2024

Name_____

Combined Science

Foundation

Chemistry: Paper 2

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

F

Foundation Tier
Chemistry Paper 2F

Wednesday 12 June 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.

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.

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

Do not write outside the box

0 1 . 1 This question is about gases.

Draw **one** line from each substance to the description of the substance.

[3 marks]

Substance	Description of substance
	Compound
Air	Element
Carbon dioxide	Hydrocarbon
Oxygen	Metal
	Mixture

Do not write outside the box

0 1 . 2 What is used to test for each of the gases?

Draw **one** line from each gas to the test for the gas.

[2 marks]

Gas	Test
Carbon dioxide	A glowing splint
	A lighted splint
Oxygen	Limewater
	Litmus paper

0 1 . 3 Give **two** reasons why the percentage of carbon dioxide in the air has decreased in the last 2.7 billion years.

[2 marks]

Tick (✓) **two** boxes.

- Combustion ☐
- Dissolved in oceans ☐
- Intense volcanic activity ☐
- Photosynthesis ☐
- Respiration ☐

Do not write outside the box

Oxygen reacts with sulfur dioxide.

The reaction is reversible.

0 1 . 4 What is the symbol for a reversible reaction?

[1 mark]

_____

0 1 . 5 Complete the sentence.

[1 mark]

In a reversible reaction the forward reaction is exothermic, so the

reverse reaction is _____ .

0 1 . 6 A reversible reaction happens in apparatus which stops the escape of reactants and products.

Complete the sentence.

[1 mark]

Equilibrium is reached when the forward and reverse reactions happen at

exactly the same _____ .

10

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 Concrete contains cement, water, sand and small stones.

0 2 . 1 Concrete is a mixture designed as a useful product.

What do we call a mixture which has been designed as a useful product?

[1 mark]

Tick (✓) **one** box.

- Finite ☐
- Formula ☐
- Formulation ☐
- Fraction ☐

0 2 . 2 Concrete contains cement.

Cement is made by heating a mixture containing silicon dioxide (SiO_2).

Why does silicon dioxide have a very high melting point?

[2 marks]

Tick (✓) **two** boxes.

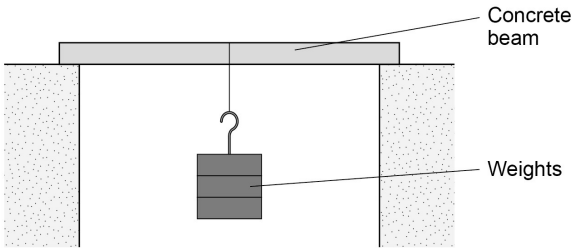
- It has a giant structure ☐
- It has a simple molecular structure ☐
- It has strong covalent bonds ☐
- It has strong ionic bonds ☐
- It has weak intermolecular forces ☐

Student **A** investigated how the mass of the small stones in concrete affects the strength of a concrete beam. All other variables were kept the same.

The student added weights until the concrete beam broke.

Figure 1 shows the apparatus Student **A** used.

Figure 1



0 2 . 3 Draw **one** line from each type of variable to the correct example of the variable.

[2 marks]

Type of variable	Example of variable
	Length of concrete beam
Control	Mass of small stones in concrete
Independent	Time taken to add weights
	Weight needed to break concrete beam

Table 1 shows Student **A**'s results.

