

Name _____



Triple Science

Foundation

Chemistry: Paper 1

The Periodic Table of Elements

1	2	3											4	5	6	7	0	
		1 H hydrogen 1																4 He helium 2
		Key																
		relative atomic mass atomic symbol name atomic (proton) number																
7 Li lithium 3	9 Be beryllium 4												11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12												27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36	
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[97] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54	
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 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	[267] Rf rutherfordium 104	[270] Db dubnium 105	[269] Sg seaborgium 106	[270] Bh bohrium 107	[270] Hs hassium 108	[278] Mt meitnerium 109	[281] Ds darmstadtium 110	[281] Rg roentgenium 111	[285] Cn copernicium 112	[286] Nh nihonium 113	[289] Fl flerovium 114	[289] Mc moscovium 115	[293] Lv livermorium 116	[293] Ts tennessine 117	[294] Og oganeson 118	

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.
Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.



Please write clearly in block capitals.

Centre number

Candidate number

Surname

Forename(s)

Candidate signature

GCSE

CHEMISTRY

Foundation Tier Paper 1

F

Thursday 16 May 2019 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

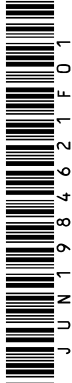
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.



IB/G/Jun19/E10

8462/1F

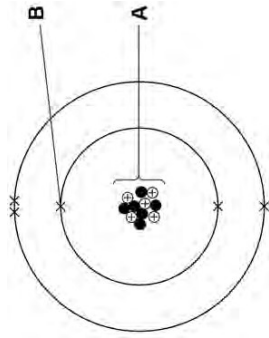
Answer **all** questions in the spaces provided.

01

This question is about atomic structure.

Figure 1 represents an atom of element Z.

Figure 1



01.1

Name the parts of the atom labelled **A** and **B**.

Choose answers from the box.

[2 marks]

electron	neutron	nucleus	proton
----------	---------	---------	--------

A

B



IB/G/Jun19/8462/1F

Do not write outside the box

0 1 . 2 Which particle has the lowest mass?

Choose the answer from the box.

[1 mark]

electron	neutron	nucleus	proton
----------	---------	---------	--------

0 1 . 3

Which group of the periodic table contains element Z?

Use Figure 1.

[1 mark]

Group _____

0 1 . 4

Give the atomic number and the mass number of element Z.

Use Figure 1.

Choose answers from the box.

[2 marks]

1	5	6	11	16
---	---	---	----	----

Atomic number _____

Mass number _____

Question 1 continues on the next page

Turn over ►



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Bromine has two different types of atom.

The atoms have a different number of neutrons but the same number of protons.

0 1 . 5

What is the name for this type of atom?

[1 mark]

Tick (✓) **one** box.

Compound	☐
Ion	☐
Isotope	☐
Molecule	☐

0 1 . 6

The different types of bromine atom can be represented as $^{79}_{35}\text{Br}$ and $^{81}_{35}\text{Br}$

The relative atomic mass (A_r) of bromine is 80

Which statement is true about the number of each type of atom in bromine?

[1 mark]

Tick (✓) **one** box.

There are fewer $^{79}_{35}\text{Br}$ atoms than $^{81}_{35}\text{Br}$ atoms.

☐

There are more $^{79}_{35}\text{Br}$ atoms than $^{81}_{35}\text{Br}$ atoms.

☐

There are the same number of $^{79}_{35}\text{Br}$ atoms and $^{81}_{35}\text{Br}$ atoms.

☐

Do not write outside the box

0 2 . 1

This question is about compounds of oxygen and hydrogen.

Figure 2 represents the structure of hydrogen peroxide.

Figure 2



0 2 . 1

What is the correct formula of hydrogen peroxide?

Tick (✓) **one** box.

H₂O₂

☐

HO₂

☐

H²O²

☐

H₂O₂

☐

[1 mark]

0 2 . 2

Which type of bonding is shown in **Figure 2**?

Tick (✓) **one** box.

Covalent

☐

Ionic

☐

Metallic

☐

[1 mark]

Turn over ►



IB/G/Jun19/8462/1F

Do not write outside the box

0 2 . 3

Hydrogen peroxide decomposes in the presence of a catalyst.

Which elements are often used as catalysts?

[1 mark]

Tick (✓) **one** box.

Alkali metals

☐

Halogens

☐

Transition metals

☐

Figure 3 shows the reaction profile for the decomposition of hydrogen peroxide.

The word equation for this reaction is:

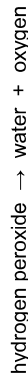
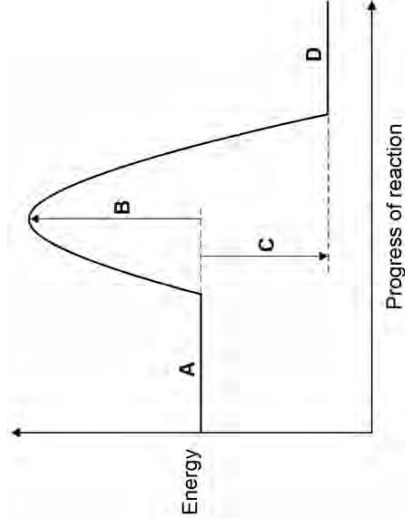


Figure 3



IB/G/Jun19/8462/1F

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Labels **A**, **B**, **C** and **D** each represent a different part of the reaction profile.

Use **Figure 3** to answer Questions **02.4** and **02.5**

0 2 . 4

Which label shows the activation energy?

[1 mark]

Tick (✓) **one** box.

A	☐	B	☐	C	☐	D	☐
---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------

0 2 . 5

Which label shows the energy of hydrogen peroxide?

[1 mark]

Tick (✓) **one** box.

A	☐	B	☐	C	☐	D	☐
---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------

0 2 . 6

The decomposition of hydrogen peroxide gives out energy to the surroundings.

What type of reaction is this?

[1 mark]

Tick (✓) **one** box.

Displacement	☐
Endothermic	☐
Exothermic	☐
Neutralisation	☐

Question 2 continues on the next page

Turn over ►



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0 2 . 7

Hydrogen and oxygen form water.

A hydrogen atom contains one electron.

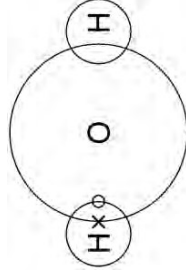
An oxygen atom contains six electrons in the outer shell.

Complete **Figure 4** to show a dot and cross diagram for a water molecule.

Show the outer electrons only.

[2 marks]

Figure 4



8



IB/G/Jun19/8462/1F

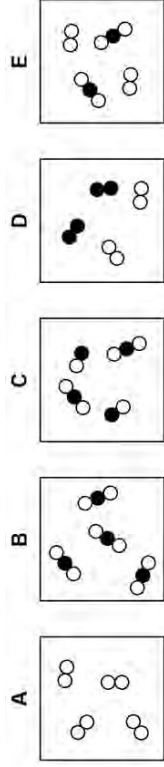
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This question is about elements, compounds and mixtures.

Figure 5 shows five different substances, A, B, C, D and E.

○ and ● represent atoms of different elements.

Figure 5



Use Figure 5 to answer Questions 03.1 to 03.3

0 3 . 1

Which substance is only one compound?

Tick (✓) one box.

A	☐	B	☐	C	☐	D	☐	E	☐
---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------

0 3 . 2

Which substance is a mixture of elements?

Tick (✓) one box.

A	☐	B	☐	C	☐	D	☐	E	☐
---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------

0 3 . 3

Which substance is a mixture of an element and a compound?

Tick (✓) one box.

A	☐	B	☐	C	☐	D	☐	E	☐
---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------

Turn over ►



IB/G/Jun19/8462/1F

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Substances are separated from a mixture using different methods.

Draw one line from each method of separation to the substance and mixture it would separate.

0 3 . 4

[2 marks]

Method of separation

Substance and mixture

chromatography

blue food colour from a mixture of food colours

copper from an alloy of copper and zinc

copper sulfate from copper sulfate solution

crystallisation

ethanol from a mixture of ethanol and water



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03.5

Sand does not dissolve in water. A student separates a mixture of sand and water by filtration.

Draw a diagram of the apparatus the student could use.

You should label:

- where the sand is collected
- where the water is collected.

[3 marks]

Diagram

Question 3 continues on the next page

Turn over ►



1 1

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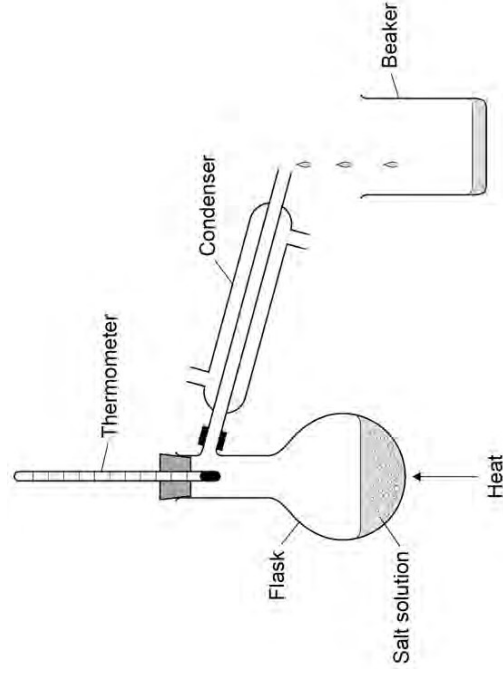
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03.6

A student distils a sample of salt solution to produce pure water.

Figure 6 shows the apparatus.

Figure 6



What temperature would you expect the thermometer to show?

[1 mark]

Tick (✓) **one** box.

0 °C	☐
10 °C	☐
50 °C	☐
100 °C	☐



1 2

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0 **3** **7** Describe how the process of distillation shown in **Figure 6** produces pure water from salt solution.

[4 marks]

Turn over for the next question

13

Turn over ►



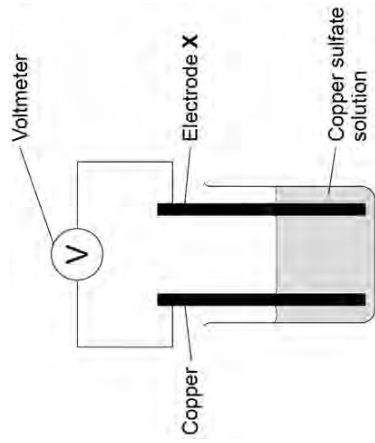
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This question is about chemical cells and batteries.

A student investigated the voltage produced by different chemical cells.

Figure 7 shows the apparatus.

Figure 7



This is the method used.

1. Use cobalt metal as electrode **X**.
2. Record the cell voltage.
3. Repeat steps 1 and 2 using different metals as electrode **X**.

0 **4** **1** Suggest **two** variables the student should keep the same to make the investigation valid.

[2 marks]

1 _____

2 _____



Do not write outside the box

Table 1 shows the student's results.

Table 1

Electrode X	Voltage of the cell in volts
cobalt	0.62
magnesium	2.71
zinc	1.10

Write the three metals used for electrode X in order of reactivity.

Use Table 1.

Most reactive

Least reactive

Copper is used as electrode X in Figure 7.

Predict the voltage of this cell.

Give one reason for your answer.

Voltage = volts

Reason

Turn over



Do not write outside the box

Describe how to make a 12 V battery using 1.5 V cells.

Which is the most suitable use for a non-rechargeable cell?

Tick (✓) one box.

Electric toy

Laptop computer

Mobile phone

Hydrogen fuel cells or rechargeable cells can be used to power electric vehicles.

Suggest one advantage and one disadvantage of using a hydrogen fuel cell compared with a rechargeable cell.

Advantage of hydrogen fuel cell

Disadvantage of hydrogen fuel cell



Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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Turn over ►



A student investigated the reaction between lumps of calcium carbonate and dilute hydrochloric acid.

This is the method used.

1. Pour 100 cm³ of dilute hydrochloric acid into a conical flask.
2. Place the conical flask on a balance.
3. Add 2 g of calcium carbonate lumps to the conical flask.
4. Wait until the calcium carbonate stops reacting.
5. Record the decrease in mass of the conical flask and contents.
6. Repeat steps 1 to 5 three more times.

The equation for the reaction is:



0 5 . 1

What is the state symbol **X** in the equation?

Tick (✓) **one** box.

aq ☐

g

☐

l

☐

s

☐

[1 mark]

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Table 2 shows the student's results.

Table 2

	Result 1	Result 2	Result 3	Result 4
Decrease in mass of the conical flask and contents in g	0.84	0.79	0.86	0.47

05.2 Why does the mass of the conical flask and contents decrease during the reaction? [1 mark]

Tick (✓) one box.

A gas escapes.

A new solution is made.

The dilute hydrochloric acid is used up.

The calcium carbonate lumps decrease in size.

05.3 What is the range of the four results in Table 2? [1 mark]

From _____ g to _____ g

05.4 Calculate the mean decrease in mass of the conical flask and contents.

Do not include the anomalous result.

Use Table 2.

[2 marks]

Mean decrease in mass = _____ g

Turn over ►

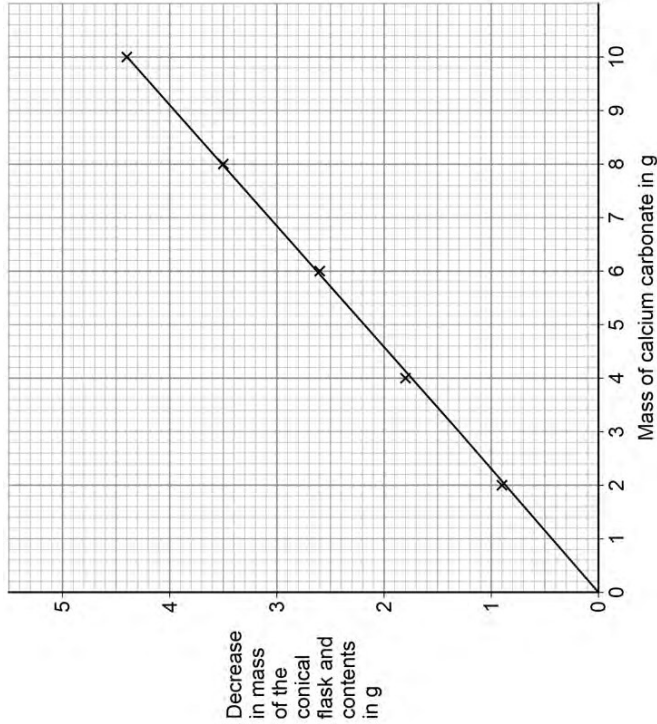


A teacher demonstrated the investigation.

