of the country.



Source: © Getty Images

The cables in the grid are made from aluminium even though copper is a better conductor of electricity. The table below gives information about these two metals.

Metal	Cost per kg/£	Melting point/ °C	Density/ g/cm ³	Relative strength
copper	4.10	1083	8.96	0.6
aluminium	0.65	659	2.70	0.4

(b) Give **one** reason why aluminium is used instead of copper and explain why this is an advantage.

[2]



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13262

[Turn over



20GSA2209

- 5 (a) Nano-sized particles of titanium dioxide and zinc oxide are used in sun-protection creams. Unlike previous sun creams they provide protection from the Sun while being invisible on the skin.

Nanoparticles are relatively new and despite thorough research by scientists, not all risks are fully evident. Due to their size they may enter human cells. They are emerging as a new class of pollutants which impact on marine ecosystems because the particles can end up in waterways reaching the sea. There may be issues in the future with disposing of them safely.

- (i) What size is a nanoparticle?

_____ m [1]

- (ii) How many atoms does a nanoparticle contain?

Circle your answer.

a few hundred : a few billion : a few million : less than ten

[1]

- (iii) Suggest **one** reason why some parents may still prefer to use visible sun creams on young children rather than using invisible sun creams containing nano-sized particles.

_____ [1]

- (iv) Give **one** reason why environmentalists may be concerned about the use of nano-sized particles in sun-protection creams.

_____ [1]



(b) Thermochromic and photochromic materials are smart materials that change colour.

(i) Explain fully what is meant by the term **smart material**.

[2]

(ii) What causes the colour to change in photochromic materials?

[1]

[Turn over



- 6 (a) The table below shows the percentages of different gases in the exhaust fumes of petrol and diesel cars.

Exhaust gases	Percentage	
	Petrol	Diesel
nitrogen	68.8	66.2
carbon dioxide	14.2	12.0
water vapour		11.0
oxygen	0.8	8.0
nitrogen oxides	0.3	0.2
carbon monoxide	1.0	0.3
hydrocarbons	0.2	0.3
sulfur dioxide	0.1	0.3
noble gases	1.7	1.7

Source: Principal Examiner

- (i) Calculate the percentage of **water vapour** in the exhaust fumes given off by a petrol car.

(Show your working out.)

_____ % [2]

- (ii) Apart from the noble gases, how many of the exhaust gases are elements?

_____ [1]



- (b) Explain fully why scientists are concerned about the increasing carbon dioxide levels in the atmosphere caused by exhaust fumes from cars.

[2]

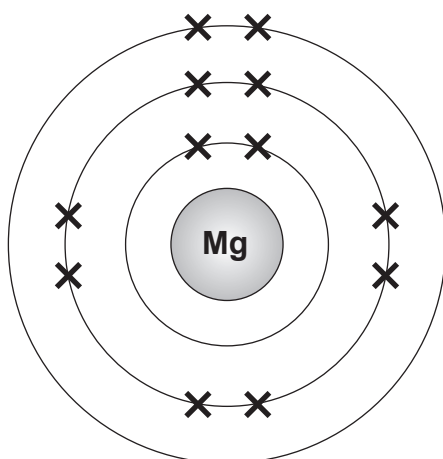
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13262

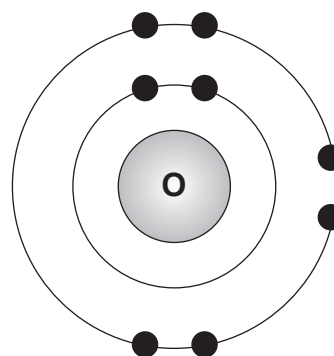


20GSA2213

7 (a) Magnesium reacts with oxygen to form magnesium oxide.



magnesium atom



oxygen atom

(i) Explain, in terms of electrons, how magnesium oxide is formed.

