2024

Name_____

Combined Science

Higher

Chemistry: Paper 1

The Periodic Table of Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
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** oganesson 118

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

* 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.

AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

GCSE
COMBINED SCIENCE: TRILOGY

H

Higher Tier
Chemistry Paper 1H

Thursday 16 May 2019 Morning Time allowed: 1 hour 15 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 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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

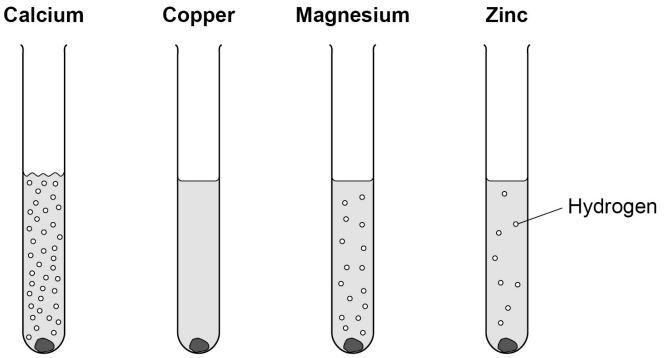
Information
- The maximum mark for this paper is 70.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

Do not write outside the box

0 1 This question is about reactions of metals.

Figure 1 shows what happens when calcium, copper, magnesium and zinc are added to hydrochloric acid.

Figure 1



0 1 . 1 What is the order of decreasing reactivity of these four metals?

[1 mark]

Tick (✓) **one** box.

Zn Ca Cu Mg ☐

Ca Cu Mg Zn ☐

Cu Zn Ca Mg ☐

Ca Mg Zn Cu ☐

Do not write outside the box

A student wants to make a fair comparison of the reactivity of the metals with hydrochloric acid.

0 1 . 2 Name **two** variables that must be kept constant.

[2 marks]

1 _____

_____

2 _____

_____

0 1 . 3 What is the independent variable in this reaction?

[1 mark]

_____

_____

0 1 . 4 Predict the reactivity of beryllium compared with magnesium.

Give a reason for your answer.

Use the periodic table.

[2 marks]

_____

Reason _____

_____

_____

0 1 . 5 A solution of hydrochloric acid contains 3.2 g of hydrogen chloride in 50 cm^3

Calculate the concentration of hydrogen chloride in g per dm^3

[3 marks]

_____

_____

_____

_____

Concentration = _____ g per dm^3

9

Turn over ►

Do not write outside the box

0 2 This question is about salts.

Ammonium nitrate solution is produced when ammonia gas reacts with nitric acid.

0 2 . 1 Give the state symbol for ammonium nitrate solution.

[1 mark]

_____

0 2 . 2 What is the formula of nitric acid?

[1 mark]

Tick (✓) **one** box.

HCl ☐

HNO_3 ☐

H_2SO_4 ☐

NH_4OH ☐

0 2 . 3 Ammonia gas dissolves in water to produce ammonia solution.

Ammonia solution contains hydroxide ions, OH^-

A student adds universal indicator to solutions of nitric acid and ammonia.

What colour is observed in each solution?

[2 marks]

Colour in nitric acid _____

Colour in ammonia solution _____

Do not write outside the box

0 2 . 4 The student gradually added nitric acid to ammonia solution.

Which row, **A**, **B**, **C** or **D**, shows the change in pH as the nitric acid is added until in excess?

[1 mark]

Tick (✓) **one** box.

	pH of ammonia solution at start	pH after addition of excess nitric acid	
A	10	7	
B	2	10	
C	7	1	
D	10	2	

0 2 . 5 Calculate the percentage by mass of oxygen in ammonium nitrate (NH_4NO_3).

Relative atomic masses (A_r): H = 1 N = 14 O = 16

Relative formula mass (M_r): NH_4NO_3 = 80

[3 marks]

Percentage by mass of oxygen = _____ %

Question 2 continues on the next page

Do not write outside the box

0 2 . 6 Describe a method to investigate how the temperature changes when different masses of ammonium nitrate are dissolved in water.

You do **not** need to write about safety precautions.

[6 marks]

14

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

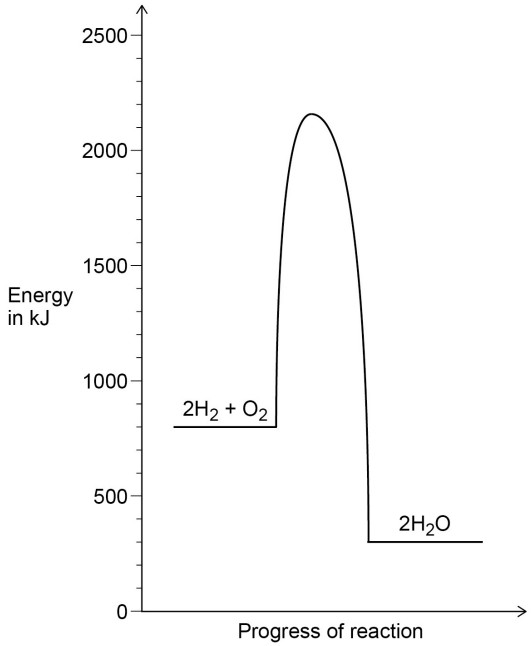
0 3 This question is about oxygen.

0 3 . 1 Hydrogen reacts with oxygen.

$$2\,H_2\,(g) + O_2\,(g) \rightarrow 2\,H_2O\,(g)$$

Figure 2 shows the relative energies of the reactants and products at a certain temperature.

Figure 2



Label the activation energy on **Figure 2.**

[1 mark]

Do not write outside the box

0 3 . 2 Determine the overall energy change for the reaction between hydrogen and oxygen shown in Question **03.1**

Use **Figure 2**.

[2 marks]

Energy change = _____ kJ

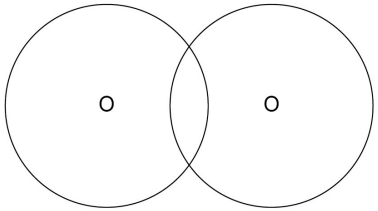
0 3 . 3 Oxygen is in Group 6 of the periodic table.

Figure 3 shows the outer energy levels in one molecule of oxygen (O_2).

Draw the electrons in the outer energy levels in **Figure 3**.

[2 marks]

Figure 3



Question 3 continues on the next page

Do not write outside the box

0 3 . 4 The equation shows the decomposition of hydrogen peroxide.

$$2\ H{-}O{-}O{-}H \rightarrow 2\ H{-}O{-}H + O{=}O$$

Table 1 shows the bond energies.

Table 1

Bond	**O–O**	**O=O**	**O–H**
Bond dissociation energy in kJ per mole	138	496	463

Calculate the overall energy change for the reaction.

[3 marks]

Energy change = _____ kJ

8

Do not write outside the box

0 4 This question is about elements in the periodic table.

0 4 . 1 What order did scientists use to arrange elements in early periodic tables?

[1 mark]

0 4 . 2 In the early periodic tables some elements were placed in the wrong groups.

Mendeleev overcame this in his periodic table.

Give **one** way Mendeleev did this.

[1 mark]

Question 4 continues on the next page

Do not write outside the box

Table 2 shows the boiling points of fluorine, chlorine and bromine.

Table 2

Element	Boiling point in °C
Fluorine	–186
Chlorine	–34
Bromine	+59

0 4 . 3 Explain why the boiling points in **Table 2** are low.

[2 marks]

0 4 . 4 Explain the trend in the boiling points in **Table 2.**

[3 marks]

Do not write outside the box

0 4 . 5 Explain why neon is unreactive.

Give the electronic structure of neon in your answer.

[2 marks]

0 4 . 6 How many atoms are there in 1 g of argon?

The Avogadro constant is 6.02×10^{23} per mole.

Relative atomic mass (A_r): Ar = 40

[2 marks]

Number of atoms in 1 g = _____

11

Turn over for the next question

Do not write outside the box

0 5 This question is about electrolysis.

0 5 . 1 Some metals are extracted from molten compounds using electrolysis.

Why is electrolysis used to extract some metals?

[1 mark]

0 5 . 2 Aluminium is produced by electrolysis of a molten mixture.

What **two** substances does the molten mixture contain?

[2 marks]

1 _____

2 _____

0 5 . 3 Copper and chlorine are produced when molten copper chloride is electrolysed.

Complete the half equation for the reaction at each electrode.