The teacher used different masses of calcium carbonate.

Figure 8 shows the teacher's results.

Figure 8



05.5 What type of variable is the mass of calcium carbonate? [1 mark]

Tick (✓) one box.

Control

Dependent

Independent



Do not write outside the box

Use **Figure 8** to answer Questions **05.6** and **05.7**

0

5

.

6

 Complete the sentence.

[1 mark]

As the mass of calcium carbonate used increases, the decrease in mass of the conical flask and contents _____.

0

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7

What is the decrease in mass of the conical flask and contents when a 3 g sample of calcium carbonate is used?

[1 mark]

Decrease in mass = _____ g

—

8

Turn over for the next question

Turn over ►



2 1

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This question is about the extraction of metals.

0

6

0

6

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1

 Tungsten is a metal.

The symbol of tungsten is W

Tungsten is produced from tungsten oxide by reaction with hydrogen.

The equation for the reaction is:



Calculate the percentage atom economy when tungsten is produced in this reaction.

Use the equation:

$$\text{percentage atom economy} = \frac{184}{(M_r \text{ WO}_3) + (3 \times M_r \text{ H}_2)} \times 100$$

Relative formula masses (M_r): $\text{WO}_3 = 232$ $\text{H}_2 = 2$

[2 marks]

Percentage atom economy = _____ %



2 2

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0 6 . 2

Aluminium is extracted from aluminium oxide.

38% of a rock sample is aluminium oxide.

Calculate the mass of aluminium oxide in 40 kg of the rock sample.

[2 marks]

Mass of aluminium oxide = _____ kg

0 6 . 3

The formula of aluminium oxide is Al_2O_3

Calculate the relative formula mass (M_r) of aluminium oxide.

Relative atomic masses (A_r): O = 16 Al = 27

[2 marks]

Relative formula mass (M_r) = _____

Question 6 continues on the next page

Turn over ►



Do not write
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0 6 . 4

60.0 kg of aluminium oxide produces a maximum of 31.8 kg of aluminium.

In an extraction process only 28.4 kg of aluminium is produced from 60.0 kg of aluminium oxide.

Calculate the percentage yield.

Give your answer to 3 significant figures.

Use the equation:

percentage yield = $\frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$

[3 marks]

Percentage yield = _____ %

0 6 . 5

Extracting metals by electrolysis is a very expensive process.

Explain why aluminium is extracted using electrolysis and not by reduction with carbon.

[2 marks]



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ANSWER IN THE SPACES PROVIDED

Turn over ►



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0 7

This question is about energy changes in reactions.

0 7 . 1

Ammonium nitrate dissolves in water.

The change is endothermic.

Which piece of equipment uses this change?

[1 mark]

Tick (✓) **one** box.

☐

Hand warmer

☐

Self-heating can

☐

Sports injury pack

A student investigated the temperature change in the reaction between dilute sulfuric acid and potassium hydroxide solution.

This is the method used.

1. Measure 25 cm³ of potassium hydroxide solution into a glass beaker.
2. Add 5 cm³ of dilute sulfuric acid.
3. Stir the solution.
4. Measure the temperature of the solution.
5. Repeat steps 2 to 4 until a total of 30 cm³ of dilute sulfuric acid has been added.



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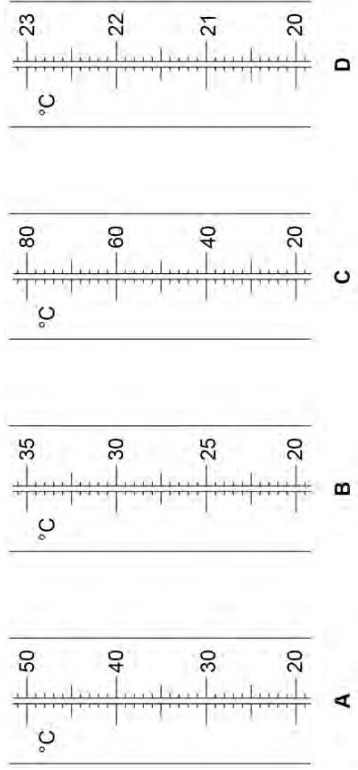
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2

Figure 9 shows part of the scales of four thermometers, **A**, **B**, **C** and **D**.

Figure 9



The student wanted to measure the temperature to a resolution of 0.1 °C

Which thermometer should the student use?

Tick (✓) **one** box.

A

B

C

D

[1 mark]

0

7

.

3

Energy is lost to the surroundings during the reaction.

What type of error does this cause in the results?

Tick (✓) **one** box.

Human error

Random error

Systematic error

Zero error

[1 mark]

Turn over ▶



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4

The student used a glass beaker for the reaction.

Name a container the student could use instead of the glass beaker to improve the accuracy of the results.

[1 mark]

0

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5

Table 3 shows the student's results.

Table 3

Volume of dilute sulfuric acid added in cm ³	Temperature in °C
5	21.2
10	22.0
15	22.8
20	23.6
25	24.4
30	25.2

Plot the data from **Table 3** on **Figure 10**.

You should:

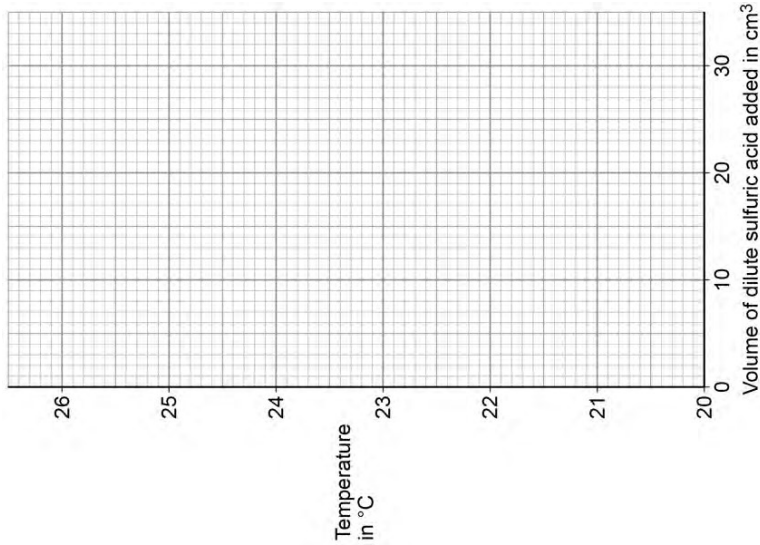
- draw a line of best fit
- extend your line of best fit to the y-axis.

[4 marks]



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Figure 10



The intercept on the y-axis of **Figure 10** shows the starting temperature of the potassium hydroxide solution.

Give the starting temperature of the potassium hydroxide solution.

Starting temperature = _____ °C

[1 mark]

0 7 . 6



Turn over ►

Do not write
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Another student repeated the investigation and obtained an anomalous result.

This result was lower than expected.

What could have caused the anomalous result?

Tick (✓) **two** boxes.

[2 marks]

The mixture was not stirred.

The temperature in the room increased.

The thermometer was not accurate.

Too little sulfuric acid was added.

Too much potassium hydroxide solution was used.

☐	☐	☐	☐	☐
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------



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ANSWER IN THE SPACES PROVIDED

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This question is about the periodic table.

In the 19th century, some scientists tried to classify the elements by arranging them in order of their atomic weights.

Figure 11 shows the periodic table Mendeleev produced in 1869.

His periodic table was more widely accepted than previous versions.

Figure 11

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Period 1	H						
Period 2	Li	Be	B	C	N	O	F
Period 3	Na	Mg	Al	Si	P	S	Cl
Period 4	K	Ca	*	Ti	V	Cr	Mn
		Cu	Zn	*	As	Se	Br
Period 5	Rb	Sr	Y	Zr	Nb	Mo	*
		Ag	Cd	Sn	Sb	Te	I

0 8 . 1

The atomic weight of tellurium (Te) is 128 and that of iodine (I) is 127

Why did Mendeleev reverse the order of these two elements?

[1 mark]



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box

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8

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2

 Mendeleev left spaces marked with an asterisk *

He left these spaces because he thought missing elements belonged there.

Why did Mendeleev's periodic table become more widely accepted than previous versions?

[3 marks]

0

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3

 Mendeleev arranged the elements in order of their atomic weight.

What is the modern name for atomic weight?

Tick (✓) **one** box.

[1 mark]

Atomic number

Mass number

Relative atomic mass

Relative formula mass

0

8

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4

 Complete the sentence.

[1 mark]

In the modern periodic table, the elements are arranged in order of

Turn over ►



Do not write
outside the
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Chlorine, iodine and astatine are in Group 7 of the modern periodic table.

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5

 Astatine (At) is below iodine in Group 7.

Predict:

- the formula of an astatine molecule
- the state of astatine at room temperature.

[2 marks]

Formula of astatine molecule

State at room temperature

0

8

.

6

 Sodium is in Group 1 of the modern periodic table.

Describe what you would see when sodium reacts with chlorine.

[2 marks]



Do not write outside the box

This question is about acids and alkalis.

Which ion do all acids produce in aqueous solution?

Tick (✓) **one** box.

- H⁺

☐
- H⁻

☐
- O²⁻

☐
- OH⁻

☐

[1 mark]

Calcium hydroxide solution reacts with an acid to form calcium chloride.

Complete the word equation for the reaction.

calcium hydroxide + _____ acid → calcium chloride + _____

[2 marks]

Question 9 continues on the next page

Turn over ►

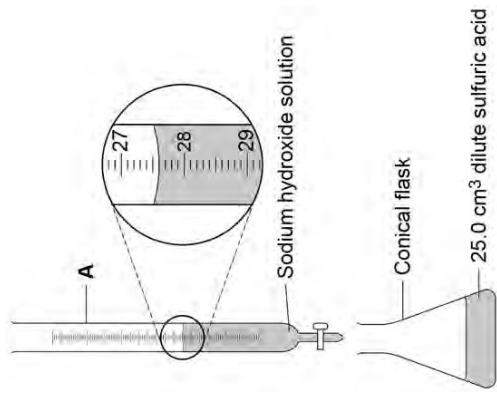


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A student investigates the volume of sodium hydroxide solution that reacts with 25.0 cm³ of dilute sulfuric acid.

Figure 12 shows the apparatus the student uses.

Figure 12



Use Figure 12 to answer Questions 09.3 and 09.4

09.3 Name apparatus A.

[1 mark]

09.4 What is the reading on apparatus A?

[1 mark]

_____ cm³



The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid.

The student tested two samples of dilute sulfuric acid, **P** and **Q**.

Describe how the student could use titrations to find which sample, **P** or **Q**, is more concentrated.

[6 marks]

[illegible]

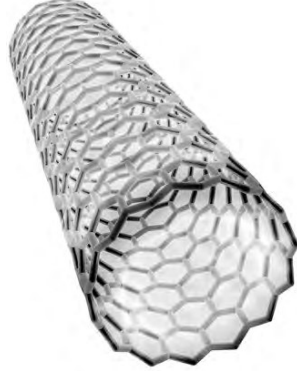
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This question is about materials and their properties.

Figure 13 shows a carbon nanotube.



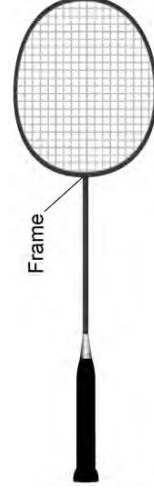
The structure and bonding in a carbon nanotube are similar to graphene.

Carbon nanotubes are used in electronics because they conduct electricity.

Explain why carbon nanotubes conduct electricity.

[2 marks]

Figure 14 shows a badminton racket.