Table 1

Mass of small stones in grams (g)	Weight needed to break concrete beam in newtons (N)
500	70
1000	100
1500	110
2000	100
2250	85
2500	65
2750	35

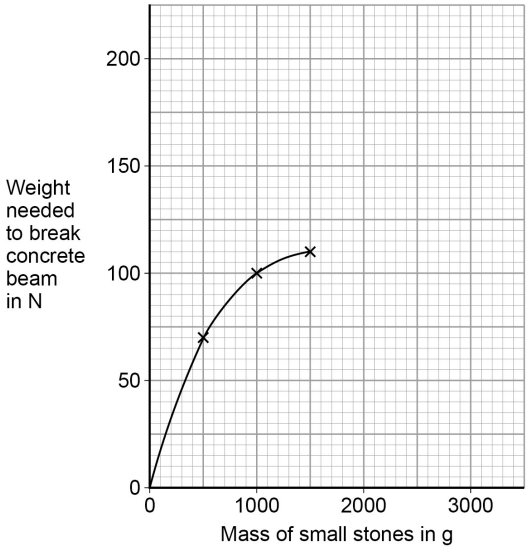
0 2 . 4 Plot the data from **Table 1** on **Figure 2**.

The first three points are plotted for you.

Draw the line of best fit.

[3 marks]

Figure 2



Do not write outside the box

0 2 . 5 What mass of small stones would be needed to make the strongest concrete?

Give a reason for your answer.

Use **Figure 2**.

[2 marks]

Mass = _____ g

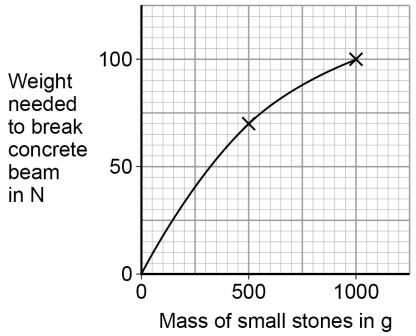
Reason _____

_____

0 2 . 6 Student **B** did a similar investigation.

Figure 3 shows Student **B**'s results.

Figure 3



How could Student **B** improve their investigation?

Use **Figure 2** and **Figure 3**.

[1 mark]

_____

_____

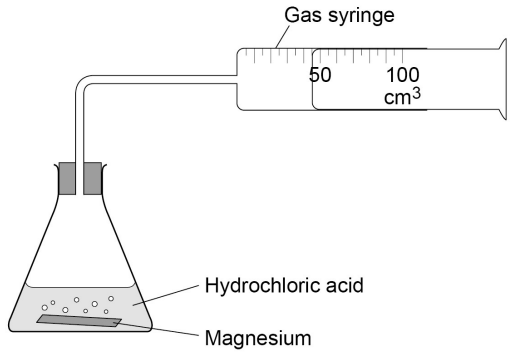
11

Do not write outside the box

0 3 A student investigated the rate of the reaction between magnesium and hydrochloric acid.

Figure 4 shows the apparatus the student used.

Figure 4



0 3 . 1 Balance the equation for the reaction.

[1 mark]

$$Mg + \_\_\_\_ HCl \rightarrow MgCl_2 + H_2$$

0 3 . 2 The student used 50 cm^3 of hydrochloric acid.

Which apparatus would measure 50 cm^3 of hydrochloric acid with the greatest accuracy?

[1 mark]

Tick (✓) **one** box.

50 cm^3 beaker ☐

50 cm^3 conical flask ☐

50 cm^3 measuring cylinder ☐

Do not write outside the box

0 3 . 3 The student measured the volume of gas produced every 20 seconds for 2 minutes.

The volume of gas was zero at the start of the experiment.

The measured volumes of gas were:

26 cm^3 38 cm^3 47 cm^3 55 cm^3 59 cm^3 60 cm^3

Complete **Table 2** to show these results.

[4 marks]

Table 2

0	0

0 3 . 4 The volumes of gas were lower than expected.

Suggest **one** reason.

[1 mark]

0 3 . 5 The student repeated the experiment using different concentrations of hydrochloric acid.

Give **two** variables the student should keep the same.

[2 marks]

1 _____

2 _____

Turn over ►

Do not write outside the box

0 3 . 6 Complete the sentences.

[3 marks]

As the concentration of the hydrochloric acid increased, the rate of the reaction _____ .

This is because there were more acid _____ in each cubic centimetre (cm^3).

So the collisions happened more _____ .