[2 marks]

Half equation at negative electrode

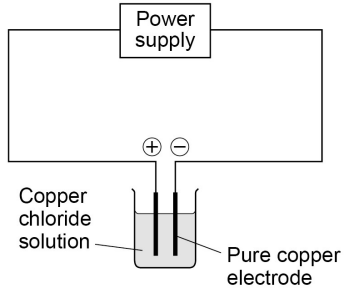
Cu^{2+} _____ → _____

Half equation at positive electrode

$2\ Cl^-$ → _____

Figure 4 shows the apparatus a student used to electrolyse copper chloride solution.

Figure 4



The student:

- measured the mass of copper deposited on the negative electrode after 60 minutes
- compared the mass deposited with the expected value.

0 5 . 4 Suggest **two** reasons why the mass deposited was different from the expected value.

[2 marks]

1 _____

_____

2 _____

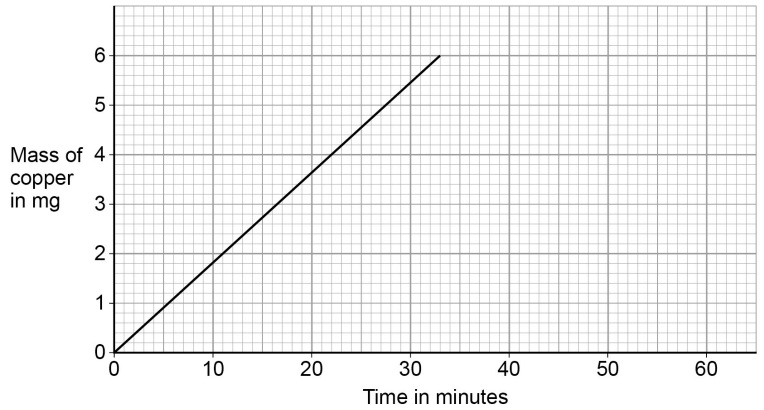
_____

Question 5 continues on the next page

Turn over ►

0 5 . 5 **Figure 5** shows the expected mass of copper produced each minute.

Figure 5



Determine the expected mass of copper after 24 hours.

Use **Figure 5**.

[3 marks]

_____

_____

_____

_____

_____

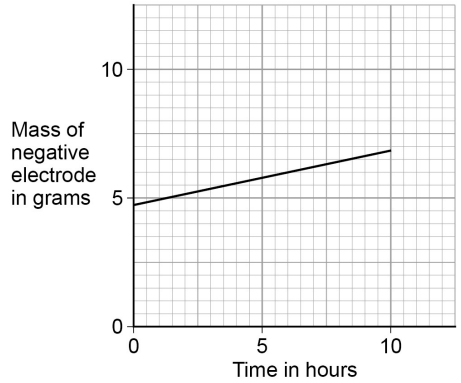
_____

Mass = _____ mg

Silver nitrate solution is electrolysed.

Figure 6 shows the change in mass of the negative electrode over 10 hours.

Figure 6



0 5 . 6 Determine the mass of the negative electrode at the start of the experiment.

Use **Figure 6.**

[1 mark]

0 5 . 7 Calculate the gradient of the line in **Figure 6.**

Give the unit.

[3 marks]

Gradient _____

Unit _____

14

0 6 This question is about sodium.

0 6 . 1 Sodium reacts with chlorine.

What is the balanced equation for the reaction?

[1 mark]

Tick (✓) **one** box.

$Na + Cl \rightarrow NaCl$ ☐

$Na + Cl_2 \rightarrow NaCl_2$ ☐

$2\ Na + Cl_2 \rightarrow 2\ NaCl$ ☐

$2\ Na + Cl \rightarrow Na_2Cl$ ☐

0 6 . 2 Hot sodium is put in a gas jar of chlorine.

Describe the observations made before, during and after the reaction.

[3 marks]

Before reaction _____

During reaction _____

After reaction _____

Do not write outside the box

0 6 . 3 Explain why sodium is less reactive than potassium.

[4 marks]

Question 6 continues on the next page

Do not write outside the box

0 6 . 4 Chlorine reacts with sodium and with hydrogen.

Compare the structure and bonding in sodium chloride and hydrogen chloride.

[6 marks]

END OF QUESTIONS

14

AQA

GCSE
COMBINED SCIENCE: TRILOGY
8464/C/1H

Chemistry Paper 1H

Mark scheme

June 2019

Version: 1.0 Final

I96G8464cIh/MS

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	Ca Mg Zn Cu		1	AO3 5.4.1.2
01.2	any **two** from: • mass (of metal / element) • surface area (of metal / element) • concentration (of acid) • volume (of acid) • temperature (of acid)	 allow weight ignore size ignore length ignore pH ignore strength ignore room temperature	2	AO3 5.4.1.2
01.3	(type of) metal / element		1	AO2 5.4.1.2

01.4		allow converse answers for magnesium MP2 only if MP1 is correct		AO3 5.1.2.3 5.1.2.5 5.4.1.2
	(beryllium is) less reactive		1	
	any **one** from: • greater attraction between nucleus and outer electrons • more energy is needed to remove electrons • loss of electrons is more difficult • outer electrons closer to nucleus • less shielding		1	
		allow higher in group allow reactivity increases down the group ignore reactivity series		

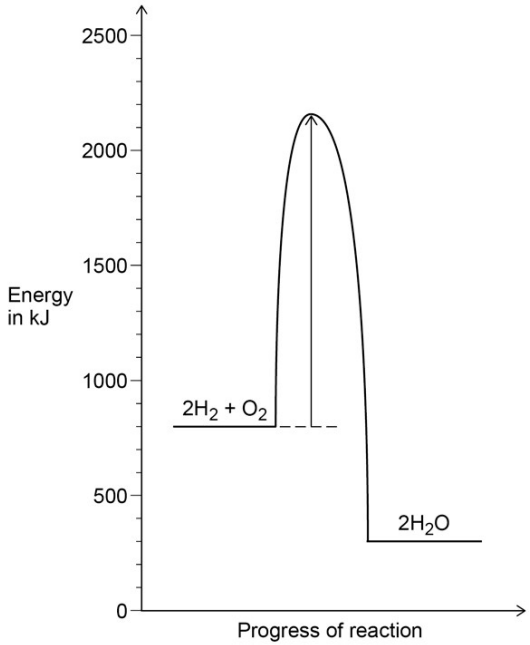
01.5		an answer of 64 (g per dm^3) scores **3** marks an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps		AO2 5.3.2.5
	$\frac{50}{1000}$ (dm^3)		1	
	= 0.05 (dm^3)		1	
	$(\frac{3.2}{0.05}) = 64$ (g per dm^3)		1	
	alternative approach: $\frac{3.2}{50}$ (1) = 0.064 (1) (× 1000) = 64 (g per dm^3) (1)			
	alternative approach: $\frac{1000}{50}$ (1) = 20 (1) (× 3.2) = 64 (g per dm^3) (1)			
		an answer of 0.16 / 0.064 / 0.64 / 6.4 / 6.4 × 10^{-5} (g per dm^3) gains **2** marks		

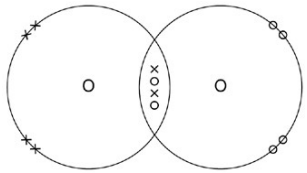
Total			**9**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(aq)	allow aq ignore aqueous ignore formulae	1	AO1 5.2.2.2
02.2	HNO_3		1	AO1 5.1.1.1 5.4.2.2
02.3	red purple **or** blue	allow orange or yellow do **not** accept green allow shades of purple eg violet	1 1	AO1 5.4.2.4
02.4	D		1	AO3 5.4.2.4
02.5	 3 × 16 **or** 48 $\frac{48}{80}$ (×100) 60 (%)	an answer of 60 (%) scores **3** marks an answer of 20 (%) scores **2** marks for: $\frac{16}{80}$ (× 100) (1) = 20 (%) (1)	 1 1 1	AO2 5.3.1.2

Question	Answers	Mark	AO/ Spec. Ref
02.6	**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 AO2
	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	5.5.1.1
	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	
	No relevant content	0	
	Indicative content **Steps** • use a suitable container eg test tube • use insulation • add water • measure the initial water temperature (with a thermometer) • add stated mass eg 1g **or** 1 spatula • stir (to dissolve the solid) • measure the final (allow lowest or highest) temperature of the solution • calculate the temperature difference **or** determine graphically • repeat with different masses • repeat with the same volume of water to access level 3 there must be an indication of how the temperature change is determined using different masses dissolved in the same quantity of water		

Total			14

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	line from reactants to top of curve (i.e. from 800 to 2160)  ignore arrowheads		1	AO1 5.5.1.2
03.2		an answer of (–) 500 (kJ) scores **2** marks ignore sign		AO2 AO3 5.5.1.2
	reads levels of reactants (800 kJ) and products (300 kJ)		1	
	(800 – 300) = 500 (kJ)	allow correct subtraction of one incorrect value determined for the energy change	1	