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GCSE
CHEMISTRY
8462/1F
Paper 1 Foundation Tier

Mark scheme
June 2019

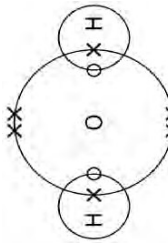
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MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2019

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	A nucleus		1	AO1 4.1.1.4
	B electron		1	4.1.1.7
01.2	electron		1	AO1 4.1.1.5
01.3	3 / three		1	AO2 4.1.2.1
01.4	(atomic number) 5		1	AO2 4.1.1.5
	(mass number) 11		1	
01.5	isotope		1	AO1 4.1.1.5
01.6	there are the same number of ⁷⁹ ₃₅ Br atoms and ⁸¹ ₃₅ Br atoms		1	AO2 4.1.1.6
Total			8	

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	H ₂ O ₂		1	AO2 4.1.1.1 4.2.1.4
02.2	covalent		1	AO1 4.2.1.4
02.3	transition metals		1	AO1 4.1.3.2
02.4	B		1	AO1 4.5.1.2
02.5	A		1	AO2 4.5.1.2
02.6	exothermic		1	AO1 4.5.1.1
02.7	1 bonding pair of electrons in the right hand overlap 4 non-bonding electrons on oxygen	 scores 2 marks allow dots, crosses, circles or e⁽⁻⁾ for electrons do not accept any change to the number of electrons in the left hand overlap do not accept non-bonding electrons on hydrogen ignore inner shell electrons drawn on oxygen	1 1	AO1 4.2.1.4
Total			8	

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	B		1	AO2 4.1.1.1 4.1.1.2
03.2	D		1	AO2 4.1.1.1 4.1.1.2
03.3	E		1	AO2 4.1.1.1 4.1.1.2
03.4	chromatography blue food colour from a mixture of food colours copper from an alloy of copper and zinc copper sulfate from copper sulfate solution crystallisation ethanol from a mixture of ethanol and water additional line from a box negates the mark for that box		1	AO2 4.1.1.2
03.5	(filter) funnel containing filter paper suitable vessel for collecting filtrate sand and water labelled in correct place		1	AO1
03.6	100 °C		1	AO2 4.1.1.2

03.7	any four from:	allow water boils / vaporises	4	AO1 4.1.1.2
	- solution is heated - water evaporates - the vapour cools in the condenser - the vapour condenses or the vapour turns to a liquid (pure) water collects in the beaker			
Total			13	

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	concentration (of solution / electrolyte)		1	AO3 4.5.2.1
	temperature (of solution / electrolyte)	ignore room temperature allow volume (of solution / electrolyte) allow size of electrodes allow distance between electrodes do not accept electrode X unqualified do not accept (measured) voltage	1	
04.2	(most reactive) magnesium zinc (least reactive) cobalt	allow Mg allow Zn allow Co	1	AO3 4.4.1.2 4.5.2.1
04.3	0 (volts)		1	AO3 4.5.2.1
	two different metals are needed to produce a voltage	dependent on voltage being given as 0 volts allow the two electrodes are the same metal allow there is no difference in reactivity (between the electrodes)	1	
04.4	connect cells (in series) use $\left(\frac{12}{1.5} = \right) 8$ cells	ignore putting cells together	1 1	AO1 AO2 4.5.2.1
04.5	electric toy		1	AO3 4.5.2.1 4.5.2.2

Question 4 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(advantage) any one from: • faster to refuel (than recharging) • can travel further (before refuelling) • hydrogen can be renewable • produces a constant voltage • no toxic chemicals released after disposal (disadvantage) any one from: • hydrogen is made from fossil fuels • hydrogen is made from non-renewable resources • hydrogen is difficult to store • hydrogen is flammable / explosive • costs more to refuel (than recharging) • costs more to manufacture • not many hydrogen filling stations	allow lasts longer allow hydrogen is renewable allow the only product is water ignore no emissions ignore expensive unqualified	1	AO3 4.5.2.1 4.5.2.2
Total			10	

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	s		1	AO2 4.2.2.2
05.2	a gas escapes		1	AO2 4.3.1.3
05.3	from 0.47 (g) to 0.86 (g)	allow from 0.86 (g) to 0.47 (g)	1	AO2 4.3.1.4
05.4	$\frac{0.84+0.79+0.86}{3}$ = 0.83 (g)	an answer of 0.83 (g) scores 2 marks an answer of 0.74 (g) scores 1 mark	1 1	AO3 AO2 4.3.1.3
05.5	independent		1	AO2 4.3.1.3
05.6	increases		1	AO2 4.3.1.3
05.7	1.3 (g)	allow 1.30 (g)	1	AO2 4.3.1.3
Total			8	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$\frac{184}{(232 + 6)} \times 100$ $= 77 \text{ (\%)}$	an answer of 77 (%) scores 2 marks	1	AO2 4.3.3.2
		an answer of 78.63247863 (%) correctly rounded to at least 2 significant figures scores 1 mark		
06.2	$\frac{38}{100} \times 40$ $= 15 \text{ (kg)}$	allow 77.31092437 (%) correctly rounded to at least 2 significant figures	1	AO2 4.3.3.2
		an answer of 15 (kg) scores 2 marks		
06.3	$(2 \times 27) + (3 \times 16)$ $= 102$	allow 15.2 (kg)	1	AO2 4.4.1.3
		an answer of 102 scores 2 marks		
06.4	$\frac{28.4}{31.8} \times 100$ $= 89.3081761 \text{ (\%)}$ $= 89.3 \text{ (\%)}$	ignore units	1	AO2 4.3.1.2
		an answer of 89.3 (%) scores 3 marks		
06.4	$\frac{28.4}{31.8} \times 100$ $= 89.3081761 \text{ (\%)}$ $= 89.3 \text{ (\%)}$	allow 89.3081761(%) correctly rounded to at least 2 significant figures	1	AO2 4.3.3.1
		allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the masses in the question		

06.5	aluminium is more reactive than carbon	allow aluminium is above carbon in the reactivity series	1	AO1 4.4.1.1 4.4.1.2 4.4.1.3 4.4.3.3
	(so) carbon cannot displace aluminium or (so) carbon cannot reduce aluminium oxide	allow (so) carbon cannot replace aluminium allow (so) carbon cannot remove oxygen from aluminium oxide allow (so) carbon will not react with aluminium oxide	1	
Total			11	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	sports injury pack		1	AO1 4.5.1.1
07.2	D		1	AO1 4.5.1.1
07.3	systematic error		1	AO1 4.5.1.1
07.4	polystyrene cup	allow other insulating containers	1	AO1 4.5.1.1
07.5	all six points plotted correctly	allow a tolerance of $\pm \frac{1}{2}$ a small square	2	AO2 4.5.1.1
	line of best fit	allow 1 mark for at least 3 points plotted correctly	1	
	line extrapolated correctly to y-axis	ignore extrapolation to y-axis	1	
07.6	20.4 (°C)	allow ecf from question 07.5 allow a tolerance of $\pm \frac{1}{2}$ a small square	1	AO2 4.5.1.1
07.7	the mixture was not stirred too little sulfuric acid was added		1 1	AO3 4.5.1.1
Total			11	

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	any one from: - so elements / iodine / tellurium were in groups with similar properties - iodine has similar properties to Br / Cl / F / Group 7 - iodine has different properties to Se / S / O / Group 6	ignore reference to atomic structure ignore references to Cr, Mn and Mo allow corresponding argument in terms of tellurium	1	AO1 4.1.2.2
08.2	Mendeleev had predicted properties of missing elements	ignore reference to atomic structure	1	AO1 4.1.2.2
	elements were discovered (that filled the spaces / gaps)		1	
	properties (of these elements) matched Mendeleev's predictions	allow atomic weights (of these elements) fitted in the spaces / gaps if no other mark awarded, allow 1 mark for in previous versions of the periodic table the pattern of similar properties broke down	1	
08.3	relative atomic mass		1	AO1 4.1.1.6
08.4	(increasing) atomic / proton number	ignore (increasing) electron number do not accept relative atomic / proton number	1	AO1 4.1.2.1
08.5	(formula) At ₂ (state) solid	ignore incorrect state symbol allow (s) ignore s	1 1	AO1 4.1.2.6

08.6	any two from: - flame (white) solid forms - colour of gas / chlorine disappears / fades	allow burns allow (white) smoke forms	2	AO1 4.1.2.5
Total			10	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	H ⁺		1	AO1 4.4.2.4
09.2	hydrochloric (acid) water	allow HCl allow H ₂ O	1 1	AO2 4.4.2.2
09.3	burette	do not accept biuret	1	AO1 4.4.2.5
09.4	27.6 (cm ³)	allow 27.60 (cm ³)	1	AO2 4.4.2.5

Question 9 continued

Question	Answers	Mark	AO/ Spec. Ref.
09.5	Level 3: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 AO1
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	AO1 x 2
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1 x 2
	No relevant content	0	
	Indicative content allow converse using acid added to alkali Key steps • measure the volume of acid • add indicator to the acid • add sodium hydroxide solution • until the colour changes • record volume of sodium hydroxide solution added • repeat procedure with the other acid Use of results • compare the two volumes of sodium hydroxide solution to find which sample P or Q is more concentrated Other points • pipette to measure volume of acid • use a few drops of indicator • swirl • use a white tile • rough titration to find approximate end point • add dropwise near the endpoint • read volume from bottom of meniscus • repeat and take a mean		4.4.2.5
Total		11	

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	contain delocalised electrons (so) electrons can move through the structure / nanotube	allow contain free electrons allow (so) electrons can carry charge through the structure / nanotube ignore throughout for through ignore current / electricity for charge	1 1	AO1 4.2.3.3
Question	Answers		Mark	AO / Spec. Ref.
10.2	Level 2: Some logically linked reasons are given. There may also be a simple judgement.		3–4	AO3 4.2.3.3 4.2.2.7
	Level 1: Relevant points are made. They are not logically linked.		1–2	
	No relevant content		0	
	Indicative content • wood is the least dense so lightest to use • aluminium is the most dense so will make the racket too heavy • carbon nanotube is the strongest so least likely to break • wood / aluminium are too weak so the racket will break more easily • carbon nanotube is the stiffest so least likely to bend out of shape • wood / aluminium are not very stiff so could bend out of shape • justified conclusion			

Question 10 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.3	(82 ² =) 6724 (nm ²) (6 x 6724 =) 40344 (nm ²) = 4.0 x 10 ⁴ (nm ²)	an answer of 4.0 x 10 ⁴ (nm ²) scores 3 marks		AO2 4.2.4.1
		an answer of 40344 (nm ²) scores 2 marks	1	
		allow 40344 (nm ²) correctly rounded to any number of significant figures	1	
		allow correct calculation using incorrectly calculated value of area of one face from step 1		
10.4	any one from: • less can be used (for the same effect) • greater surface area (to volume ratio)	allow 4.0344 x 10 ⁴ (nm ²) correctly rounded to 1 or more significant figures	1	AO3 4.2.4.2
		allow a correctly calculated and rounded conversion to standard form of an incorrect calculation of surface area		
Total			10	



Please write clearly in block capitals.

Centre number

Candidate number

Surname

Forename(s)

Candidate signature

I declare this is my own work.

GCSE

CHEMISTRY

F

Foundation Tier Paper 1

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.



J U N 2 1 8 4 6 2 1 F 0 1

IB/M/Jun21/E/17

8462/1F



0 2

IB/M/Jun21/8462/1F

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

Do not write
outside the
box

0 1 1

This question is about elements, compounds and mixtures.

0 1 1

Substance **A** contains only one type of atom.

Substance **A** does **not** conduct electricity.

Which type of substance is **A**?

Tick (✓) **one** box.

- Compound ☐
- Metallic element ☐
- Mixture ☐
- Non-metallic element ☐

[1 mark]

0 1 2

Substance **B** contains two types of atoms.

The atoms are chemically combined together in fixed proportions.

Which type of substance is **B**?

Tick (✓) **one** box.

- Compound ☐
- Metallic element ☐
- Mixture ☐
- Non-metallic element ☐

[1 mark]

Turn over ►



Do not write
outside the
box

0 1 3

What is the name of the elements in Group 0 of the periodic table?

Tick (✓) **one** box.

- Alkali metals ☐
- Halogens ☐
- Noble gases ☐
- Transition metals ☐

[1 mark]

0 1 4

Which statement about the elements in Group 0 is correct?

Tick (✓) **one** box.

- All elements in the group are very reactive. ☐
- All elements in the group form negative ions. ☐
- The boiling points increase down the group. ☐
- The relative atomic masses (A_r) decrease down the group. ☐

[1 mark]



0 1 . 5 Neon is in Group 0.

What type of particles are in a sample of neon?

Tick (✓) **one** box.

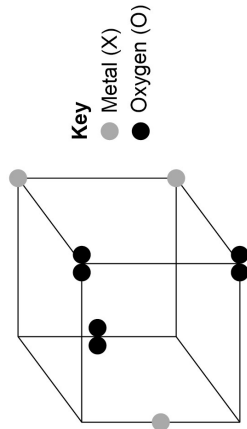
Atoms	☐
Ions	☐
Molecules	☐

[1 mark]

0 1 . 6

Figure 1 represents part of the structure of an oxide of a metal.

Figure 1



Determine the empirical formula of this oxide.

Empirical formula = XO ____

[1 mark]

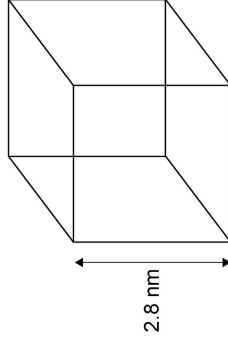
Turn over ►



A nanoparticle of a metallic element is a cube.

Figure 2 shows a diagram of the nanoparticle.

Figure 2



0 1 . 7

The surface area of a cube is given by the equation:

$$\text{surface area} = (\text{length of side})^2 \times 6$$

Calculate the surface area of the cube in Figure 2.

Give your answer to 2 significant figures.

[3 marks]

Surface area (2 significant figures) = _____ nm²



01.8

Fine and coarse particles of the metallic element are also cubes.

The length of a fine particle cube is 10 times smaller than the length of a coarse particle cube.

How does the surface area to volume ratio of the fine particle cube compare with that of the coarse particle cube?

[1 mark]

Tick (✓) **one** box.

☐

Both surface area to volume ratios are the same.

☐

The surface area to volume ratio of the fine particle is 10 times greater.

☐

The surface area to volume ratio of the fine particle is 10 times smaller.

10

Turn over for the next question

Turn over ▶



02.

This question is about chemical cells and batteries.

02.1

Three different types of battery can be used to power a TV remote control.

Table 1 gives information about these batteries.

Table 1

	Zinc-carbon battery	Alkaline battery	Nickel- metal hydride battery
Cost of battery in £ (pounds)	0.17	0.50	1.50
Rechargeable?	No	No	Yes
Time before needing to replace or recharge in months	5	12	8

Give **one** advantage of each type of battery.

[3 marks]

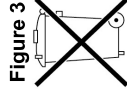
Zinc-carbon _____

Alkaline _____

Nickel-metal hydride _____

02.2

Figure 3 shows a symbol printed on batteries.



This symbol shows that batteries should not be put in household waste.

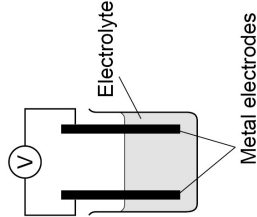
Suggest why batteries should **not** be put in household waste.