12

Do not write outside the box

0 4 Large hydrocarbon molecules can be cracked to produce smaller, more useful molecules.

Alkanes and alkenes are produced when hydrocarbons are cracked.

0 4 . 1 Give **two** conditions used for cracking.

[2 marks]

1 _____

2 _____

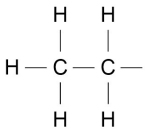
0 4 . 2 Butane (C_4H_{10}) is an alkane.

Figure 5 shows part of the displayed structural formula of butane.

Complete the displayed structural formula of butane in **Figure 5**.

[1 mark]

Figure 5



0 4 . 3 Butane burns in oxygen.

Complete the word equation for the complete combustion of butane.

[2 marks]

butane + oxygen → _____ + _____

Question 4 continues on the next page

Do not write outside the box

0 4 . 4 Ethene is an alkene.

Give a test for alkenes.

Give the result of the test if an alkene is present.

[2 marks]

Test _____

Result _____

_____

0 4 . 5 Each year many tonnes of crude oil are extracted from the Earth.

It took millions of years for the crude oil to be formed.

What do we call development that meets the needs of current generations without compromising the resources for future generations?

[1 mark]

Tick (✓) **one** box.

Finite development ☐

Global development ☐

Natural development ☐

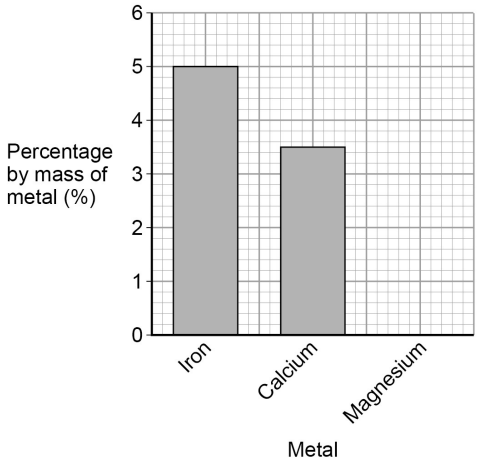
Sustainable development ☐

8

Do not write outside the box

0 5 **Figure 6** shows the percentage by mass of some metals in the Earth's crust.

Figure 6



0 5 . 1 What is the percentage by mass of calcium in the Earth's crust?

[1 mark]

Tick (✓) **one** box.

3.25% ☐ 3.50% ☐ 4.50% ☐ 5.00% ☐

0 5 . 2 The percentage by mass of magnesium in the Earth's crust is 2.1%

Draw the bar for magnesium on **Figure 6**.

[1 mark]

Question 5 continues on the next page

Do not write outside the box

0 5 . 3 Copper sulfate is produced during the extraction of copper from the Earth's crust.

Copper is produced from copper sulfate solution using iron.

The word equation for the reaction is:

copper sulfate + iron → iron sulfate + copper

From the equation a company calculated that 648 kg of copper sulfate are needed to produce 617 kg of iron sulfate and 258 kg of copper.

Calculate the mass of iron needed to make 258 kg of copper.

[2 marks]

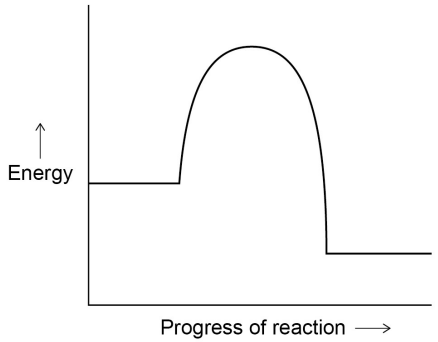
Mass = _____ kg

Do not write outside the box

Copper is used as a catalyst.

0 5 . 4 **Figure 7** shows the reaction profile for a reaction without a catalyst.