03.3		allow combination of circles, dots, crosses or $e^{(-)}$		AO2 5.2.1.4
	two shared pairs in overlap		1	
	all non-bonding electrons in outer shell (4 electrons on each O atom)	ignore any inner shell electrons	1	
		 diagram scores 2 marks		

03.4		an answer of (–) 220 (kJ) scores **3** marks an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps		AO2 5.1.1.1 5.5.1.1 5.5.1.3
	(bonds broken) ((4×463) + (2×138) =) **2128**		1	
	(bonds made) ((4×463) + (496) =) **2348**		1	
	(energy change = bonds broken – bonds made) (2128 – 2348 =) (–) **220** (kJ)	ignore energy change sign allow correct calculation using incorrect values from step 1 and/or step 2	1	
	alternative approach: (bonds broken) (2× (O–O) = (2×138) =) **276** (1) (bonds made) (1× (O=O) =) **496** (1) (energy change = bonds broken – bonds made) (276 – 496 =) (–) **220** (kJ) (1)			

Total			**8**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	atomic weight	do **not** accept atomic mass or A_r	1	AO1 5.1.2.2
04.2	left gaps / spaces **or** changed the order based on atomic weights	allow placed them in correct groups according to properties do **not** accept reference to atomic number	1	AO1 5.1.2.2
04.3	weak forces between the molecules **or** weak intermolecular forces	allow weak intermolecular bonds do **not** accept incorrect references to covalent bonds	1	AO1 AO3 5.1.2.6 5.2.2.4
	(so) little energy required to overcome / break the forces between molecules **or** (so) little energy required to overcome / break the intermolecular forces	allow (so) little energy required to separate the molecules allow (so) little energy required to overcome / break the intermolecular bonds ignore less energy	1	

04.4	(the) molecules get larger going down the group (so the) forces between the molecules increase **or** (so the) intermolecular forces increase (so the) boiling points increase going down the group **or** (so the) boiling points increase with increasing relative atomic mass	allow converse explanation in terms of boiling point allow (so) more energy is needed to separate the molecules	1 1 1	AO1 AO3 5.1.2.6 5.2.2.4
04.5	2,8 (so) stable arrangement of electrons **or** (so) full outer shell	allow diagram or description	1 1	AO1 5.1.2.4
04.6	$\frac{1}{40}$ × 6.02 × 10^{23} **or** 0.025 × 6.02 × 10^{23} 1.51 × 10^{22}	an answer of 1.51 × 10^{22} scores **2** marks allow 1.505 × 10^{22}	 1 1	AO2 5.3.2.1
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	metal is too reactive to be extracted using carbon **or** metal reacts with carbon	allow metal is more reactive than carbon	1	AO1 5.4.3.3
05.2	aluminium oxide cryolite	either order ignore bauxite **or** aluminium ore	 1 1	AO1 5.4.3.3
05.3	negative electrode: $Cu^{2+} + 2e^- \rightarrow Cu$ positive electrode: $2Cl^- \rightarrow Cl_2 + 2e^-$	allow multiples allow $2Cl^- - 2e^- \rightarrow Cl_2$	 1 1	AO2 5.4.3.2 5.4.3.5
05.4	any **two** from: • concentration / volume of solution was different • impurities in solution • error in timing • copper falls off (electrode) • copper removed when drying electrode • electrode not dry (when weighed) • voltage / current was different	 allow copper at bottom of beaker ignore power supply ignore recorded mass inaccurately	2	AO3 5.4.3.4

05.5		an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps		AO2 5.4.3.4
	reading of mass at stated time	allow tolerance of ± ½ small square eg at 30 minutes value is 5.4 (mg)	1	
	factor from time to 24 hours	eg 5.4 × 48 $\left(=\frac{24 \text{ hours}}{30 \text{ minutes}}\right)$ allow correct calculation using incorrectly read value for mass at time quoted	1	
	correct evaluation	eg = 259 (mg)	1	
	alternative approach:			
	calculates the gradient (1)	eg (1.8÷10) = 0.18		
	gradient × time in minutes in 24 hours (1)	eg 0.18 × 24 × 60 **or** eg 0.18 × 1440 allow correct use of incorrectly determined gradient		
	correct evaluation (1)	eg = 259 (mg)		

05.6	4.75 (g)	allow values in range 4.7–4.8 (g)	1	AO2 5.4.3.4

05.7		an answer in the range 0.18–0.25 scores **2** marks (**3** marks with correct unit)		AO2 5.4.3.4
	(working) Y increase **and** X increase measured from graph	allow ecf from question **05.6**		
	and substitution into $\frac{\text{Y increase}}{\text{X increase}}$	eg = $\frac{2.0}{10}$	1	
	correct evaluation	eg = 0.2	1	
	(units) g/hour	allow g/h **or** g/hr **or** g per hour	1	

Total			**14**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	2 Na + Cl_2 → 2 NaCl		1	AO2 5.1.1.1 5.1.2.5
06.2	(before) silver solid / liquid / metal **or** green (gas) (during) yellow flame **or** white smoke **or** green colour fades / disappears (after) white solid / powder	 allow grey solid / metal allow yellow (gas) allow orange / white flame allow vigorous reaction 	 1 1 1	AO1 5.1.2.5

06.3	 (sodium has) fewer energy levels / shells <u>outer</u> electron / shell is closer to nucleus **or** <u>outer</u> electron / shell is less shielded (so) greater attraction between nucleus and outer electron / shell (so) outer electron is less easily lost	allow converse for potassium allow diagrams of electron structure allow (so) loses an / one electron less easily allow (so) more energy needed to remove an / one electron	 1 1 1 1	AO1 5.1.2.5

Question	Answers	Mark	AO/ Spec. Ref
06.4	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4–6	AO1 AO2
	Level 1: Relevant features are identified and differences noted.	1–3	
	No relevant content	0	

Indicative content

	sodium chloride	hydrogen chloride
differences in bonding	ionic	covalent
	metal & non-metal	two non-metals
	transferring electrons	sharing electrons
	ions (Na^+ and Cl^-)	molecules
	charged particles	neutral **or** no overall charge
differences in structure	**giant** structure or lattice	**small** / **simple** / **discrete** molecules
	electrostatic	intermolecular forces
	(electrostatic forces) are **strong**	(intermolecular forces) are **weak**
	act in all directions	random **or** between the molecules
	regular	irregular / random
similarities in bonding	full shells **or** stability	full shells **or** stability
	(transferring) electrons	(sharing) electrons
	strong bonds	**strong** (covalent) bonds
similarities in structure	(electrostatic) forces	(intermolecular) forces

ignore properties eg melting points, conduct electricity

to access level 2 there must be a comparison of the structure **and** bonding **and** magnitude of both sodium chloride **and** hydrogen chloride.

Total			**14**

AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: TRILOGY

H

Higher Tier
Chemistry Paper 1H

Time allowed: 1 hour 15 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.
- 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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

Information
- The maximum mark for this paper is 70.
- 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.

Do not write outside the box

0 1 This question is about the periodic table.

0 1 . 1 **Figure 1** shows part of Mendeleev's version of the periodic table.

Figure 1

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

Which group of elements had **not** been discovered when Mendeleev's version of the periodic table was published?

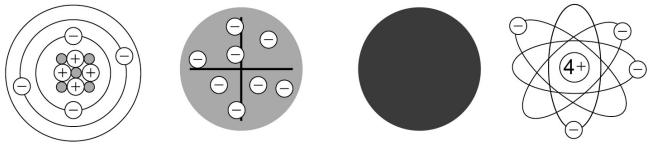
[1 mark]

_____

Do not write outside the box

Figure 2 represents different models of the atom.

Figure 2



A B C D

0 1 . 2 Which model represents the plum pudding model?

[1 mark]

Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☐

0 1 . 3 Which model resulted from Chadwick's experimental work?

[1 mark]

Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☐

Question 1 continues on the next page

Do not write outside the box

Potassium has different isotopes.

0 1 . 4 What is meant by 'isotopes'?

You should refer to subatomic particles.

[2 marks]

0 1 . 5 **Table 1** shows the mass numbers and the percentage abundance of two isotopes of potassium.

Table 1

Mass number	Percentage abundance
39	93.1
41	6.9

Calculate the relative atomic mass (A_r) of potassium.

Give your answer to 1 decimal place.

[3 marks]

Relative atomic mass (1 decimal place) = _____

8

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 2 Acids react to produce salts.

Universal indicator is added to water and then nitric acid is added to the mixture.

0 2 . 1 Give the colour change when nitric acid is added to the mixture of universal indicator and water.