[1 mark]



Figure 4 shows a chemical cell.

Figure 4



The order of reactivity of three metals is shown below.

Iron	(Most reactive)
Tin	↑
Copper	(Least reactive)

Which combination of metal electrodes would give the highest voltage in the chemical cell in Figure 4?

[1 mark]

Tick (✓) **one** box.

- Copper and iron☐
- Iron and tin☐
- Tin and copper☐

The voltage produced by the cell in Figure 4 depends on the type of electrodes and the type of electrolyte.

Suggest **one** other factor that could affect the voltage produced.

[1 mark]

Turn over ▶

Water is produced in a hydrogen fuel cell.

Complete the word equation to show the reaction that produces water in a hydrogen fuel cell.

[2 marks]

_____ + _____ → water



This question is about Group 1 elements.

0

3

.

1

Complete **Table 2** to show the electronic structure of a potassium atom.

0

3

.

1

[1 mark]

Table 2

Atom	Number of electrons	Electronic structure
Sodium	11	2,8,1
Potassium	19	

Why do Group 1 elements have similar chemical properties?

0

3

.

2

[1 mark]

Tick (✓) **one** box.

They have the same number of electron shells.

They have the same number of outer shell electrons.

They have two electrons in the first shell.

What is the type of bonding in sodium?

0

3

.

3

[1 mark]

Tick (✓) **one** box.

Covalent

Ionic

Metallic

Turn over ►



Table 3 shows observations made when lithium, potassium and rubidium react with water.

Table 3

Element	Observations
Lithium	Bubbles slowly Floats Moves slowly
Sodium	1 _____ 2 _____
Potassium	Bubbles very quickly Melts into a ball Floats Moves very quickly Flame
Rubidium	Sinks Melts into a ball Explodes with a flame

0

3

.

4

 Give **two** observations you could make when sodium reacts with water.

Write your answers in **Table 3**.

[2 marks]



03.5

How does the reactivity of the elements change going down Group 1?

[1 mark]

03.6

Give **two** ways in which the observations in **Table 3** show the change in reactivity going down Group 1.

[2 marks]

1

2

03.7

Which gas is produced when Group 1 elements react with water?

[1 mark]

Tick (✓) **one** box.

Carbon dioxide

☐

Hydrogen

☐

Nitrogen

☐

Oxygen

☐

Turn over ►



03.8

Sodium fluoride is an ionic compound.

Figure 5 shows dot and cross diagrams for a sodium atom and a fluorine atom.

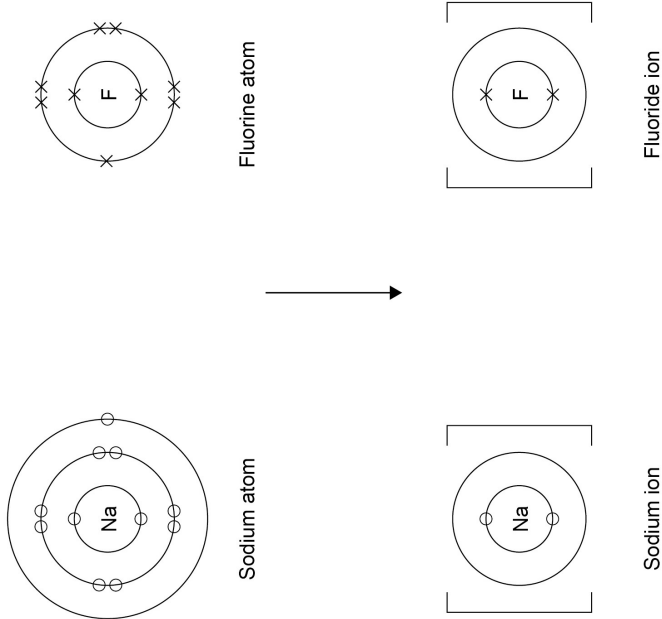
Complete **Figure 5** to show what happens when a sodium atom and a fluorine atom react to produce sodium fluoride.

You should:

- complete the electronic structures of the sodium ion and the fluoride ion
- give the charges on the sodium ion and the fluoride ion.

[3 marks]

Figure 5



Turn over for the next question

DO NOT WRITE/ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Turn over ►



A student investigated the reactivity of metals with hydrochloric acid.

This is the method used.

- 1. Measure 50 cm³ of hydrochloric acid into a polystyrene cup.
- 2. Measure the temperature of the hydrochloric acid.
- 3. Add one spatula of metal powder to the hydrochloric acid and stir.
- 4. Measure the highest temperature the mixture reaches.
- 5. Calculate the temperature increase for the reaction.
- 6. Repeat steps 1 to 5 three more times.
- 7. Repeat steps 1 to 6 with different metals.

Table 4 shows the student's results.

Table 4

Metal	Temperature increase in °C				Mean temperature increase in °C
	Trial 1	Trial 2	Trial 3	Trial 4	
Cobalt	6	7	5	9	7
Magnesium	54	50	37	55	X
Zinc	18	16	18	20	18

0 4 . 1

Calculate the mean temperature increase **X** for magnesium in Table 4.

Do **not** include the anomalous result in your calculation.

[2 marks]

X = _____ °C



0 4 . 2 Determine the order of reactivity for the metals cobalt, magnesium and zinc.

Use **Table 4**.

[1 mark]

Most reactive _____
Least reactive _____

0 4 . 3 The range of measurements either side of the mean shows the uncertainty in the mean temperature increase.

Complete the sentence.

Use **Table 4**.

[1 mark]

The mean temperature increase for zinc is $18 \pm$ _____ °C

0 4 . 4 What type of variable is the volume of hydrochloric acid in this investigation?

[1 mark]

Tick (✓) **one** box.

Control ☐
Dependent ☐
Independent ☐

0 4 . 5 Suggest **one** way of improving **step 3** in the method to give results which are more repeatable.

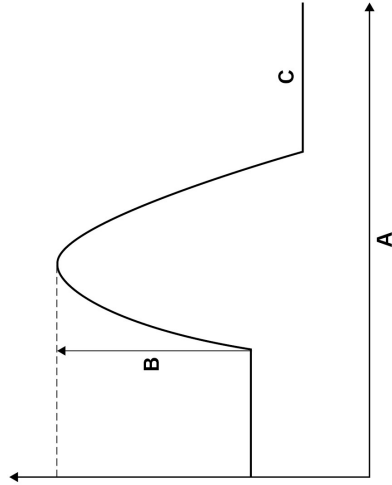
[1 mark]

Turn over ►



0 4 . 6 **Figure 6** shows a reaction profile for the reaction of magnesium with hydrochloric acid.

Figure 6



What do labels **A**, **B** and **C** represent on **Figure 6**?

Choose answers from the box.

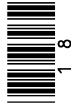
[3 marks]

activation energy	energy	overall energy change
products	progress of reaction	reactants

A _____

B _____

C _____



This question is about acids and alkalis.

0 5 . 1

Which ion do acids produce in aqueous solution?

0 5 . 1

Tick (✓) **one** box.

H^+ ☐ OH^- ☐ O^{2-} ☐

[1 mark]

Acids react with alkalis.

0 5 . 2

What is the name of this type of reaction?

[1 mark]

Tick (✓) **one** box.

Decomposition ☐
Electrolysis ☐
Neutralisation ☐
Redox ☐

Balance the equation for the reaction between sulfuric acid and potassium hydroxide.

0 5 . 3

[1 mark]



Universal indicator turns purple in potassium hydroxide solution.

0 5 . 4

What is the pH of the solution?

[1 mark]

Tick (✓) **one** box.

1 ☐ 4 ☐ 7 ☐ 14 ☐

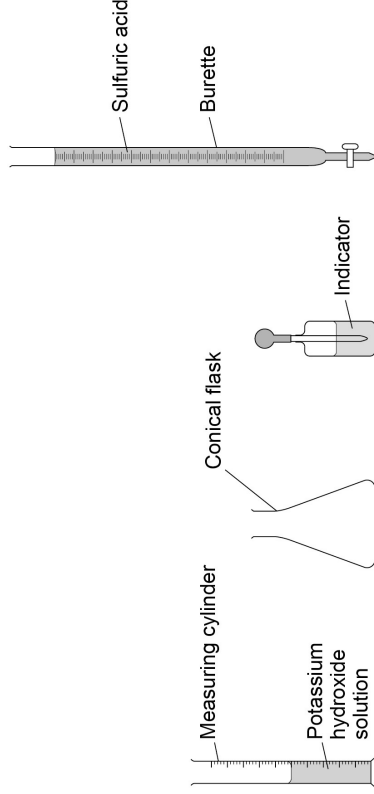
Turn over ►



A student does a titration to find the volume of sulfuric acid that reacts with 25 cm³ of potassium hydroxide solution.

Figure 7 shows the equipment used.

Figure 7



0 5 . 5

The 25 cm³ of potassium hydroxide solution is measured with the measuring cylinder.

Which piece of equipment could the student use to measure the 25 cm³ of potassium hydroxide solution more accurately?

[1 mark]

Tick (✓) **one** box.

Beaker ☐
Evaporating basin ☐
Pipette ☐
Test tube ☐



6	5	0
---	---	---

Describe how the student would use the equipment in **Figure 7** to complete the titration.

[5 marks]

[illegible]

10

Turn over for the next question

Turn over ►

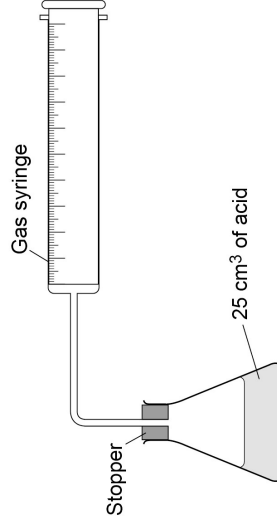
6	0
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This question is about metal carbonates.

A student investigated the reaction of copper carbonate with an acid.

Figure 8 shows the apparatus.

Figure 8



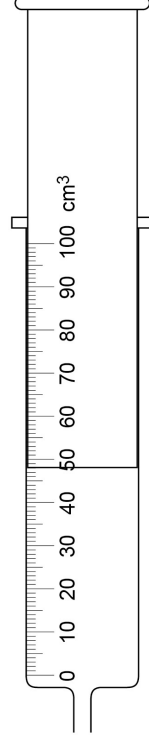
This is the method used.

1. Pour 25 cm³ of the acid into a conical flask.
2. Weigh 0.10 g of copper carbonate.
3. Remove the stopper and add the copper carbonate to the flask.
4. Quickly replace the stopper.
5. Record the maximum volume of gas collected in the gas syringe.
6. Repeat steps 1 to 5 with different masses of copper carbonate.

0	6	.	1
---	---	---	---

Figure 9 shows the gas syringe during the experiment.

Figure 9



What is the reading on the gas syringe?

[1 mark]

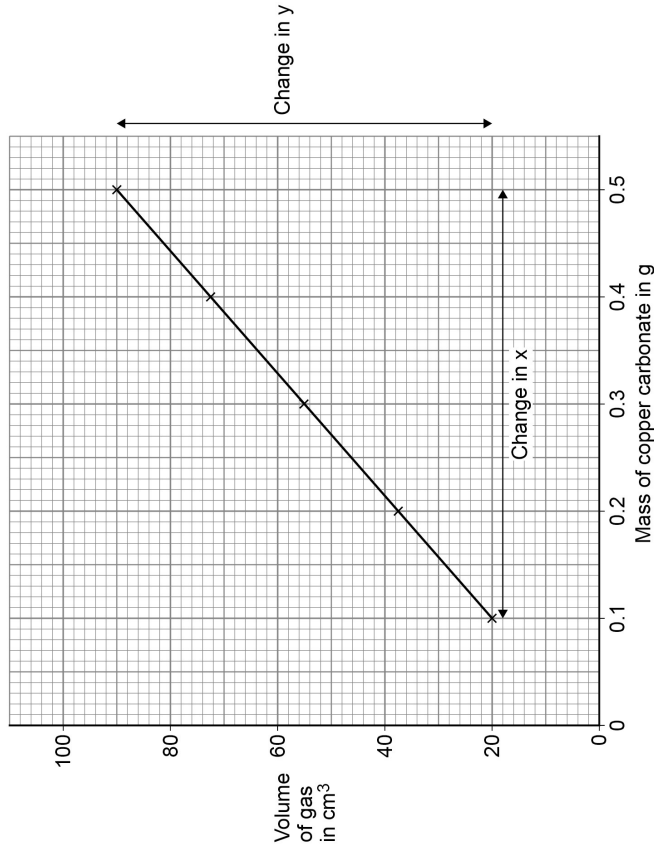
cm³

06.2

The student plotted the results on a graph.

Figure 10 shows the student's graph.

Figure 10



Determine the gradient of the line of best fit.

You should:

- calculate the values of the change in y and the change in x
- calculate the gradient of the line of best fit.

[4 marks]

Change in y = _____ cm³

Change in x = _____ g

Gradient _____

Gradient = _____ cm³/g

Turn over ►



06.3

Copper chloride was produced in the reaction.

Which acid reacts with copper carbonate to produce copper chloride?

[1 mark]

Tick (✓) **one** box.

Hydrochloric acid	☐
Nitric acid	☐
Sulfuric acid	☐

06.4

The reaction between copper carbonate and the acid produced a gas.

What was the gas?

[1 mark]

Tick (✓) **one** box.

Carbon dioxide	☐
Chlorine	☐
Hydrogen	☐
Oxygen	☐



A different student produced a pure, dry sample of copper chloride using the same reaction.

This is the method used.

- 1. Add excess copper carbonate to the acid.
- 2. Filter the mixture.
- 3. Heat the solution gently until crystals start to form.
- 4. Leave for 24 hours.
- 5. Remove the crystals.
- 6. Rinse with water and dry the crystals.

0

6

.