Figure 7

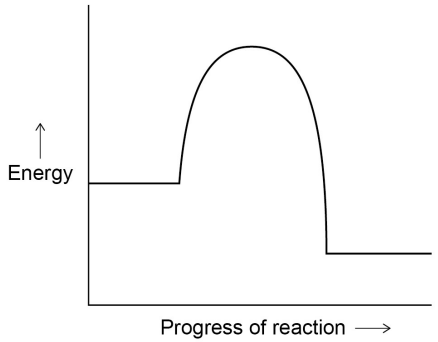


Draw an arrow on **Figure 7** to show the activation energy.

[1 mark]

0 5 . 5 The reaction profile for the reaction without a catalyst is shown again in **Figure 8.**

Figure 8



Draw a reaction profile on **Figure 8** for the same reaction with a catalyst.

[2 marks]

Turn over ►

Do not write outside the box

0 5 . 6 What are catalysts in biological systems called?

[1 mark]

Tick (✓) **one** box.

- Detergents ☐
- Enzymes ☐
- Polymers ☐
- Solvents ☐

8

Do not write outside the box

0 6 Water that is safe to drink contains dissolved substances.

0 6 . 1 What do we call water that is safe to drink?

[1 mark]

Tick (✓) **one** box.

Desalinated ☐

Filtered ☐

Fresh ☐

Potable ☐

0 6 . 2 Describe a test for pure water.

Give the result of the test if the water is pure.

[2 marks]

Test _____

Result _____

_____

_____

Question 6 continues on the next page

Do not write outside the box

0 6 . 3 Describe a method to determine the mass of dissolved solids in a 100 cm^3 sample of river water.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

0 6 . 4 A sample of river water contains 125 mg per dm^3 of dissolved solids.

Calculate the mass of dissolved solids in grams in 250 cm^3 of this sample of river water.

Give your answer to 2 significant figures.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

Mass of dissolved solids = _____ g

Do not write outside the box

0 6 . 5 A water company allows a maximum of 500 mg per dm^3 of sulfate ions in drinking water.

A sample of drinking water contains 44 mg per dm^3 of sulfate ions.

Calculate the percentage (%) of the maximum allowed mass of sulfate ions in the sample of drinking water.

[2 marks]

Percentage (%) of the maximum allowed mass = _____ %

13

Turn over for the next question

Do not write outside the box

0 7 This question is about atmospheric pollutants from fuels.

0 7 . 1 Fuel burns in a car engine.

Describe how oxides of nitrogen are produced in a car engine.

[2 marks]

Do not write outside the box

0 7 . 2 **Table 3** shows the carbon footprint during the manufacture and use of three cars.

Table 3

Car	Mass of CO_2 produced during manufacture in kg	Mass of CO_2 produced when driving in kg per km	Total mass of CO_2 produced from manufacture and 40 000 km driving in kg	Total mass of CO_2 produced from manufacture and 100 000 km driving in kg
Car A	14 000	0.123	18 920	26 300
Car B	20 000	0.085	23 400	28 500
Car C	23 000	0.044	24 760	27 400

Evaluate the carbon footprint of the cars.

Use information from **Table 3**.

[6 marks]