[1 mark]

Tick (✓) **one** box.

- Blue to red ☐
- Green to purple ☐
- Green to red ☐
- Red to purple ☐

0 2 . 2 What happens to the pH of water when nitric acid is added?

[1 mark]

Tick (✓) **one** box.

- Decreases ☐
- Stays the same ☐
- Increases ☐

0 2 . 3 What is the state symbol for nitric acid?

[1 mark]

_____

Do not write outside the box

Zinc carbonate reacts with nitric acid.

The word equation for the reaction is:

zinc carbonate + nitric acid → zinc nitrate + water + carbon dioxide

white solid — colourless solution

0 2 . 4 Give **two** observations that would be made when zinc carbonate is added to nitric acid until the zinc carbonate is in excess.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 5 The formula of the zinc ion is Zn^{2+}

The formula of the nitrate ion is NO_3^-

What is the formula for zinc nitrate?

[1 mark]

Tick (✓) **one** box.

$ZnNO_3$ ☐

$Zn(NO_3)_2$ ☐

Zn_2NO_3 ☐

$Zn_2(NO_3)_2$ ☐

Question 2 continues on the next page

Do not write outside the box

0 2 . 6 Acids react with insoluble metal oxides to produce salts.

Plan a method to produce a pure, dry sample of the soluble salt copper chloride from an acid and a metal oxide.

[6 marks]

_____

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12

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 3 This question is about energy change.

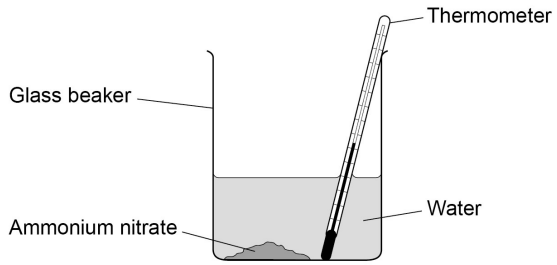
A student investigated the temperature change when 10 g of ammonium nitrate was added to 100 cm^3 of water.

This is the method used.

1. Measure the temperature of 100 cm^3 of water.
2. Add 10 g of ammonium nitrate.
3. Stir once.
4. Measure the temperature of the solution every minute for 7 minutes.

Figure 3 shows the apparatus.

Figure 3



0 3 . 1 What is the dependent variable in this investigation?

[1 mark]

0 3 . 2 Give **three** improvements to the investigation to make the results more accurate.

[3 marks]

1 _____

_____

2 _____

_____

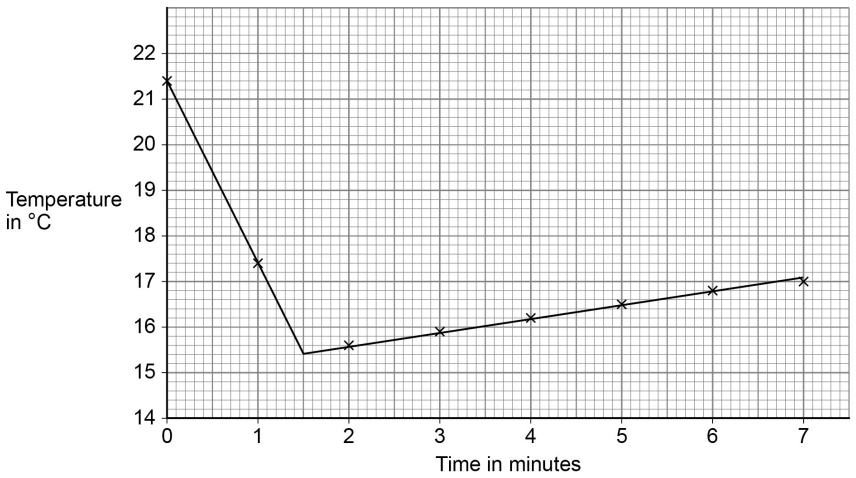
3 _____

_____

Do not write outside the box

0 3 . 3 **Figure 4** shows the results.

Figure 4



Explain the results.

[4 marks]

Question 3 continues on the next page

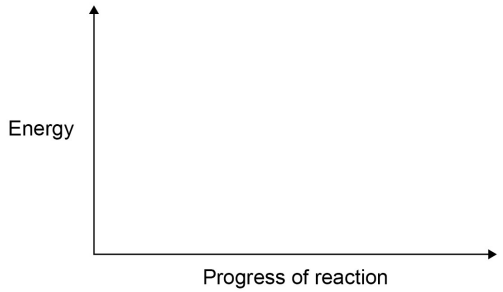
Do not write outside the box

0 3 . 4 Draw a reaction profile for an exothermic reaction.

You should label:

- the energy level of the reactants and of the products
- the activation energy
- the overall energy change.

[4 marks]



12

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 4 Carbon can exist in a number of different structures.

0 4 . 1 The first fullerene to be discovered was Buckminsterfullerene.

What is the formula of Buckminsterfullerene?

[1 mark]

Tick (✓) **one** box.

C_{40} ☐

C_{50} ☐

C_{60} ☐

C_{70} ☐

0 4 . 2 Graphite is a form of carbon.

Explain why graphite conducts electricity.

[2 marks]

Do not write outside the box

Steel is an alloy of iron and carbon.

0 4 . 3 Explain why steel is harder than iron.

[3 marks]

0 4 . 4 Iron is alloyed with carbon and other metals to make stainless steel.

A stainless steel fork contains 71.92% iron.

Table 2 shows the mass of each element in the fork.

Table 2

Element	Iron	Carbon	Chromium	Nickel
Mass of element in g	**X**	0.05	10.44	5.80

Calculate the mass of iron (**X**) in the fork.

[4 marks]

X = _____ g

10

Turn over ►

Do not write outside the box

0 5 This question is about the electrolysis of aqueous solutions.

Hydrogen gas and chlorine gas are produced when sodium chloride solution is electrolysed.

0 5 . 1 Hydrogen ions (H^+) are attracted to the negative electrode.

The half equation for the reaction at the negative electrode is:

$$2H^+ + 2e^- \rightarrow H_2$$

What type of reaction happens at the negative electrode?

Give the reason for your answer.

[2 marks]

Type of reaction _____

Reason _____

_____

0 5 . 2 Chloride ions are attracted to the positive electrode.

Complete the half equation for the production of chlorine gas (Cl_2).

[2 marks]

___ Cl^- → _____ + _____

Do not write outside the box

0 5 . 3 Hydrogen gas and oxygen gas are produced when sodium sulfate solution is electrolysed.

Explain how oxygen gas is produced in the electrolysis of sodium sulfate solution.

[4 marks]

8

Turn over for the next question

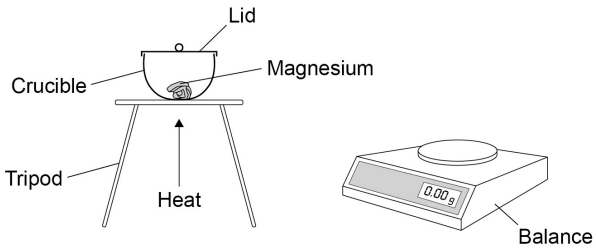
Do not write outside the box

0 6 Metal oxides are produced when metals are heated in air.

A student investigated the change in mass when 0.12 g of magnesium was heated in air.

Figure 5 shows the apparatus.

Figure 5



The student measured the mass of magnesium oxide produced.

0 6 . 1 0.12 g of magnesium reacted to produce 0.20 g of magnesium oxide.

Calculate the number of moles of oxygen gas (O_2) that reacted.

Relative atomic mass (A_r): O = 16

[3 marks]

Moles of oxygen gas = _____

Do not write outside the box

0 6 . 2 The student repeated the experiment **without** a lid on the crucible.

Suggest why the mass of magnesium oxide produced would be different without a lid on the crucible.

[2 marks]

0 6 . 3 Copper reacts with oxygen to produce copper oxide.

63.5 g of copper produces 79.5 g of copper oxide.

Calculate the mass of copper oxide produced when 0.50 g of copper reacts with oxygen.

Give your answer to 3 significant figures.

[3 marks]

Mass (3 significant figures) = _____ g

Question 6 continues on the next page

Do not write outside the box

0 6 . 4 Iron reacts with oxygen to produce an oxide of iron.

0.015 moles of iron reacts with 0.010 moles of oxygen gas (O_2).

Determine:

- the formula of the iron oxide produced
- the balanced symbol equation for the reaction.

[4 marks]

Formula of iron oxide = _____

Balanced symbol equation

12

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 7 Methane, ethane, propane and butane all react with oxygen to produce carbon dioxide and water.