5

Why was the solution heated gently in **step 3**?

[1 mark]

Tick (✓) **one** box.

To evaporate acid

To evaporate copper carbonate

To evaporate water

0

6

.

6

How should the solution be heated gently in **step 3**?

[1 mark]

9

Turn over ►



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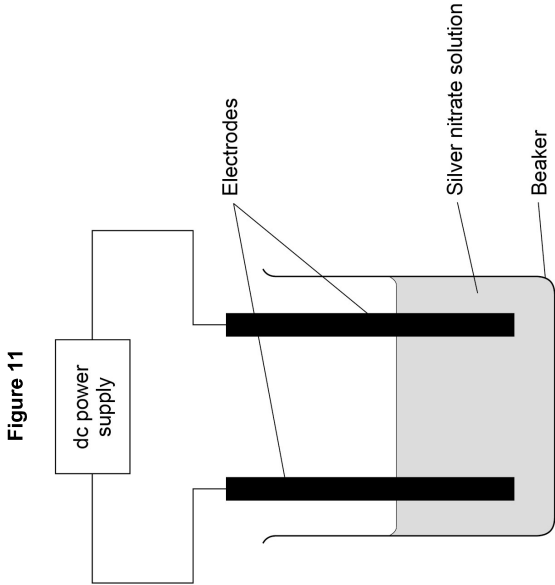
07

This question is about electrolysis.

Some students investigated the electrolysis of silver nitrate solution.

This electrolysis produces silver at the negative electrode.

Figure 11 shows the apparatus.



- This is the method used.
1. Weigh the negative electrode.
 2. Set up the apparatus shown in **Figure 11**.
 3. Switch on the power supply.
 4. Switch off the power supply after five minutes.
 5. Rinse the negative electrode with water and allow to dry.
 6. Reweigh the negative electrode.
 7. Repeat steps 1 to 6 for different times.

Turn over ►



07.1

Some silver did not stick to the negative electrode but fell to the bottom of the beaker.

The students needed to weigh this silver.

How could the students separate the silver from the silver nitrate solution?

[1 mark]

Tick (✓) **one** box.

- By chromatography ☐
- By crystallisation ☐
- By distillation ☐
- By filtration ☐

Table 5 shows the students' results.

Table 5

Time in minutes	Mass of silver in g
0	0.00
5	0.06
10	0.12
15	0.18
20	0.24
25	0.30



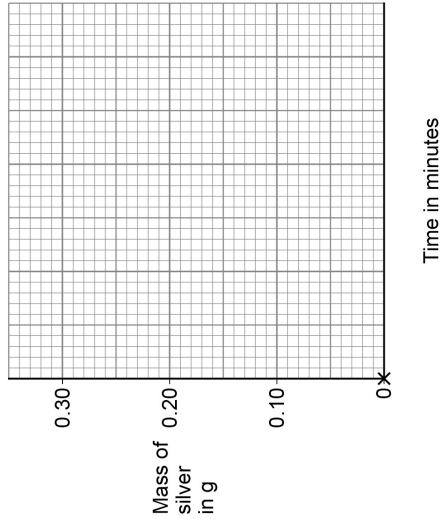
07.2 Draw a graph on Figure 12.

You should:

- use a suitable scale for the x-axis
- plot the data from Table 5
- draw a line of best fit.

[4 marks]

Figure 12



07.3 Determine the mass of silver that would be produced after 12 minutes.

Use Figure 12.

[1 mark]

Mass of silver = _____ g

Question 7 continues on the next page

Turn over ►



07.4 A student investigated the electrolysis of two aqueous salt solutions.

Hydrogen is produced at the negative electrode when the metal in the salt solution is more reactive than hydrogen.

Complete Table 6 to show what the student would observe at the negative electrode for each salt solution.

[2 marks]

Table 6

Salt solution	Observation at negative electrode
Copper sulfate	
Sodium chloride	

07.5 A teacher demonstrates the electrolysis of molten lead bromide.

The products at the electrodes are lead and bromine.

Why should the teacher do the demonstration in a fume cupboard?

[1 mark]

07.6 Two other molten compounds are electrolysed.

Complete Table 7 to show the molten compounds and the products.

[3 marks]

Table 7

Molten compound electrolysed	Product at the negative electrode	Product at the positive electrode
Zinc chloride		
	Potassium	Iodine



Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Turn over ►



This question is about carbon and its compounds.

0 8

Fullerenes are molecules of carbon atoms.

The first fullerene to be discovered was Buckminsterfullerene (C_{60}).

0 8 . 1

What shape is a Buckminsterfullerene molecule?

[1 mark]

0 8 . 2

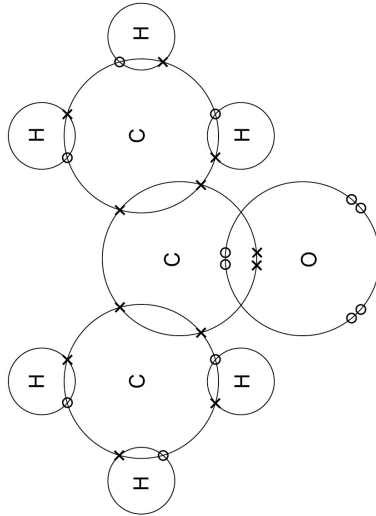
Give **one** use of a fullerene.

[1 mark]

Propanone is a compound of carbon, hydrogen and oxygen.

Figure 13 shows the dot and cross diagram for a propanone molecule.

Figure 13



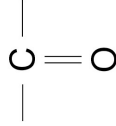
0 8 . 3

Complete **Figure 14** to show a propanone molecule.

Use a line to represent each single bond.

Use **Figure 13**.

[1 mark]

Figure 14

0 8 . 4

Determine the molecular formula of propanone.

Use **Figure 13**.

[1 mark]

Molecular formula = _____

0 8 . 5

Propanone is a liquid with a low boiling point.

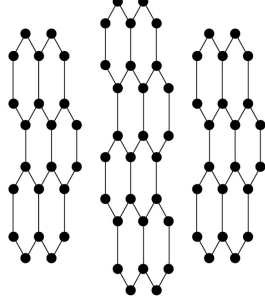
Why does propanone have a low boiling point?

Tick (✓) **one** box.

[1 mark]

The covalent bonds are strong. ☐The covalent bonds are weak. ☐The intermolecular forces are strong. ☐The intermolecular forces are weak. ☐**Turn over** ►

0 8 . 6

Figure 15 represents the structure of graphite.**Figure 15**

Explain why graphite is:

- a good electrical conductor
- soft and slippery.

You should answer in terms of structure and bonding.

[6 marks]

Turn over for the next question

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Turn over ▶



This question is about atomic structure and the periodic table.

Gallium (Ga) is an element that has two isotopes.

Give the meaning of 'isotopes'.

You should answer in terms of subatomic particles.

[2 marks]

Table 8 shows the mass numbers and percentage abundances of the isotopes of gallium.

Table 8

Mass number	Percentage abundance (%)
69	60
71	40

Calculate the relative atomic mass (A_r) of gallium.

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass (1 decimal place) =



Gallium (Ga) is in Group 3 of the modern periodic table.

0

9

.

3

 Give the numbers of electrons and neutrons in an atom of the isotope $^{69}_{31}\text{Ga}$ [2 marks]

Number of electrons _____

Number of neutrons _____

0

9

.

4

 What is the most likely formula of a gallium ion? [1 mark]

Tick (✓) **one** box.

- Ga⁺

☐
- Ga⁻

☐
- Ga³⁺

☐
- Ga³⁻

☐

0

9

.

5

 Gallium was discovered six years after Mendeleev published his periodic table. Give **two** reasons why the discovery of gallium helped Mendeleev's periodic table to become accepted. [2 marks]

- 1 _____
- 2 _____

9

Turn over ►



This question is about the extraction of metals.

Element **R** is extracted from its oxide by reduction with hydrogen.

The equation for the reaction is:



1

0

.

1

 The sum of the relative formula masses (M_r) of the reactants ($3\text{H}_2 + \text{RO}_3$) is 150

Calculate the relative atomic mass (A_r) of **R**.

Relative atomic masses (A_r): H = 1 O = 16

[2 marks]

Relative atomic mass (A_r) of **R** = _____

1

0

.

2

 Identify element **R**.

You should use:

- your answer to **question 10.1**
- the periodic table.

[1 mark]

Identity of **R** = _____



10.3

Carbon is used to extract tin (Sn) from tin oxide (SnO₂).

The equation for the reaction is:



Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12 O = 16 Sn = 119

[3 marks]

Percentage atom economy = _____ %

Question 10 continues on the next page

Turn over ►



10.4

Tungsten (W) is a metal.

Tungsten is extracted from tungsten oxide (WO₃).

All other solid products from the extraction method must be separated from the tungsten.

Table 9 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 9

Method	Reactant	Relative cost of reactant	Products
1	Carbon	Low	Tungsten solid Carbon dioxide gas Tungsten carbide solid
2	Hydrogen	High	Tungsten solid Water vapour
3	Iron	Low	Tungsten solid Iron oxide solid

Evaluate the three possible methods for extracting tungsten from tungsten oxide. [4 marks]

END OF QUESTIONS



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Write the question numbers in the left-hand margin.

Question
number

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outside the
box*



[illegible][illegible]

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	non-metallic element		1	AO3 4.1.1.1 4.1.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	compound		1	AO1 4.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	noble gases		1	AO1 4.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	the boiling points increase down the group		1	AO1 4.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	atoms		1	AO1 4.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	XO ₂		1	AO2 4.2.1.3



Question 1 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	$(2.8)^2 \times 6$	allow an answer correct to 2 significant figures resulting from an incorrect attempt at the calculation	1	AO2 4.2.4.1
	= 47.04		1	
	= 47 (nm ²)		1	
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.8	the surface area to volume ratio of the fine particle is 10 times greater		1	AO1 4.2.4.1
Total			10	

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(zinc-carbon) cheap(est)	allow do not have to be thrown away	1	AO3 4.5.2.1
	(alkaline) long(est) lasting		1	
	(nickel-metal hydride) rechargeable		1	
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	any one from:	allow (batteries) can ignite / explode ignore dangerous	1	AO3 4.5.2.1
	(metal / alkaline waste) can be toxic / harmful / corrosive (metal / alkaline waste) could cause pollution in landfill sites - recycling would save resources			
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	copper and iron		1	AO2 4.5.2.1

Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	any one from: - temperature (of electrolyte / solution) - concentration (of electrolyte / solution)	ignore type of electrode / electrolyte allow size / mass / length of electrode allow surface area of electrode allow distance between electrodes allow volume of solution / electrolyte	1	AO3 4.5.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	hydrogen oxygen	allow H ₂ allow O ₂	1 1	AO2 4.5.2.2
Total			8	

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	2,8,8,1		1	AO2 4.1.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	they have the same number of outer shell electrons		1	AO1 4.1.2.1 4.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	metallic		1	AO1 4.2.1.5 1-3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	any two from: - bubbles (very) quickly - melts (into a ball) - floats - moves (very) quickly	allow flame	2	AO1 4.1.2.5 4.4.1.2

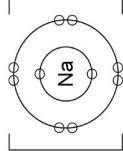
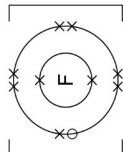
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	(reactivity) increases (down the group)		1	AO1 4.1.2.5

Question 3 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	any two from: - increasing speed of movement - increasing rate of bubble production - doesn't melt → melts - no flame → flame or flame → explosion		2	AO3 4.1.2.5 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	hydrogen		1	AO1 4.1.2.5 4.4.1.2

Question 3 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.8	sodium ion structure 2,8 fluoride ion structure 2,8	allow any combination of circles, dots, crosses or e ⁽⁻⁾	1	AO2 4.2.1.2
	+ charge on sodium ion and – charge on fluoride ion		1	
	an answer of  sodium ion +  fluoride ion		1	
scores 3 marks				

Total	12
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Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	$\frac{54 + 50 + 55}{3}$		1	AO3
	= 53 (°C)	if no other mark awarded allow 1 mark for $\frac{54 + 50 + 37 + 55}{4} = 49 \text{ (°C)}$	1	AO2 4.4.1.2 4.5.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	(most reactive) magnesium zinc (least reactive) cobalt	allow ecf from question 04.1	1	AO3 4.4.1.2 4.5.1.1 RPA4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	(18 ±) 2 (°C)		1	AO2 4.3.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	control		1	AO1 4.4.1.2 4.5.1.1 RPA4

Question 4 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	use the same mass of metal / powder		1	AO3 4.4.1.2 4.5.1.1 RPA4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(A) progress of reaction		1	AO1 4.5.1.2
	(B) activation energy		1	
	(C) products		1	

Total			9	
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Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	H ⁺		1	AO1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	neutralisation		1	AO1 4.4.2.2 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	$\text{H}_2\text{SO}_4 + 2\text{KOH} \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$	allow multiples	1	AO2 4.1.1.1 4.4.2.2 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	14		1	AO1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	pipette		1	AO3 4.4.2.5 RPA2

Question 5 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	add potassium hydroxide (solution) to the (conical) flask		1	AO1 4.4.2.5 RPA2
	add (a few drops of) indicator		1	
	add the (sulfuric) acid (from the burette)		1	
	until the colour (of the indicator) changes		1	
	read the volume from the burette		1	

Total		10
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Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	48 (cm ³)		1	AO2 4.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(change in y =) 70 (cm ³)		1	AO2 4.4.2.2
	(change in x =) 0.4 (g)		1	
	(gradient =) $\frac{70}{0.4}$	allow correct use of incorrectly derived values for change in y and / or change in x	1	
	= 175 (cm ³ /g)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	hydrochloric acid		1	AO2 4.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	carbon dioxide		1	AO1 4.4.2.2

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	to evaporate water		1	AO1 4.4.2.3 RPA1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	using a (boiling) water bath or using an electric heater		1	AO1 4.4.2.3 RPA1