END OF QUESTIONS

8

Do not write outside the box

There are no questions printed on this page

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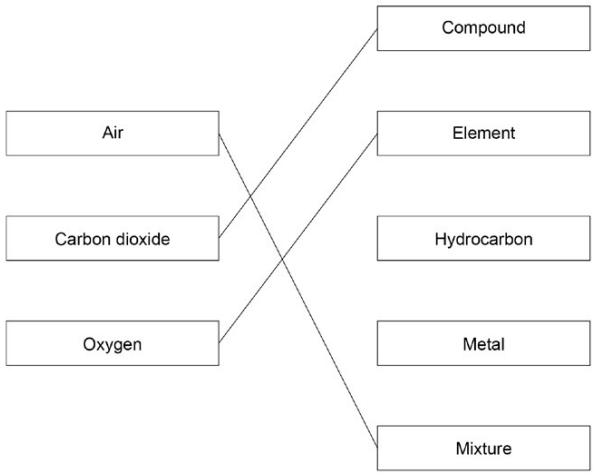
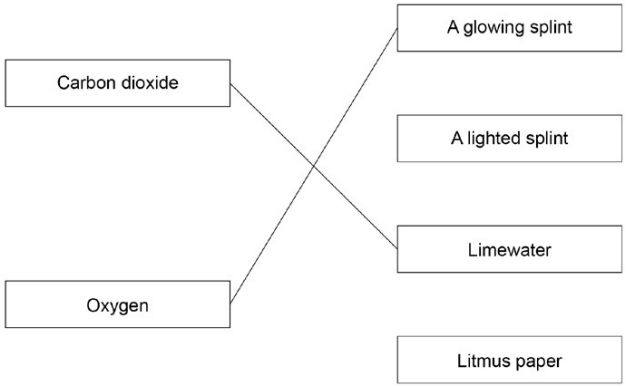
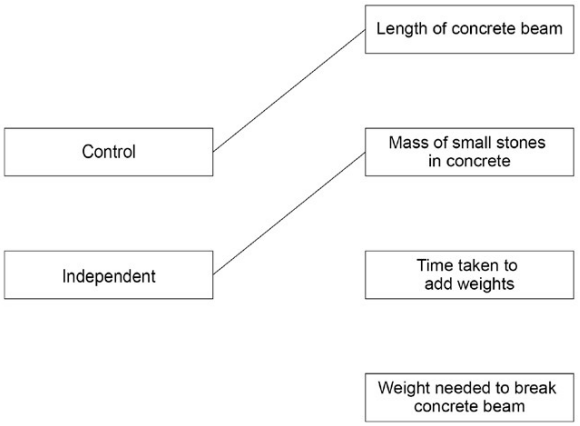
ANSWER IN THE SPACES PROVIDED

MARK SCHEME – GCSE COMBINED SCIENCE: TRILOGY – 8464/C/2F – JUNE 2019

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	 If more than one line is drawn from any one substance and not crossed out, no mark is given for that substance. The other marks can be awarded.		1 1 1	AO2.1 5.1.1.2 5.8.1.1 5.1.1.1
01.2	 If more than one line is drawn from any one gas and not crossed out, no mark is awarded for that gas. The other mark can be awarded.		1 1	AO1.1 5.8.2.2 5.8.2.3
01.3	dissolved in oceans photosynthesis		1 1	AO1 5.9.1.2 5.9.1.4

01.4	⇌	ignore any other words, formulae or symbols	1	AO1.1 5.6.2.1
01.5	endothermic (reaction)	spelling must be correct do **not** accept exothermic	1	AO1.1 5.6.2.2
01.6	rate (of reaction)	allow speed or velocity do **not** accept any other response	1	AO1 5.6.2.3
Total			**10**	

MARK SCHEME – GCSE COMBINED SCIENCE: TRILOGY – 8464/C/2F – JUNE 2019

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	formulation		1	AO1 5.8.1.2
02.2	it has a giant structure it has strong covalent bonds		1 1	AO1 5.2.2.6 5.2.1.4
02.3			1 1	AO3 AO2 5.8.1.2
02.4	all points correctly plotted line of best fit	allow a tolerance of ± ½ a small square allow 1 mark for 3 points correctly plotted allow reasonable attempt at line of best fit using incorrectly plotted points	2 1	AO2.2 5.8.1.2