0 7 . 1 Suggest why a mixture of methane and oxygen does **not** react at room temperature.

Answer in terms of particles.

[2 marks]

0 7 . 2 **Table 3** shows the energy released when methane, ethane and propane react with oxygen to produce carbon dioxide and water.

Table 3

	Compound reacted with oxygen		
	Methane	Ethane	Propane
Formula of compound	CH_4	C_2H_6	C_3H_8
Energy released in kJ/mol	680	1160	1640

Predict the energy released when butane (C_4H_{10}) reacts with oxygen to produce carbon dioxide and water.

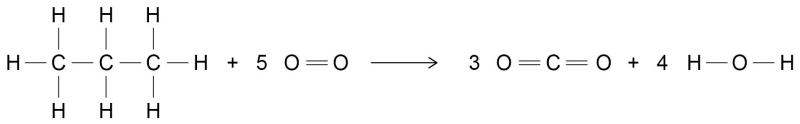
[1 mark]

Energy released = _____ kJ/mol

Do not write outside the box

0 7 . 3 Propane reacts with oxygen to produce carbon dioxide and water.

The displayed formula equation for the reaction is:



The reaction is exothermic.

In the reaction, the energy released when forming new bonds is 1640 kJ/mol greater than the energy needed when breaking bonds.

Table 4 shows bond energies.

Table 4

Bond	**H–C**	**C–C**	**O=O**	**C=O**	**O–H**
Bond energy in kJ/mol	410	**X**	500	740	460

Calculate the C—C bond energy (**X**).

[5 marks]

X = _____ kJ/mol

8

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

Question number	Additional page, if required. Write the question numbers in the left-hand margin.

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AQA

GCSE
COMBINED SCIENCE: TRILOGY
8464/C/1H

Chemistry Paper 1H

Mark scheme

June 2021

Version: 1.0 Final Mark Scheme

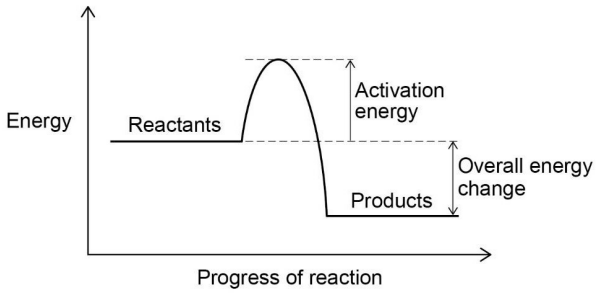
2 1 6 G 8 4 6 4 C 1 H / M S

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	(Group) 0 **or** noble gases		1	AO2 5.1.2.2
01.2	B		1	AO2 5.1.1.3
01.3	A		1	AO3 5.1.1.3
01.4	(atoms with the) same number of protons	allow atoms with the same atomic number allow atoms of the same element ignore the same number of electrons	1	AO1 5.1.1.5
	(but with) different numbers of neutrons	ignore (but with) different mass numbers do **not** accept (but with) different relative atomic mass	1	
01.5	$\frac{(39 \times 93.1) + (41 \times 6.9)}{100}$		1	AO2 5.1.1.6
	= 39.138		1	
	= 39.1	allow correctly rounded answer to **1** decimal place from an incorrect calculation using all the values given in the question	1	
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	green to red		1	AO1 5.4.2.4
02.2	decreases		1	AO1 5.4.2.4
02.3	(aq)	allow aq ignore aqueous ignore HNO_3	1	AO1 5.2.2.2
02.4	any **two** from: • (white) solid disappears • fizzing **/** bubbles / effervescence • (then) stops fizzing • (white) solid left at the end / bottom	 allow a gas is produced ignore colourless solution	2	AO3 5.4.2.2 5.4.2.3
02.5	$Zn(NO_3)_2$		1	AO2 5.1.1.1 5.4.2.2

Question	Answers	Mark	AO / Spec. Ref.
02.6	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 5.4.2.2 5.4.2.3 RPA8
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method 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: • react hydrochloric acid • (with) copper oxide • in a suitable container • warm (hydrochloric) acid • add copper oxide • until is in excess **or** until solid remains • stir • filter excess copper oxide • pour solution / filtrate into evaporating basin • use of water bath **or** use of electric heater • to heat gently **or** partially evaporate • leave to cool / crystallise For level 3 the correct chemicals must have been selected.		
Total		**12**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	temperature (of solution)	allow temperature change	1	AO1 5.5.1.1
03.2	any **three** from: • insulate the beaker **or** use polystyrene cup • add a lid • stir more (times) • repeat the experiment **and** calculate the mean (ignoring anomalous results) • use smaller volume (of water) • use larger mass of ammonium nitrate • more accurate balance • use digital thermometer **or** use a more accurate thermometer		3	AO3 5.5.1.1
03.3	(from 0 to 1.5 minutes the) temperature decreases (because) ammonium nitrate dissolving is endothermic (then) after 1.5 minutes the temperature increases (because) energy transfers to the solution from the surroundings	allow the temperature decreases (from 21.4 ºC to 15.4 ºC) (then) after 15.4 ºC the temperature increases	1 1 1 1	AO3 5.5.1.1

03.4	labelled horizontal lines for reactants and products, with the product line below the level of the reactant line reaction pathway line from reactants to maximum labelled activation energy line from reactants to products labelled overall energy change	 allow curve to start / finish anywhere along reactant / product lines	1 1 1 1	AO1 5.5.1.2
	the diagram below scores 4 marks  			
Total			**12**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	C_{60}		1	AO1 5.2.3.3
04.2	(graphite has) delocalised electrons (so the delocalised electrons) carry electrical charge through the structure	 allow (so the delocalised electrons) move through the structure	1 1	AO1 5.2.3.2
04.3	carbon atoms have different sizes to iron atoms / ions (so carbon atoms) distort the layers of iron atoms / ions (therefore) the layers cannot slide		1 1 1	AO1 5.2.2.7
04.4	(percentage and mass of other elements) 28.08 (%) = 16.29 (g) (mass of fork) = $\frac{16.29}{28.08} \times 100$ (g) = 58.01 (g) (mass of iron = $\frac{71.92}{100} \times 58.01$) = 41.72 (g)	 allow (mass of fork – mass of other elements) = 41.72 (g) allow 41.7 (g) allow correct use of incorrect calculation of mass and / or percentages	 1 1 1 1	AO2 5.2.2.7
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	reduction (as H^+ ions) gain electrons	ignore electrolysis	1 1	AO2 AO1 5.4.1.4 5.4.3.1 5.4.3.4 RPA 9
05.2	$2\,Cl^- \rightarrow Cl_2 + 2\,e^-$	allow $2\,Cl^- - 2\,e^- \rightarrow Cl_2$ ignore state symbols allow **1** mark for $Cl_2 + e^-$ allow **1** mark for $-\ e^-$ (on lhs) **and** Cl_2 (on rhs)	2	AO2 5.4.1.4 5.4.3.1 5.4.3.4 RPA9
05.3	water molecules break down to produce OH^- ions (which are) attracted to the positive electrode (where OH^- ions are) oxidised **or** (where OH^- ions) lose electrons	 allow dissociate to produce OH^- ions ignore discharged ignore oxygen is produced as no halide is present	1 1 1 1	AO1 5.4.1.4 5.4.3.1 5.4.3.4 5.4.3.5 RPA9
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(mass of oxygen = 0.20 – 0.12) = 0.08 (g)		1	AO2 5.1.1.1 5.3.1.1 5.3.1.3 5.3.2.1 5.4.1.1
	(moles of oxygen) = $\frac{0.08}{32}$	allow **1** mark for 0.005 if derived from $\frac{0.08}{16}$	1	
	= 0.0025		1	
06.2	(without a lid the) mass of magnesium oxide was less		1	AO3 5.4.1.1
	(because) products escaped	allow magnesium oxide escaped	1	
06.3	(mass of copper oxide =) $\frac{79.5}{63.5} \times 0.5$		1	AO2 5.1.1.1 5.3.1.1 5.3.1.3 5.3.2.1 5.3.2.2 5.3.2.3 5.4.1.1
	= 0.62598 (g)		1	
	= 0.626 (g)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all the values in the question	1	