Total			9	
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Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	by filtration		1	AO3 4.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	10 minutes per 2 cm on x-axis	allow 5 minutes per 1 cm on x-axis	1	AO2 4.4.3.4
	all points plotted correctly	allow a tolerance of $\pm \frac{1}{2}$ a small square allow 1 mark for 3 or 4 points plotted correctly	2	
	line of best fit	allow line of best fit drawn using incorrect plots	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	0.14 (g)	allow ecf from question 07.2 allow a tolerance of $\pm \frac{1}{2}$ a small square	1	AO2 4.4.3.4

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	(copper sulfate solution) pink / orange / red / brown solid	allow copper plating allow metal for solid	1	AO2 4.4.1.2 4.4.3.4 RPA3
	(sodium chloride solution) bubbles / effervescence / fizzing	if no other mark awarded allow 1 mark for copper and hydrogen	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	toxic / poisonous (fumes)	allow harmful / corrosive (fumes) ignore dangerous / deadly / lethal	1	AO3 4.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.									
07.6	<table><tr><th>Molten compound electrolysed</th><th>Product at the negative electrode</th><th>Product at the positive electrode</th></tr><tr><td>(zinc chloride)</td><td>zinc (1)</td><td>chlorine (1)</td></tr><tr><td>potassium iodide</td><td>(potassium)</td><td>(iodine)</td></tr></table>	Molten compound electrolysed	Product at the negative electrode	Product at the positive electrode	(zinc chloride)	zinc (1)	chlorine (1)	potassium iodide	(potassium)	(iodine)	allow 1 mark if zinc and chlorine the wrong way round	2	AO2 4.4.3.2
		Molten compound electrolysed	Product at the negative electrode	Product at the positive electrode									
		(zinc chloride)	zinc (1)	chlorine (1)									
		potassium iodide	(potassium)	(iodine)									
1													

Total			12
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Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	spherical	allow ball-shaped ignore round / circular	1	AO1 4.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	any one from: • drug delivery (round the body) • hydrogen storage • anti-oxidants • reduction of bacterial growth • catalysts • (cylindrical fullerenes for) strengthening materials • (spherical fullerenes for) lubricants		1	AO1 4.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	$ \begin{array}{ccccccc} & & \text{H} & & & & \\ & & & & & & \\ \text{H} & - & \text{C} & - & \text{C} & - & \text{H} \\ & & & & & & \\ & & \text{H} & & \text{O} & & \end{array} $		1	AO2 4.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	C ₃ H ₆ O	allow CH ₃ COCH ₃ allow elements in any order	1	AO2 4.2.1.4

Question 8 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	the intermolecular forces are weak		1	AO1 4.2.2.1 4.2.2.4

Question	Answers	Mark	AO/ Spec. Ref
08.6	Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.2.2.6 4.2.3.2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • bonds are covalent • giant / macromolecular structure • three (covalent) bonds per carbon atom or • only three electrons per carbon atom used in (covalent) bonds • so one electron per carbon atom (is delocalised) • these delocalised electrons • can move through the structure • carrying (electrical) charge • so graphite conducts electricity • layered structure • of (interlocking) hexagonal rings • with weak (intermolecular) forces between layers or • no (covalent) bonds between layers • so the layers can slide over each other • so graphite is soft and slippery		

Total		11
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Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	(atoms with the) same number of protons	allow atoms with the same atomic number allow atoms of the same element	1	AO1 4.1.1.4 4.1.1.5
	(but with) different numbers of neutrons	ignore the same number of electrons ignore (but with) different mass numbers	1	
		do not accept (but with) different relative atomic mass		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	$(A_r =) \frac{(69 \times 60) + (71 \times 40)}{100}$		1	AO2 4.1.1.6
	= 69.8		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	(number of electrons) = 31		1	AO2 4.1.1.4 4.1.1.5
	(number of neutrons) = 38		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	Ga ³⁺		1	AO3 4.2.1.2

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	(gallium) fitted in a gap (Mendeleev had left)		1	AO2 4.1.2.2
	(gallium's) properties were predicted correctly (by Mendeleev)	allow (gallium's) properties matched the rest of the group	1	
Total			9	

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	$(3 \times M_r \text{ H}_2\text{O} = 3 \times (2 + 16) =) 54$		1	AO2 4.3.1.1
	$(A_r \text{ R} = 150 - 54 =) 96$	ignore units	1	4.3.1.2
	alternative approach: $(M_r \text{ RO}_3 = 150 - 6 =) 144$ (1) $(A_r \text{ R} = 144 - (3 \times 16) =) 96$ (1)	ignore units		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	$(\text{R} =) \text{molybdenum} / \text{Mo}$	allow ecf from question 10.1	1	AO3 4.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.3	$(\text{total } M_r \text{ of reactants}) = 163$		1	AO2 4.3.1.2
	$(\% \text{ atom economy} =) \frac{119}{163} (\times 100)$	allow correct use of an incorrectly calculated value of total M_r	1	4.3.3.2
	$= 73$ (%)	allow 73.00613 (%) correctly rounded to at least 2 significant figures	1	

Question 10 continued

Question	Answers	Mark	AO / Spec. Ref.
10.4	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3 4.4.1.3
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content - carbon and iron are the cheapest reactants - hydrogen is the most expensive reactant - separating solid products is expensive - separating solid products is time consuming - in method 1, tungsten needs to be separated from tungsten carbide - in method 1, some tungsten is lost as tungsten carbide - in method 1, the carbon dioxide produced will escape - in method 2, the water vapour produced will escape - in method 2, no separation of solids is needed - in method 3, tungsten needs to be separated from iron oxide		

Total		10
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Please write clearly in block capitals.

Centre number Candidate number

Surname

Forename(s)

Candidate signature I declare this is my own work.

GCSE CHEMISTRY

Foundation Tier Paper 1

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.



IB/M/Jun22/E10

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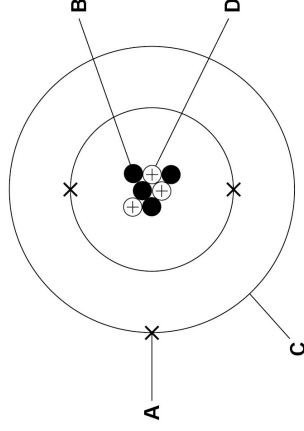
0 1

This question is about atoms.

0 1 . 1

Figure 1 represents an atom of an element.

Figure 1



Draw **one** line from each name to the correct label.

[2 marks]

Name

Label

Neutron

A

Proton

B

C

D



0 2

IB/M/Jun22/8462/1F

- 0 1 . 2
- An atom of element **Y** has:
- an atomic number of 9
 - a mass number of 19.

Give the number of electrons and the number of neutrons in this atom.

Choose answers from the box.

[2 marks]

1	9	10	19	28
---	---	----	----	----

Number of electrons _____

Number of neutrons _____

Question 1 continues on the next page

Turn over ►



Table 1 shows information about two isotopes of element **Z**.

Table 1

	Mass number	Percentage abundance (%)
Isotope A	39	93.3
Isotope B	41	6.7

0 1 . 3

Calculate the relative atomic mass (A_r) of element **Z**.

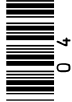
Use **Table 1** and the equation:

$$A_r = \frac{(\text{mass number} \times \text{percentage}) \text{ of isotope A} + (\text{mass number} \times \text{percentage}) \text{ of isotope B}}{100}$$

Give your answer to 3 significant figures.

[3 marks]

A_r (3 significant figures) = _____



Do not write
outside the
box

0

1

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4

Suggest the identity of element Z.

Use the periodic table.

[1 mark]

Element Z _____

0

1

.

5

Complete the sentence.

Choose the answer from the box.

[1 mark]

electrons	neutrons	protons
-----------	----------	---------

Isotopes of the same element have different mass numbers because the isotopes have different numbers of _____.

—

9

Turn over for the next question

Turn over ►



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outside the
box

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ANSWER IN THE SPACES PROVIDED



This question is about elements, compounds and mixtures.

0 2 . 1

Which type of substance is hydrogen?

0 2 . 1

Tick (✓) one box.

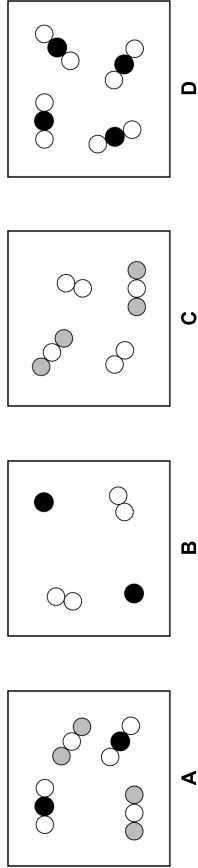
Element	☐
Compound	☐
Mixture	☐

[1 mark]

The diagrams in Figure 2 represent different substances.

● and ○ represent atoms of three different elements.

Figure 2



Use Figure 2 to answer questions 02.2 and 02.3.

0 2 . 2 Which diagram represents a mixture of compounds?

[1 mark]

A	☐	B	☐	C	☐	D	☐
---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------

0 2 . 3 Which diagram represents a mixture of elements?

[1 mark]

A	☐	B	☐	C	☐	D	☐
---	--------------------------	---	--------------------------	---	--------------------------	---	--------------------------

Turn over ►

Substances can be separated from mixtures by using different methods.

0 2 . 4

Complete the sentence.

[1 mark]

Sand can be separated from a mixture of sand and water by

_____.

A mixture of four liquids was fractionally distilled.

Figure 3 shows the apparatus used.

Figure 3

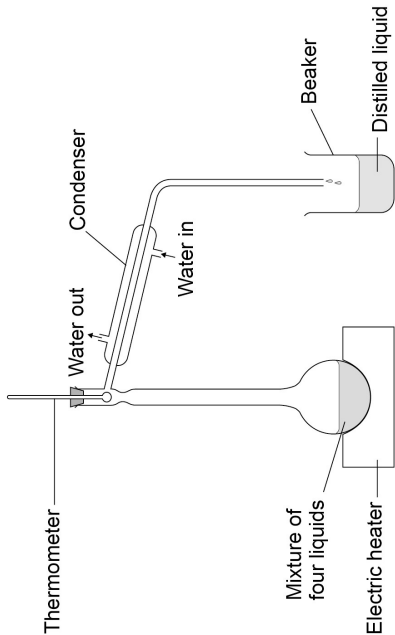


Table 2 shows the boiling points of the four liquids in the mixture.

Table 2

Liquid	Boiling point in °C
A	97
B	138
C	78
D	118

Which liquid in **Table 2** would distil and be collected in the beaker first? **[1 mark]**

Liquid _____

Suggest what would happen to the temperature of the water as the water flows through the condenser. **[1 mark]**

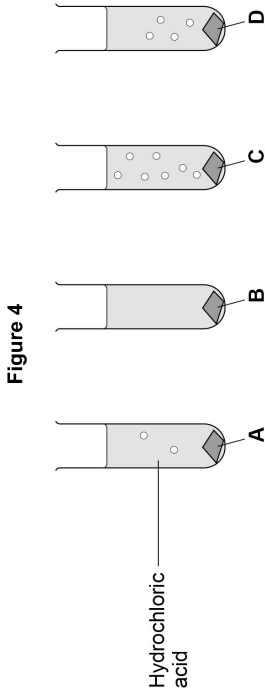
Describe how to obtain sodium chloride crystals from sodium chloride solution by crystallisation. **[2 marks]**

Turn over for the next question

Turn over ►



This question is about acids.
A student added four metals, **A**, **B**, **C** and **D** to hydrochloric acid.
Figure 4 shows the rate of bubbling in each tube.



Use **Figure 4** to answer questions **03.1** and **03.2**.

Which metal is copper? **[1 mark]**

Tick (✓) **one** box.

A	B	C	D
--------------------------------	--------------------------------	--------------------------------	--------------------------------

Which metal is the most reactive? **[1 mark]**

Tick (✓) **one** box.

A	B	C	D
--------------------------------	--------------------------------	--------------------------------	--------------------------------

A metal oxide reacts with an acid to produce zinc sulfate and water. **[2 marks]**

Name the metal oxide _____

Name of acid _____



0

3

.

4

 Universal indicator is used to measure the pH of a solution.

Draw **one** line from each pH to the colour of universal indicator in a solution with that pH.

[2 marks]

pH	Colour of universal indicator
1	Blue
	Green
	Purple
7	Red
	Yellow

Question 3 continues on the next page

Turn over ►



A student reacts an acid with an alkali in a titration.

0

3

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 What is the type of reaction when an acid reacts with an alkali?

[1 mark]

Tick (✓) **one** box.

Combustion	
Decomposition	
Neutralisation	

0

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6

Figure 5 shows a piece of equipment used to measure the volume of the acid in the titration.

Figure 5



What is the name of this piece of equipment?

[1 mark]

Tick (✓) **one** box.

Burette	
Pipette	
Syringe	
Tube	



Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Turn over ►



This question is about the periodic table.

Figure 6 shows an early version of the periodic table published by a scientist.

Figure 6

H									
Li	Be	B	C	N	O	F			
Na	Mg	Al	Si	P	S	Cl			
K	Ca	?	Ti	V	Cr	Mn	Fe	Co	Ni
	Cu	Zn	?	As	Se				
Rb	Sr	Y	Zr	Nb	Mo	?	Ru	Rh	Pd
	Ag	Cd	In	Sb	Te	I			

0 4 . 1

The scientist left gaps in the periodic table in Figure 6.

Each gap is represented by a question mark (?).

Give **one** reason why the scientist left gaps in this periodic table.

[1 mark]

0 4 . 2

Which scientist published the periodic table in Figure 6?

Tick (✓) **one** box.

Bohr

Chadwick

Mendeleev

[1 mark]



0

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3

 The modern periodic table is different from the periodic table in **Figure 6**.

One extra group of elements has been added.