[3]

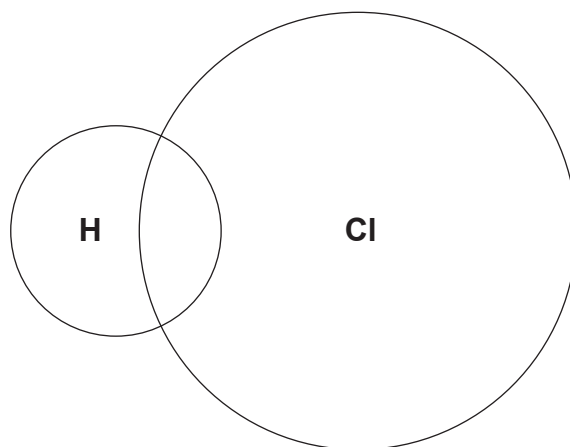
(ii) What is the formula for the oxide ion that is formed?

[1]



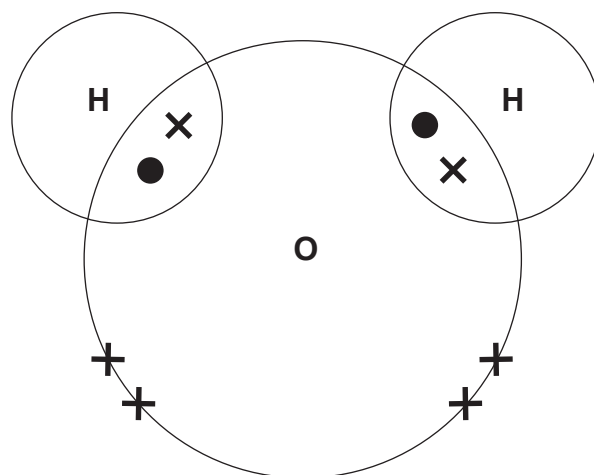
Hydrogen chloride has the formula HCl.

- (b) Complete the dot and cross diagram below to show the bonding in hydrogen chloride. Show the outer electrons only.



[1]

- (c) The bonding in a molecule of water is shown below.



- (i) Label **one** lone pair of electrons in the diagram above using the letter **L**. [1]

- (ii) Name the type of bonding present in a molecule of water.

[1]

[Turn over]

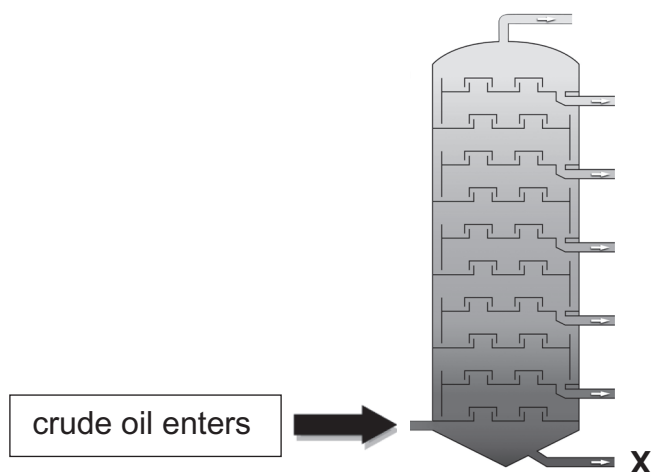


8 Crude oil is described as a finite resource.

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

_____ [1]

(b) The fractionating column shown below is used to separate crude oil into different hydrocarbons.



(i) Describe how this column separates the crude oil.

_____ [3]

(ii) Name the fraction labelled **X** in the diagram.

_____ [1]

(c) One of the hydrocarbons produced is propane.

(i) Name the homologous series (family) that propane belongs to.

_____ [1]



(ii) Complete and balance the symbol equation below for the combustion of propane.



[Turn over



9 In 1869 Dmitri Mendeleev developed a periodic table. This has been changed considerably over the years to produce the modern Periodic Table.

Describe how Mendeleev arranged the elements in his periodic table and how scientific ideas have changed over time to develop the modern Periodic Table. Your answer should include:

- similarities between Mendeleev's table and the modern Periodic Table and
- differences between Mendeleev's table and the modern Periodic Table.

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

[illegible]



THIS IS THE END OF THE QUESTION PAPER



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For Examiner's use only	
Question Number	Marks
1	
2	
3	
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5	
6	
7	
8	
9	

Total Marks	
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Examiner Number

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