06.4	3:2 ratio Fe : O_2 (molecules) **or** 3:4 ratio Fe : O (atoms)		1	AO2 5.1.1.1 5.3.1.1 5.3.1.3 5.3.2.1 5.3.2.2 5.3.2.3 5.4.1.1
	(formula) Fe_3O_4	allow **1** mark for Fe_3O_2 from 3:2 ratio Fe : O (atoms) (MP2 but not MP1)	1	
	$3Fe + 2O_2 \rightarrow Fe_3O_4$	allow multiples allow correct use of incorrectly determined formula allow **1** mark for Fe, O_2 and Fe_3O_4 **or** allow **1** mark for Fe, O_2 and incorrectly determined formula	2	
Total			**12**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	particles collide (but at room temperature) particles have insufficient energy **or** (but) have energy less than the activation energy (so collisions are not successful)		1 1	AO3 5.5.1.2
07.2	2120 (kJ/mol)		1	AO3 5.5.1.2 5.5.1.3
07.3	 (bonds broken = (8 × 410) + 2 **X** + (5 × 500) = 5780 + 2 **X** (bonds formed = (6 × 740) + (8 × 460) = 8120 (bonds broken – bonds formed = energy released) (5780 + 2 **X**) – 8120 = – 1640 (2 **X** =) 700 (**X** =) 350 (kJ/mol)	allow C–C for **X** allow (bonds broken = (8 × 410) + (5 × 500) = 5780 allow correct use of incorrect values from step 1 and/or step 2 allow correct use of incorrect value from step 3	 1 1 1 1 1	AO2 5.5.1.3
Total			**8**	

AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: TRILOGY

H

Higher Tier
Chemistry Paper 1H

Time allowed: 1 hour 15 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.
- 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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

Information
- The maximum mark for this paper is 70.
- 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.

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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0 1 This question is about salts.

Green copper carbonate and sulfuric acid can be used to produce blue copper sulfate crystals.

0 1 . 1 **Excess** copper carbonate is added to sulfuric acid.

Give **three** observations you would make.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 1 . 2 How can the excess copper carbonate be removed?

[1 mark]

_____

_____

0 1 . 3 The pH of the solution changes during the reaction.

What is the pH of the solution at the end of the reaction?

[1 mark]

pH = _____

0 1 . 4 Copper carbonate and sulfuric acid react to produce copper sulfate.

What type of reaction is this?

[1 mark]

_____

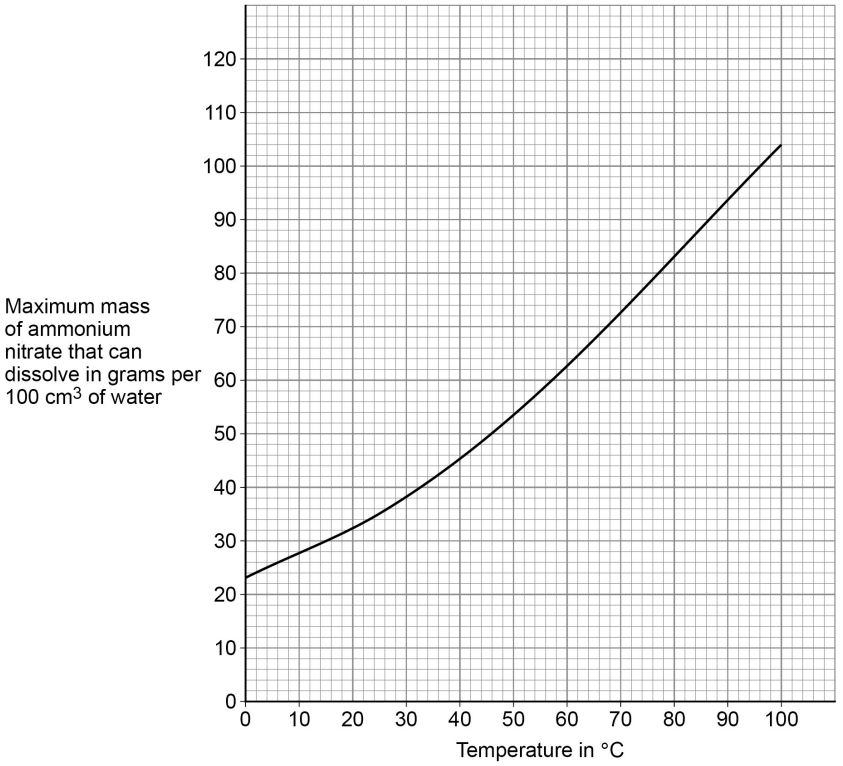
Turn over ►

Do not write outside the box

0 1 . 5 Ammonium nitrate is a salt.

Figure 1 shows the maximum mass of ammonium nitrate that can dissolve in 100 cm^3 of water at different temperatures.

Figure 1



A student adds ammonium nitrate to water at 80 °C until no more dissolves.

The student cools 100 cm^3 of this solution of ammonium nitrate from 80 °C to 20 °C to produce crystals of ammonium nitrate.

Determine the mass of ammonium nitrate that crystallises on cooling 100 cm^3 of this solution from 80 °C to 20 °C

[3 marks]

Mass = _____ g

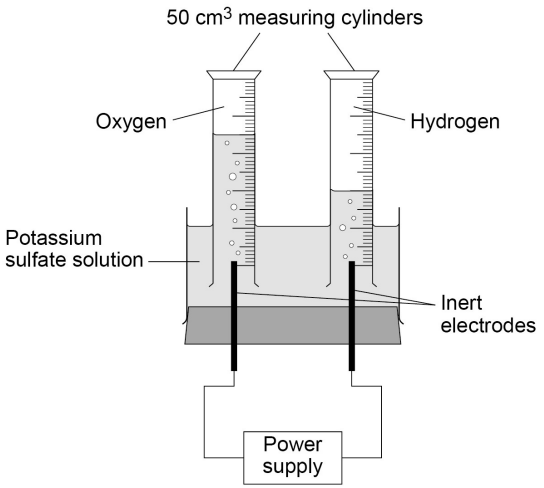
9

Turn over for the next question

0 2 This question is about electrolysis.

Figure 2 shows the apparatus used to investigate the electrolysis of potassium sulfate solution.

Figure 2



0 2 . 1 Potassium sulfate contains K^+ and SO_4^{2-} ions.

What is the formula of potassium sulfate?

[1 mark]

Tick (✓) **one** box.

KSO_4 ☐

K_2SO_4 ☐

$K(SO_4)_2$ ☐

$K_2(SO_4)_2$ ☐

Do not write outside the box

0 2 . 2 What are the volumes of gases collected in the electrolysis experiment?

Use **Figure 2.**

[1 mark]

Volume of hydrogen = _____ cm^3

Volume of oxygen = _____ cm^3

0 2 . 3 A student made the following hypothesis:

'The volumes of gases collected in this electrolysis experiment are in the same ratio as hydrogen atoms to oxygen atoms in a water molecule.'

Explain how the volumes of gases collected in the experiment in **Figure 2** support the student's hypothesis.

Use your answer to Question **02.2**

[2 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 4 The experiment is repeated 4 times.

The volumes of oxygen collected in the 4 experiments are:

6 cm^3 9 cm^3 10 cm^3 11 cm^3

The mean volume of oxygen collected in the 4 experiments is 9 cm^3

The measure of uncertainty is the range of a set of measurements about the mean.

What is the measure of uncertainty in the 4 experiments?

[1 mark]

Tick (✓) **one** box.

9 ± 1 cm^3 ☐

9 ± 2 cm^3 ☐

9 ± 3 cm^3 ☐

0 2 . 5 The potassium sulfate solution has 0.86 g of potassium sulfate dissolved in 25 cm^3 of water.

Calculate the mass of potassium sulfate needed to make 1.0 dm^3 of solution.

[3 marks]

Mass = _____ g

8

Do not write outside the box

0 3 Plan an investigation to find the order of reactivity of three metals.

You should use the temperature change when each metal reacts with hydrochloric acid.

[6 marks]

6

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

0 4 This question is about Group 7 elements.

0 4 . 1 What are the Group 7 elements known as?

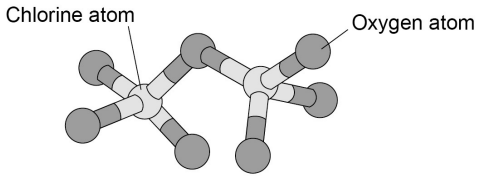
[1 mark]

0 4 . 2 Why do Group 7 elements react in similar ways?

[1 mark]

0 4 . 3 **Figure 3** shows the structure of a molecule of chlorine oxide.