What is the name of the extra group of elements in the modern periodic table? **[1 mark]**

Tick (✓) **one** box.

- Alkali metals

☐
- Halogens

☐
- Noble gases

☐

0

4

.

4

 Why do the elements in Group 1 of the modern periodic table have similar chemical properties?

Tick (✓) **one** box.

- The elements all form negative ions.

☐
- The elements all have one electron in the outer shell.

☐
- The elements all have the same number of shells.

☐

Question 4 continues on the next page

Turn over ▶



0

4

.

5

Table 3 shows the melting points of the first five elements going down Group 1.

Table 3

Element	Melting point in °C
Lithium	181
Sodium	98
Potassium	X
Rubidium	39
Caesium	29

Predict value **X**.

[1 mark]

X = _____ °C

0

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 Give **one** observation you would see when a small piece of potassium is added to water.

[1 mark]



0 4 . 7 Table 4 shows information about the first five elements going down Group 7.

Table 4

Element	State at 150 °C	Symbol	Formula of the compound with hydrogen
Fluorine	gas	F	HF
Chlorine	_____	Cl	HCl
Bromine	gas	Br	HBr
Iodine	liquid	I	HI
Astatine	solid	At	_____

Complete Table 4.

[2 marks]

0 4 . 8

The elements in Group 7 consist of molecules.

What is the formula of a molecule of bromine?

[1 mark]

Tick (✓) one box.

Br	☐
Br ₂	☐
Br ²	☐
2Br	☐

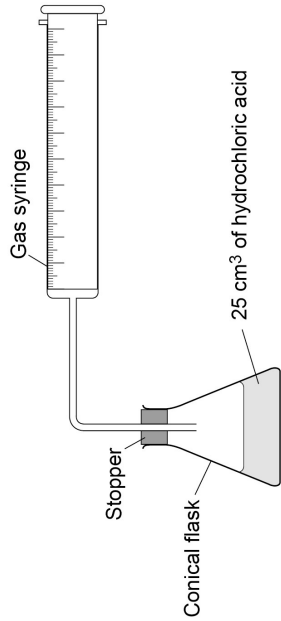
9

Turn over ►

0 5 A student investigated the reaction of magnesium with hydrochloric acid.

Figure 7 shows the apparatus used.

Figure 7



This is the method used.

1. Set up the apparatus as shown in Figure 7.

2. Cut 10 mm of magnesium ribbon.

3. Remove the stopper.

4. Add the magnesium ribbon to the conical flask.

5. Replace the stopper as quickly as possible.

6. Record the final reading on the gas syringe when the reaction has stopped.

7. Repeat steps 1 to 6 three more times.

8. Repeat steps 1 to 7 with different lengths of magnesium ribbon.



0

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Which gas is produced when magnesium reacts with hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

Carbon dioxide

☐

Chlorine

☐

Hydrogen

☐

Oxygen

☐

0

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2

What was the independent variable in the investigation?

[1 mark]

0

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3

Give **one** control variable in the investigation.

[1 mark]

Question 5 continues on the next page

Turn over ►



Table 5 shows the results for one length of magnesium ribbon.

Table 5

	Trial 1	Trial 2	Trial 3	Trial 4
Volume of gas produced in cm ³	19	36	37	32

One of the results was anomalous.

0

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Which trial in **Table 5** gave an anomalous result?

[1 mark]

Trial

0

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Suggest **one** reason for the anomalous result in **Table 5**.

[1 mark]

0

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Table 6 shows the mean volume of gas produced for each length of magnesium ribbon.

Table 6

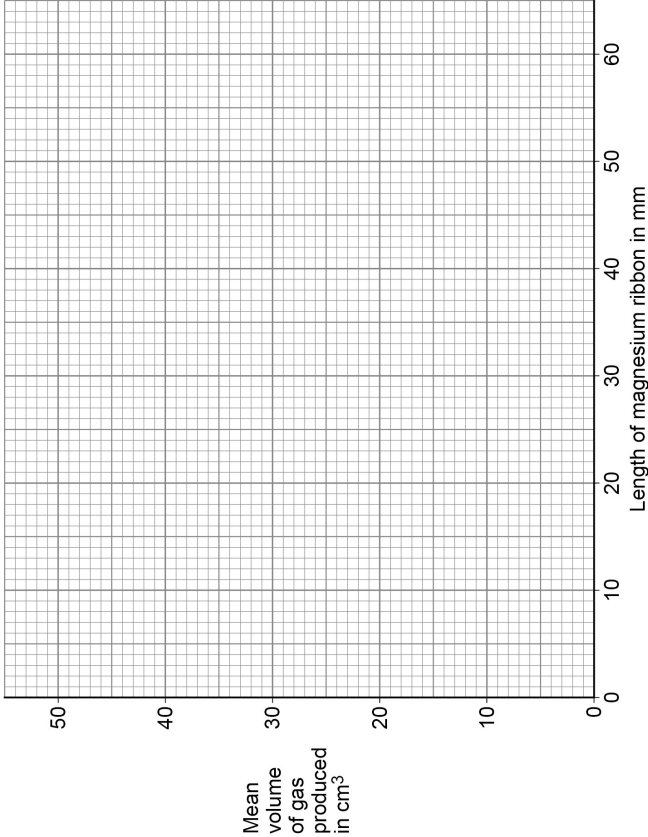
Length of magnesium ribbon in mm	10	20	30	40	50	60
Mean volume of gas produced in cm ³	7	14	21	28	35	42

Plot the data from **Table 6** on **Figure 8**.

Draw a line of best fit.

[3 marks]

Figure 8



0

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7

 Complete the sentence.

[1 mark]

As the length of the magnesium ribbon increases, the mean volume of gas produced

9

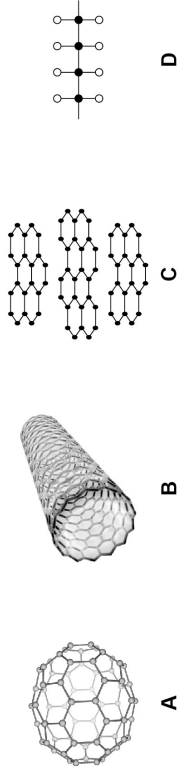
Turn over ►



This question is about carbon and compounds of carbon.

Figure 9 shows diagrams that represent different structures.

Figure 9



Use **Figure 9** to answer questions **06.1** and **06.2**.

0

6

.

1

Which diagram represents graphite?

[1 mark]

Tick (✓) **one** box.

A

☐

B

☐

C

☐

D

☐

0

6

.

2

Which diagram represents poly(ethene)?

[1 mark]

Tick (✓) **one** box.

A

☐

B

☐

C

☐

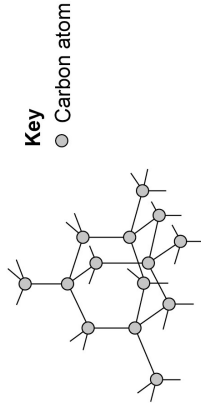
D

☐



Figure 10 represents the structure of diamond.

Figure 10



0 6 . 3 How many covalent bonds does each carbon atom form in diamond?

[1 mark]

0 6 . 4 Which is a property of diamond?

[1 mark]

Tick (✓) **one** box.

Conducts electricity

☐

Low melting point

☐

Very hard

☐

Question 6 continues on the next page

Turn over ►

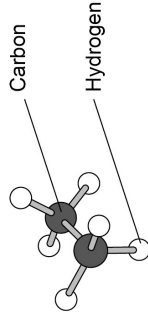


2 3

IB/M/Jun22/8462/1F

Figure 11 shows a model of a molecule.

Figure 11



Complete the molecular formula of the molecule.

[1 mark]

Molecular formula = C H

Carbonic acid is a compound of carbon.

The formula of carbonic acid is H₂CO₃

0 6 . 6 Which ion is produced by carbonic acid in aqueous solution?

[1 mark]

Tick (✓) **one** box.

H⁺

☐

OH⁻

☐

O²⁻

☐

0 6 . 7 Calculate the relative formula mass (*M_r*) of carbonic acid (H₂CO₃).

[2 marks]

Relative atomic masses (*A_r*): H = 1 C = 12 O = 16

Relative formula mass (*M_r*) =

8



2 4

IB/M/Jun22/8462/1F

07.1

This question is about small particles.

07.1

Coarse particles, fine particles and nanoparticles are all small particles.

Which is the largest particle?

Tick (✓) **one** box.

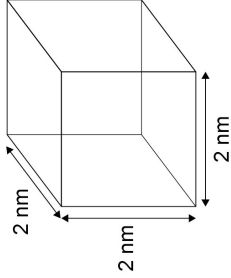
Coarse particle	☐
Fine particle	☐
Nanoparticle	☐

[1 mark]

07.2

Figure 12 shows a cubic nanoparticle.

Figure 12



The surface area of the cubic nanoparticle is 24 nm².

Calculate:

- the volume of the cubic nanoparticle
- the simplest surface area : volume ratio of the cubic nanoparticle.

[4 marks]

Volume = _____ nm ³
Simplest surface area : volume ratio = _____ : 1

Turn over ►



07.3

Catalysts made of nanoparticles are often more effective than catalysts made of normal sized particles.

Complete the sentences.

[2 marks]

Compared with normal sized particles, the surface area to volume ratio of nanoparticles is _____.

This means that the mass of a nanoparticle catalyst needed to have the same effect as the same catalyst made of normal sized particles is _____.

07.4

Silver nanoparticles can be added to the material used to make socks.

Some facts about silver and bacteria are:

- silver nanoparticles are small enough to be breathed in
- silver is very expensive
- silver can kill bacteria
- bacteria can cause infections
- bacteria can break down sweat to produce unpleasant smells.

Suggest **one** advantage and **one** disadvantage of wearing socks containing silver nanoparticles.

[2 marks]

Advantage _____
Disadvantage _____



0 7 . 5

- An atom has a radius of 1×10^{-10} m.
A spherical nanoparticle has a radius of 1×10^{-8} m.

How many times larger is the radius of the nanoparticle than the radius of the atom?
[1 mark]

Tick (✓) one box.

- 2 times
- 10 times
- 100 times
- 200 times

10

Turn over for the next question

Turn over ►

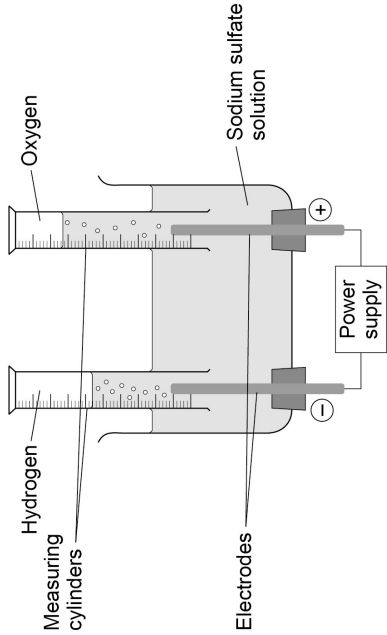


0 8

- This question is about electrolysis.
Ionic compounds decompose when they are electrolysed.
A student electrolyses sodium sulfate solution.

Figure 13 shows the apparatus used.

Figure 13



0 8 . 1

Sodium sulfate solution contains:

- hydrogen ions
- hydroxide ions
- sodium ions
- sulfate ions.

Oxygen is produced at the positive electrode.

Which ions are discharged at the positive electrode to produce oxygen?

[1 mark]

Tick (✓) one box.

- Hydrogen ions
- Hydroxide ions
- Sodium ions
- Sulfate ions



0

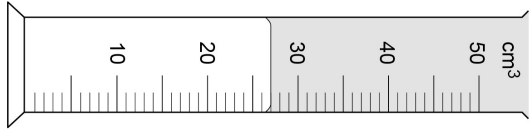
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2

Figure 14 shows one of the measuring cylinders during the electrolysis.

Figure 14



What is the volume of gas in the measuring cylinder?

[1 mark]

Volume of gas = _____ cm³

0

8

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3

 Ionic compounds can be electrolysed when molten or dissolved in water.

Why can ionic compounds **not** be electrolysed when solid?

You should answer in terms of ions.

[1 mark]

Turn over ►



0

8

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4

Table 7 shows the products of electrolysis of two molten compounds.

Table 7

Molten compound	Product at negative electrode	Product at positive electrode
Potassium iodide	Potassium	_____
Zinc bromide	_____	Bromine

Complete **Table 7**.

[2 marks]

0

8

.

5

The electrolysis of molten sodium chloride is used to extract sodium metal.

Why is sodium metal extracted by electrolysis instead of by reduction with carbon?

[1 mark]

Tick (✓) **one** box.

Carbon conducts electricity.

Carbon is less reactive than sodium.

Carbon reduction uses more energy.

0

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6

What is the state symbol for molten sodium chloride?

[1 mark]

Tick (✓) **one** box.

(aq)

(g)

(l)

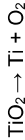
(s)



0 8 . 7

Titanium can be produced from titanium oxide by electrolysis.

The equation for the reaction is:



Calculate the percentage atom economy for the production of titanium from titanium oxide by electrolysis.

Use the equation:

Percentage atom economy = $\frac{\text{Relative atomic mass of desired product}}{\text{Relative formula mass of reactant}} \times 100$

Relative atomic mass (A_r): $\text{Ti} = 48$

Relative formula mass (M_r): $\text{TiO}_2 = 80$

[2 marks]

Percentage atom economy = _____ %

—
9

Turn over for the next question

Turn over ►

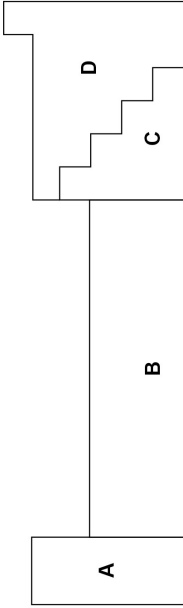


0 9 . 1

This question is about metals and non-metals.