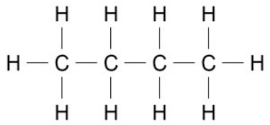
MARK SCHEME – GCSE COMBINED SCIENCE: TRILOGY – 8464/C/2F – JUNE 2019

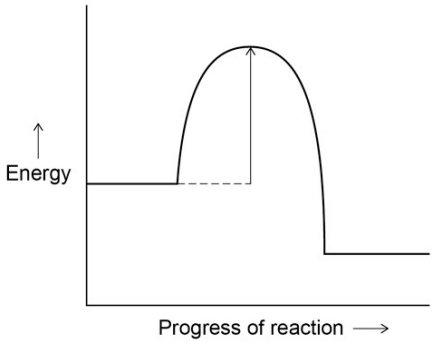
02.5	1500 (g) highest point on graph	allow range from 1400 (g) to 1600 (g) allow ecf from graph drawn in **Figure 2** MP2 dependent on MP1 allow highest / largest / greatest / most weight needed to break concrete. ignore numbers quoted from graph ignore strongest	1 1	AO3 5.8.1.2
02.6	take more measurements	allow indication of a greater range of values or allow indication of measurements at smaller intervals ignore repeat the investigation	1	AO3 5.8.1.2
Total			**11**	

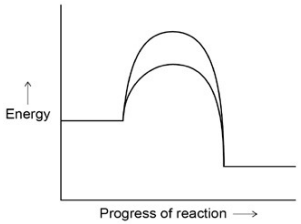
MARK SCHEME – GCSE COMBINED SCIENCE: TRILOGY – 8464/C/2F – JUNE 2019

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	2	allow multiples of whole equation	1	AO2 5.1.1.1 5.3.1.1 5.6.1.1 10.2.11
03.2	50 cm^3 measuring cylinder		1	AO3 5.6.1.1 10.2.11
03.3	headings: time **and** volume (of gas) units: s **and** cm^3 time values correct (and match units) volume values match time values	allow in either column allow any units of time and volume placed in relevant column ignore incorrect representation of time values if no other marks awarded allow **1** mark for time with correct units or volume with correct units	1 1 1 1	AO2 5.6.1.1 10.2.11
03.4	any **one** from: • concentration of the acid was lower (than expected) • some (gas) escaped • impure magnesium • temperature lower (than expected)	answers must relate to figure 4 ignore answers relating to amount or surface area or time	1	AO3 5.6.1.2 10.2.11

03.5	any **two** from: • length of magnesium or surface area of magnesium • volume of acid • temperature (of acid)	 allow mass of magnesium allow same form of magnesium allow same size of magnesium ignore concentration of hydrochloric acid ignore room temperature	2	AO2 5.6.1.2 10.2.11
03.6	increased particles frequently	allow went up allow got bigger allow ions or molecules ignore concentration allow often	1 1 1	AO1 5.6.1.2 5.6.1.3 10.2.11
Total			**12**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	any **two** from: • high temperature • catalyst • steam • high pressure • low oxygen atmosphere	ignore heat / hot allow a temperature between 400 °C and 900 °C allow aluminium oxide, alumina, porous pot, zeolites	2	AO1 5.7.1.4
04.2		all bonds and atoms must be present	1	AO1 5.7.1.1
04.3	carbon dioxide water	in either order allow CO_2 allow H_2O	1 1	AO1.1 5.7.1.3
04.4	bromine (water) turns (from orange / brown / yellow to) colourless	do **not** accept bromide MP2 is dependent on MP1 allow decolourises ignore clear	1 1	AO1 5.7.1.4
04.5	sustainable development		1	AO1 5.10.1.1
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	3.50 %		1	AO2 5.10.1.1
05.2	correct bar to 2.1 (%)	allow a tolerance of ± ½ a small square	1	AO2 5.10.1.1
05.3	(617 + 258) – 648 **or** 875 – 648 = 227 (kg)	an answer of 227 (kg) scores **2** marks	1 1	AO2 5.3.1.1
05.4	 ignore arrow heads		1	AO1 5.6.1.4

05.5	(curve) starts and ends at same energy levels as existing curve maximum of curve below maximum of existing curve	ignore references to activation energy only award if MP1 correct an answer of  scores **2** marks	1 1	AO1 5.6.1.4