Figure 3



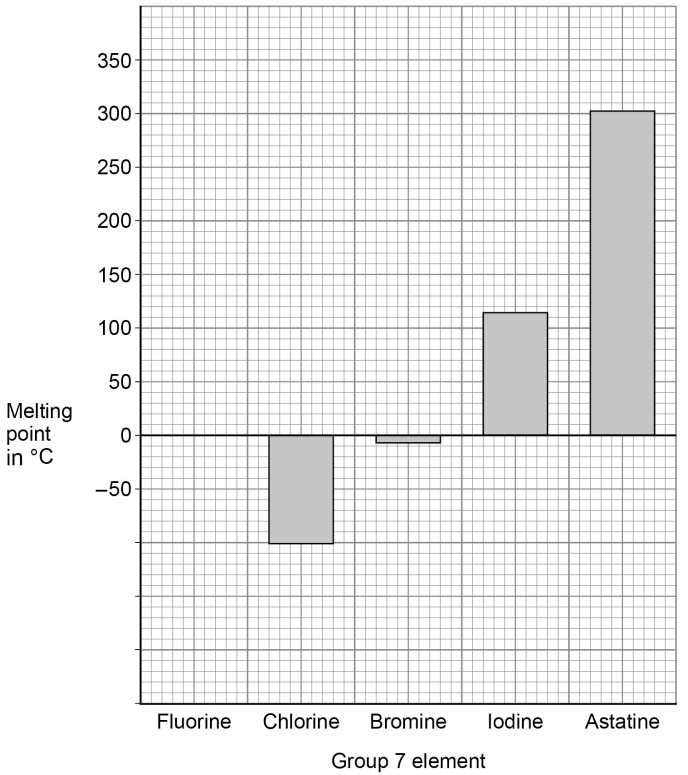
What is the molecular formula of the chlorine oxide molecule in **Figure 3**?

[1 mark]

Question 4 continues on the next page

Figure 4 shows the melting points of some Group 7 elements.

Figure 4



0 4 . 4 The melting point of fluorine is –220 °C

Complete **Figure 4.**

You should:

- complete the scale on the y-axis
- draw the bar for the melting point of fluorine.

[2 marks]

Do not write outside the box

0 4 . 5 Explain the trend in the melting points of the Group 7 elements.

Use **Figure 4.**

[3 marks]

0 4 . 6 What is the state symbol for bromine at –50 °C?

Use **Figure 4.**

[1 mark]

Tick (✓) **one** box.

(aq) ☐ (g) ☐ (l) ☐ (s) ☐

0 4 . 7 Evaporation and boiling occur at the surface of bromine at its boiling point.

Name **one** more process that happens at the surface of bromine at its boiling point.

[1 mark]

10

Turn over for the next question

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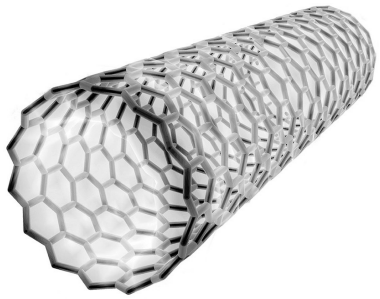
0 5 This question is about structure and bonding.

0 5 . 1 **Figure 5** represents part of a carbon molecule.

Figure 5



Name the type of carbon molecule in **Figure 5.**

[1 mark]

0 5 . 2 Suggest **one** property that makes the carbon molecule in **Figure 5** useful in nanotechnology.

[1 mark]

Do not write outside the box

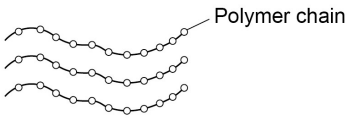
0 5 . 3 An alloy of aluminium contains small amounts of other metals.

Explain why other metals are added to aluminium.

[4 marks]

0 5 . 4 **Figure 6** represents part of the structure of a polymer.

Figure 6



Compare the bonding within the chains with the forces between the chains in this polymer.

[3 marks]

9

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0 6 This question is about hydrogen chloride and hydrochloric acid.

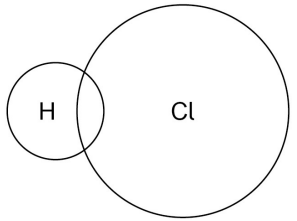
0 6 . 1 Complete the dot and cross diagram to represent the bonding in hydrogen chloride on **Figure 7**.

Use dots (o) and crosses (x) to represent electrons.

You should show only the electrons in the outer shells.

[2 marks]

Figure 7



0 6 . 2 Hydrogen chloride dissolves in water to produce hydrochloric acid.

Hydrochloric acid is a strong acid.

What is meant by the term strong acid?

[1 mark]

0 6 . 3 Describe how magnesium can be used to distinguish between a strong acid and a weak acid of the same concentration.

[2 marks]

Do not write outside the box

0 6 . 4 The concentration of hydrochloric acid is increased by a factor of 100

What is the change in pH?

[2 marks]

Question 6 continues on the next page

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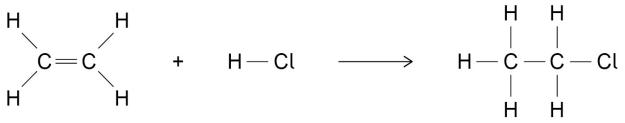
0 6 . 5 Ethene and hydrogen chloride react to produce chloroethane.

The displayed formulae equation for the reaction is:



The reaction is exothermic.

In the reaction the energy released forming new bonds is 56 kJ/mol greater than the energy needed to break existing bonds.

Table 1 shows some bond energies.

Table 1

Bond	**H–C**	**C=C**	**H–Cl**	**C–C**	**C–Cl**
Bond energy in kJ/mol	413	**X**	431	346	339

Calculate the bond energy **X**.

[4 marks]

X = _____ kJ/mol

11

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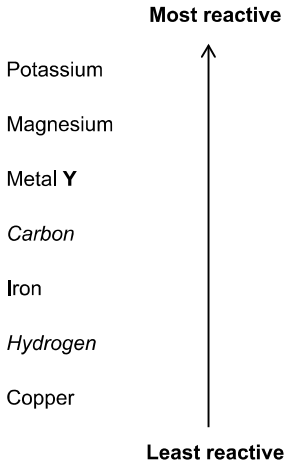
0 7 This question is about elements and compounds.

0 7 . 1 **Figure 8** shows a reactivity series.

Figure 8



Give the method and conditions used to extract metal **Y** from a compound of metal **Y**.

[2 marks]

Question 7 continues on the next page

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Sodium reacts with titanium chloride ($TiCl_4$) to produce titanium.

0 7 . 2 Complete the equation.

You should balance the equation.

[2 marks]

____ Na + $TiCl_4$ → _____ + _____

0 7 . 3 The reaction between sodium and titanium chloride is a redox reaction.

Write a half-equation to show that sodium is oxidised in this reaction.

[2 marks]

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0 7 . 4 108 g of aluminum reacts with 1.21 kg of copper chloride to produce copper.

The equation for the reaction is:

$$2\,Al + 3\,CuCl_2 \rightarrow 3\,Cu + 2\,AlCl_3$$

Calculate the maximum mass of copper produced in grams (g).

You should determine the limiting reactant.

Relative atomic masses (A_r): Al = 27 Cu = 63.5

Relative formula masses (M_r): $CuCl_2$ = 134.5 $AlCl_3$ = 133.5

[6 marks]

Limiting reactant is _____

Mass of copper = _____ g

Question 7 continues on the next page

Turn over ►

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Sodium metal and sodium chloride are both able to conduct electricity.

0 7 . 5 Describe how sodium metal conducts electricity.

[2 marks]

0 7 . 6 Explain how sodium chloride can conduct electricity.

[3 marks]

17

END OF QUESTIONS

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AQA

GCSE
COMBINED SCIENCE: TRILOGY
8464/C/1H

Chemistry Paper 1H

Mark scheme

June 2022

Version: 1.0 Final Mark Scheme

226G8464C1H/MS

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	any **three** from: • green solid / powder • colourless solution • blue solution formed • copper carbonate disappears • fizzing / effervescence **or** bubbles (of gas) • stops fizzing • solid / powder left at the end **or** copper carbonate left at the end	 ignore green copper carbonate allow colour (of solution) changes allow solid disappears ignore gas allow fizzing slows down allow (container) gets hot **or** allow temperature increases	3	AO2 AO3 5.4.2.2 5.4.2.3 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	filtration **or** filter		1	AO1 5.4.2.3 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	7		1	AO1 5.4.2.3 5.4.2.4 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	neutralisation	allow exothermic	1	AO1 5.4.2.2 5.4.2.4 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	83 (g at 80 °C)	allow a value in range 82–84 (g at 80 °C)	1	AO2
	32 (g at 20 °C)	allow a value in range 32–33 (g at 20 °C)	1	AO2
	(83–32 =) 51 (g)	allow a correct calculation using incorrectly read values for mass at 80 °C and/or 20 °C	1	AO3 5.4.2.3