Figure 15 shows an outline of part of the periodic table.

Figure 15



0 9 . 1

Element **Q** is a dull solid with a melting point of 44 °C.

Element **Q** does not conduct electricity.

Which section of the periodic table in **Figure 15** is most likely to contain element **Q**?

[1 mark]

Tick (✓) **one** box.

A

B

C

D

0 9 . 2

Element **R** forms ions of formula **R²⁺** and **R³⁺**.

Which section of the periodic table in **Figure 15** is most likely to contain element **R**?

[1 mark]

Tick (✓) **one** box.

A

B

C

D

0 9 . 3

Give **two** differences between the physical properties of the elements in Group 1 and those of the transition elements.

[2 marks]

1

2



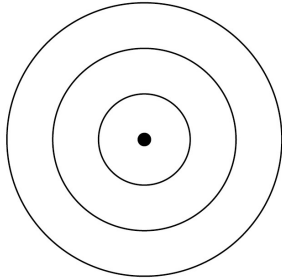
09.4

Complete **Figure 16** to show the electronic structure of an aluminium atom.

Use the periodic table.

[1 mark]

Figure 16



09.5

Aluminium is a metal.

Describe how metals conduct electricity.

Answer in terms of electrons.

[3 marks]

09.6

Name the type of bonding in compounds formed between metals and non-metals.

[1 mark]

Turn over ►



09.7

Magnesium oxide is a compound formed from the metal magnesium and the non-metal oxygen.

Describe what happens when a magnesium atom reacts with an oxygen atom.

You should refer to electrons in your answer.

[4 marks]



1 0 . 2

Determine the gradient of the line of best fit in **Figure 17**.

Use the equation:

Gradient = $\frac{\text{Change in highest temperature}}{\text{Change in mass}}$

Give the unit.

[5 marks]

Gradient = _____ Unit _____

1 0 . 3

The initial temperature of the reaction mixture is where the line of best fit would meet the *y*-axis.

Determine the initial temperature of the reaction mixture.

Show your working on **Figure 17**.

[2 marks]

Initial temperature of the reaction mixture = _____ °C

Turn over ►



1 0 . 4

Another student repeated the investigation but added sodium carbonate until the sodium carbonate was in excess.

Which sketch graph shows the results obtained when sodium carbonate was added until in excess?

[1 mark]

Tick (✓) **one** box.

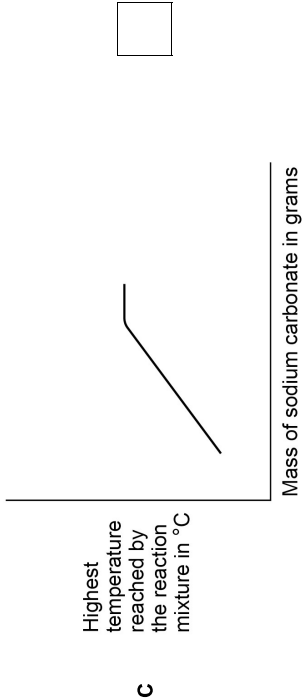
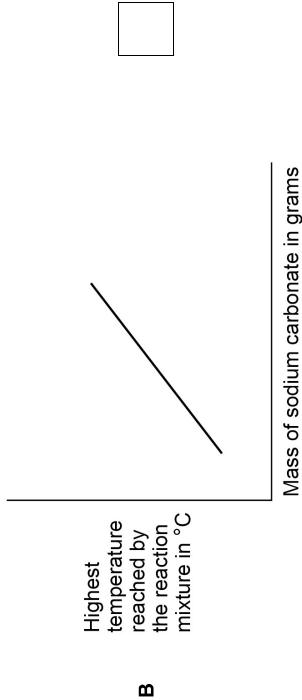
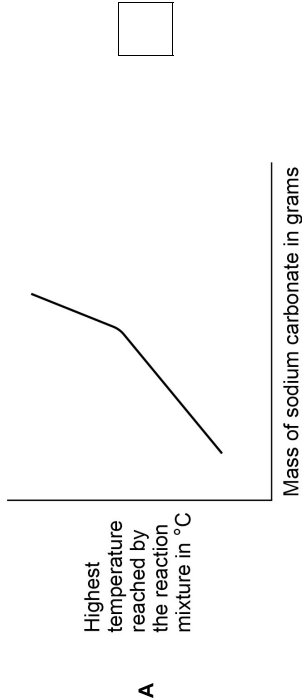
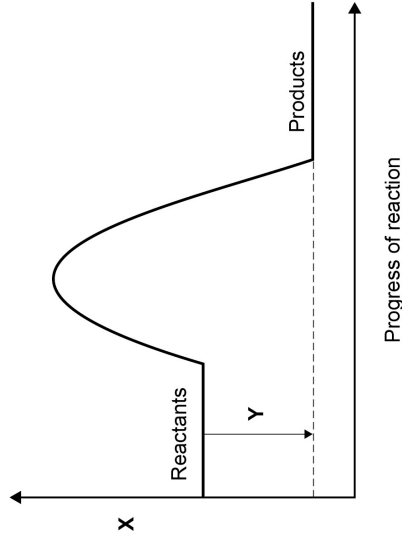


Figure 18 shows a reaction profile for the reaction of sodium carbonate with hydrochloric acid.

Figure 18



1 0 . 5 What do labels **X** and **Y** represent on **Figure 18**?

[2 marks]

X _____

Y _____

1 0 . 6 How does the reaction profile show that the reaction is exothermic?

[1 mark]

Use **Figure 18**.

17

END OF QUESTIONS

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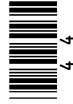
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GCSE CHEMISTRY 8462/1F

Paper 1 Foundation Tier

Mark scheme

June 2022

Version: 1.0 Final Mark Scheme



Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	Name Neutron Proton Label A B C D do not accept more than one line from a box on the left		1	AO1 4.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	(number of electrons) 9 (number of neutrons) 10		1 1	AO2 4.1.1.5

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	B		1	AO3 4.4.1,2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	C		1	AO3 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	zinc (oxide) sulfuric (acid)	allow ZnO allow H ₂ SO ₄	1 1	AO2 4.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	C	allow 78 (°C)	1	AO3 4.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	increases	allow becomes warmer / hotter	1	AO3 4.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	heat (the solution) until crystallisation point is reached leave the solution (to cool / crystallise)	allow heat (the solution) until crystals start to form allow heat (the solution) to reduce the volume allow heat (the solution) to evaporate (some of the water) if no other mark is awarded allow 1 mark for heat the solution to dryness	1 1	AO1 4.1.1.2 4.4.2.3 RPA1

Total Question 2		8
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Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	pH	Colour of universal indicator do not accept more than one line from a box on the left	1 1	AO1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	neutralisation		1	AO1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	burette		1	AO1 4.4.2.5 RPA2

Total Question 3	8
-------------------------	----------

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	for elements that had not been discovered (at that time) or so that elements with similar properties are grouped together	ignore references to atomic number / mass / weight allow for missing elements	1	AO1 4.1.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	Mendeleev		1	AO1 4.1.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	noble gases		1	AO3 4.1.2.2 4.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	the elements all have one electron in the outer shell		1	AO1 4.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	63 (°C)	allow a value in the range 49 to 88 (°C)	1	AO3 4.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	any one from: • floats • moves (on the surface) • melts • fizzes / bubbles • flame	allow forms a ball ignore colour of flame allow explodes / disappears ignore references to heat / temperature / sounds	1	AO1 4.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	State at 150 °C	Symbol	Formula of the compound with hydrogen	1
	Fluorine	F	HF	
	Chlorine	Cl	HCl	
	Bromine	Br	HBr	
	Iodine	I	HI	
	Astatine	At	HAt	
			1	AO3 4.1.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.8	Br ₂		1	AO1 4.1.2.6

Total Question 4	9
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Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	hydrogen		1	AO1 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	length of magnesium ribbon		1	AO2 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	any one from: • volume of (hydrochloric) acid • concentration of (hydrochloric) acid • width / thickness of magnesium ribbon	allow temperature of (hydrochloric) acid allow temperature of solution	1	AO3 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(trial) 1	allow 19 (cm ³)	1	AO3 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	any one from: • some gas escaped before the stopper was put in • apparatus leaked • reaction not finished (when reading taken) • less than 25cm³ of (hydrochloric) acid used • magnesium (ribbon) not long enough	allow the stopper was not replaced quickly enough	1	AO3 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6 View with Figure 8	all six points correctly plotted line of best fit	allow a tolerance of $\pm \frac{1}{2}$ a small square allow 1 mark for four or five points correctly plotted	2 1	AO2 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	increases		1	AO2 4.4.2.1

Total Question 5

9

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	C		1	AO1 4.2.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	D		1	AO1 4.2.1.4 4.2.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	4 / four		1	AO1 4.2.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	very hard		1	AO1 4.2.2.6 4.2.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	C ₂ H ₆		1	AO2 4.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	H ⁺		1	AO1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.7	$(M_r =)$ $(1 \times 2) + 12 + (16 \times 3)$ $= 62$	allow $(M_r =) 2 + 12 + 48$	1 1	AO2 4.3.1.2

Total Question 6	8
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Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	coarse particle		1	AO1 4.2.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	(volume =) 2^3 = 8 (nm ³)	allow (volume =) $2 \times 2 \times 2$	1	AO2 4.2.4.1
	(surface area : volume) = 24 : 8	allow correct use of an incorrectly calculated volume	1	
	(simplest ratio) = 3 : 1		1	
			1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	high(er) / large(r)		1	AO1 4.2.4.1
	lower / less / smaller		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	(advantage) any one from: - stops (unpleasant) smells - can stop (foot) infections	allow specific (foot) infections allow silver can kill bacteria	1	AO3 4.2.4.2
	(disadvantage) any one from: - high cost (of socks) - could be harmful if breathed in	allow silver is (very) expensive	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	100 times		1	AO2 4.1.1.5 4.2.4.1

Total Question 7

10

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	hydroxide ions		1	AO1 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	27 (cm ³)		1	AO2 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	ions cannot move (freely in a solid)	allow ions are fixed in place (in a solid)	1	AO1 4.2.2.1 4.2.2.3 4.4.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	Molten compound	Product at negative electrode	1	AO2 4.4.3.2
	Potassium iodide	Potassium		
	Zinc bromide	Zinc Iodine Bromine		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	carbon is less reactive than sodium		1	AO1 4.4.1.2 4.4.1.3 4.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	(l)		1	AO1 4.2.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.7	(percentage atom economy =) $\frac{48}{80} \times 100$ = 60 (%)		1 1	AO2 4.3.3.2

Total Question 8

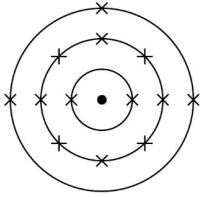
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Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	D		1	AO3 4.1.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	B		1	AO3 4.1.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	any two from: (Group 1 elements) • have lower melting / boiling points • have lower densities • are less strong • are softer	allow converse statements for transition elements allow (Group 1 elements are) more malleable / ductile allow (Group 1 elements) are not useful as catalysts ignore transition elements form coloured compounds ignore transition elements form ions with different charges ignore references to chemical properties	2	AO1 4.1.3.1 4.1.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4		allow any combination of x, •, o, e ⁻ for electrons	1	AO2 4.1.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	delocalised electrons (the electrons) carry (electrical) charge (the electrons move) through the metal / aluminium / structure	allow free electrons ignore current / electricity for charge ignore throughout for through	1 1 1	AO1 4.2.1.5 4.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	ionic		1	AO1 4.2.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.7	magnesium (atom) loses electrons		1	AO2 4.2.1.1 4.2.1.2
	oxygen (atom) gains electrons		1	
	two electrons (are transferred)		1	
	magnesium ions and oxide ions are formed	allow Mg ²⁺ (ions) and O ²⁻ (ions) are formed allow magnesium forms positive ions and oxygen forms negative ions allow (both) form a complete outer shell	1	
Total Question 9			13	

Question 10

Question	Answers	Mark	AO / Spec. Ref.
10.1	Level 3: The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.5.1.1 RPA 4
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content.	0	
	Indicative content • measure volume of (hydrochloric) acid • with a measuring cylinder • pour (hydrochloric) acid into a suitable container eg polystyrene cup • measure the initial temperature (of hydrochloric acid) • with a thermometer • add a known mass of sodium carbonate • measured with a balance • stir • measure the highest temperature reached • repeat with different masses of sodium carbonate • or • add successive masses of sodium carbonate to the same mixture • repeat the whole investigation • use the same starting temperature • use the same volume of (hydrochloric) acid each time • use the same concentration of (hydrochloric) acid each time		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2 View with Figure 17	change in highest temperature	allow a tolerance of $\pm \frac{1}{2}$ a small square	1	AO2 4.5.1.1 RPA4
	corresponding change in mass	allow a tolerance of $\pm \frac{1}{2}$ a small square	1	
	(gradient =) <u>change in highest temperature</u> change in mass	allow correct use of an incorrectly determined change in highest temperature and / or change in mass	1	
	(gradient =) 1.6		1	
	$^{\circ}\text{C/g}$	allow $^{\circ}\text{C/gram(s)}$	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.3 View with Figure 17	extrapolates line to the y-axis	allow a tolerance of $\pm \frac{1}{2}$ a small square allow a correctly determined value from an incorrectly extrapolated line	1	AO2 4.5.1.1 RPA4
	alternative approach: (highest temperature at 1.0 g – change in highest temperature per gram =) 22.2 – 1.6 (1) = 20.6 ($^{\circ}\text{C}$) (1)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	C		1	AO3 4.5.1.1 RPA4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.5	(X) energy		1	AO1 4.5.1.2
	(Y) (overall) energy change		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.6	(level of) products is below (level of) reactants	allow the energy decreases (overall) allow energy is transferred to the surroundings ignore references to bond making / breaking	1	AO1 4.5.1.2

Total Question 10			17	
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