Total Question 1		9

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	K_2SO_4		1	AO2 5.1.1.1 5.4.3.4 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	(volume of hydrogen) 30 (cm^3) **and** (volume of oxygen) 15 (cm^3)		1	AO2 5.4.3.4 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	(because) the ratio of volume of hydrogen : oxygen is 2 : 1 (and this is the) **same** as the ratio of hydrogen (atoms) : oxygen (atoms) in (formula of) H_2O **OR** (because) the ratio of volume of hydrogen : oxygen is **not** 2 : 1 (1) (and this is) **different** to the ratio of hydrogen (atoms) : oxygen (atoms) in (formula of) H_2O (1)	**must** relate to the volumes given in question **02.2**	1 1	AO3 5.4.3.4 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	9 ±3 cm^3		1	AO2 5.3.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	(conversion) ($\frac{25}{1000}$ =) 0.025 (dm^3)		1	AO2 5.3.2.5 5.4.3.4
	(concentration =) $\frac{0.86}{0.025}$	allow correct use of incorrect / no conversion	1	
	= 34.4 (g per dm^3)	allow 34 (g per dm^3)	1	
	OR			
	(conversion) $\frac{1000}{25}$ (1)			
	= 40 (1)			
	(40 × 0.86) = 34.4 (g per dm^3) (1)	allow correct use of incorrect / no conversion allow 34 (g per dm^3)		
	OR			
	(concentration =) $\frac{0.86}{25}$ (1)			
	= 0.0344 (1)			
	(conversion) (0.0344 × 1000) = 34.4 (g per dm^3) (1)	allow 34 (g per dm^3)		

Total Question 2		8

Question 3

Question	Answers	Mark	AO / Spec. Ref.
03	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	AO3
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1
	No relevant content.	0	
	Indicative Content • measure volume of (hydrochloric) acid • into a suitable container eg polystyrene cup • measure the initial temperature (of hydrochloric acid) • with a thermometer • add stated mass of one metal • stir • measure the highest temperature reached of the solution **or** measure temperature reached after a set time period • determine the temperature difference • repeat • repeat for each metal • with same mass • in same physical state (powder, lump, etc) • with the same volume and / or concentration of (hydrochloric) acid • use results to arrange metals in order of reactivity • most reactive metal has the largest temperature change to access level 3 there must be an indication of how the temperature change is determined with the same mass of the 3 different metals reacted with the same volume of (hydrochloric) acid		5.1.4.2 RPA2

Total Question 3		6

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	halogens		1	AO1 5.1.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	all have 7 electrons in outer shell **or** all have 7 outer electrons	allow energy level for shell allow same number of outer electrons allow one electron required to complete the outer shell	1	AO1 5.1.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	Cl_2O_7		1	AO2 5.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	*y*-axis scale correct from –100 to –250 °C bar correctly plotted at –220 °C	 allow a tolerance of ± ½ a small square	1 1	AO2 5.1.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(the) molecules increase in size going down the group	allow converse explanation in terms of decreasing melting point allow atoms increase in size going down the group allow increase in number of electron shells going down group	1	AO3
	(so the) forces between the molecules increase **or** (so the) intermolecular forces increase		1	AO1
	(so the) melting points increase going down the group **or** (so the) melting points increase with increasing relative atomic mass	allow (so) more energy is needed to separate the molecules	1	AO1 5.1.2.6 5.2.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(s)		1	AO3 5.1.2.6 5.2.2.1 5.2.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	condensation	allow condensing ignore evaporating and boiling	1	AO1 5.2.2.1

Total Question 4		**10**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	fullerene	allow (carbon) nanotube do **not** accept Buckminsterfullerene	1	AO1 5.2.3.3

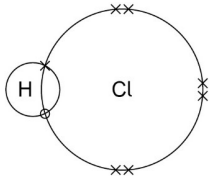
Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	any **one** from: • conducts heat • conducts electricity • very high length to diameter ratio	 allow large surface area to volume ratio allow high tensile strength allow can trap other molecules / atoms / ions	1	AO2 5.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	other metal atoms have different sizes to aluminium atoms (so) the layers of aluminium atoms are distorted (so) the layers cannot slide (which) makes the alloy harder	 allow (so) the atoms cannot slide over each other allow (which) makes the alloy stronger	1 1 1 1	AO1 5.2.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	covalent bonds (between atoms) in the chain intermolecular forces between the chains covalent bonds are strong **and** intermolecular forces are weak		1 1 1	AO1 5.2.2.5

Total Question 5		**9**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1		allow any combination of circles, dots, crosses or $e^{(-)}$		AO1 5.1.2.6 5.2.1.4
	one shared pair in overlap		1	
	6 non-bonding electrons in outer shell of chlorine	do **not** accept extra electron(s) on outer shell of hydrogen ignore any inner shell electrons	1	
		an answer of  scores **2** marks		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	completely ionises in aqueous solution	allow completely dissociates in aqueous solution	1	AO1 5.4.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	fizzing / effervescence **or** magnesium disappears		1	AO3 5.4.2.5
	at a greater rate with a strong acid	allow converse with weak acid	1	
		allow for **2** marks strong acid has a greater temperature increase		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(pH) decreases	allow pH is lower	1	AO1
	by (a unit of) 2		1	AO2 5.4.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	(bonds broken = (4 × 413) + C=C + 431 =) 2083 + **C=C**		1	AO2 5.5.1.3
	(bonds made = (346 + 339 + (5 × 413) =) 2750		1	
	(energy released = bonds made – bonds broken =) 56 = 2750 – [2083 + C=C]	allow correct use of incorrect value(s) from step 1 and / or step 2	1	
	(C=C) = 611 (kJ/mol)		1	

Total Question 6		11

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	electrolysis		1	AO3 5.4.1.3
	of molten compound (of metal **Y**)	allow liquid for molten	1	5.4.3.2 5.4.3.3
	OR			
	displacement (1)			
	by heating with a more reactive metal **or** by heating with potassium / magnesium (1)			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	4 Na + $TiCl_4$ → 4 NaCl + Ti	allow multiples allow **1** mark for NaCl **and** Ti with incorrect / no balancing	2	AO2 5.1.1.1 5.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	$Na \rightarrow Na^+ + e^-$	ignore state symbols allow multiples allow **1** mark for $Na \rightarrow Na^+ + e^-$ with incorrect balancing	2	AO2 5.4.1.2 5.4.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	**method 1:** (moles of Al = $\frac{108}{27}$ =) 4		1	AO2 5.3.2.2 5.3.2.4
	(moles $CuCl_2$ = $\frac{1210}{134.5}$ =) 8.996	allow 9	1	
	(identifying limiting reactant) 4 moles Al gives 6 moles Cu 8.996 moles $CuCl_2$ gives 8.996 moles Cu	allow correct use of an incorrectly calculated value(s) for moles of Al and / or $CuCl_2$	1	
	therefore aluminium is the limiting reactant	must follow on from MP3	1	
	(mass of Cu = 2 × 3 × 63.5) = 6 × 63.5		1	
	= 381 (g)		1	

07.4 cont.	**method 2:** $2Al + 3CuCl_2 \rightarrow 3Cu + 2AlCl_3$ (2×27) (3×134.5) (3×63.5) 54 (g) 403.5 (g) 190.5 (g) (1) (1) (1) (so) 108 g Al (reacts with 807 g $CuCl_2$) to produce 381 g Cu (1)	allow correct use of an incorrect calculation of mass for Al / $CuCl_2$ / Cu		
	(so) there is excess $CuCl_2$ **or** 807 g $CuCl_2$ is less than 1210 g $CuCl_2$ (1)			
	therefore aluminium is limiting reactant (1)	must follow on from MP4 / MP5		
	method 3: 134.5 g $CuCl_2$ produces 63.5 g Cu (1)			
	(mass conversion 1.21 kg $CuCl_2$ =) 1210 (g) (1)			
	1210 g $CuCl_2$ produces ($\frac{63.5}{134.5}$ × 1210 =) 571 g Cu (1)	allow correct use of an incorrect / no conversion of mass of $CuCl_2$		
	54 g Al produces 190.5 g Cu (1)			
	108 g Al produces ($\frac{190.5}{54}$ × 108 =) 381 (g) (1)			
	(therefore) aluminium is the limiting reactant (1)	must follow on from MP3 and MP5		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	delocalised electrons carry (electrical) charge through the metal / sodium	allow free electrons ignore throughout for through ignore current / electricity MP2 is dependent upon MP1	1 1	AO1 5.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(conducts electricity) when liquid / molten **or** (conducts electricity) in (aqueous) solution (because) <u>ions</u> (ions) are free to move **or** (ions) allow charge to flow	allow (conducts electricity) when dissolved in water	1 1 1	AO1 5.2.2.3

Total Question 7		17