05.6	enzymes		1	AO1 5.6.1.4

Total			**8**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	potable		1	AO1 5.10.1.2
06.2		allow boils at 100°C for **2** marks		AO2 5.8.1.1
	boil (water)	ignore heat do **not** accept filter do **not** accept incorrect test	1	
	(boils) at 100°C		1	
		alternative approach freeze (water) (1) (freezes) at 0°C (1) if no other mark awarded, allow 1 mark for evaporate or distil water **and** no solid left		
06.3	**Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		3–4	AO1 5.10.1.2 10.2.13
	Level 1: The design/plan would not necessarily lead to a valid outcome. Some steps are identified, but the plan may not be logically sequenced.		1–2	
	No relevant content		0	
	Indicative content • weigh container. • measure volume (100 cm^3) of water into container. • evaporate / heat until dry. • weigh container and remaining solids. • determine mass of dissolved solids to access Level 2 there should be an indication of using a known volume of water, heating until dry and determining the mass of solid.			

MARK SCHEME – GCSE COMBINED SCIENCE: TRILOGY – 8464/C/2F – JUNE 2019

06.4	(conversion of cm^3 to dm^3) ($250\ cm^3$ =) $\frac{250}{1000}$ or 0.25 (dm^3) (conversion of mg to g) (125 mg =) $\frac{125}{1000}$ or 0.125 (g) (0.25 × 0.125) = 0.03125 =0.031 (g)	an answer of 0.031 (g) scores **4** marks allow correct calculation from incorrect attempt(s) at conversion allow an answer correctly rounded to 2 significant figures from an incorrect calculation that uses the values in the question	 1 1 1 1	AO2 5.3.2.5 10.2.13

06.5	$\frac{44}{500} \times 100$ = 8.8 (%)	an answer of 8.8 (%) or 9 (%) scores **2** marks allow 9 (%)	1 1	AO2 5.10.1.2 10.2.13

Total			**13**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	high temperatures (in the engine) enable oxygen and nitrogen (from air) to react	 allow combine / bond for react	1 1	AO1 5.9.3.1

07.2	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content Examples of relevant points might include: • car **C** produces the most CO_2 during manufacture • car **A** produces the most CO_2 per km when driving • car **C** produces the most CO_2 from manufacture and 40,000km when driving • car **B** produces the most CO_2 from manufacture and 100,000km when driving Examples of linked statements might include: • car **A** produces least CO_2 during manufacture, but most CO_2 per km • car **C** produces most CO_2 during manufacture, but least CO_2 per km • car **A** produces least CO_2 during manufacture, but car **C** produces the least CO_2 per km Examples of judgements might include: • overall car **A** has the smallest carbon footprint as it has the smallest CO_2 production during manufacture, the smallest mass of CO_2 after 40,000km of driving and the smallest mass of CO_2 produced after 100,000km of driving. • car **A** eventually (after 157,895km) will have the largest carbon footprint because the mass of carbon dioxide produced per km is highest.		AO3 5.9.2.2 5.9.2.45.10.2.1

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

F

Foundation Tier
Chemistry Paper 2F

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 Fresh water contains low levels of dissolved salts.

Water reacts with anhydrous copper sulfate in a reversible reaction.

The word equation for the reaction is:

water + anhydrous copper sulfate ⇌ hydrated copper sulfate

0 1 . 1 How does the equation show that the reaction is reversible?

[1 mark]

_____

_____

0 1 . 2 Complete the sentences.

Choose answers from the box.

[2 marks]

blue	**green**	**orange**	**white**	**yellow**

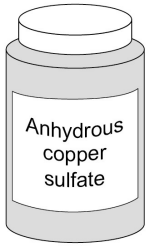
The colour of anhydrous copper sulfate is _____ .

The colour of hydrated copper sulfate is _____ .

Do not write outside the box

0 1 . 3 **Figure 1** shows anhydrous copper sulfate in a sealed container.

Figure 1



Suggest **one** reason why anhydrous copper sulfate is kept in a sealed container.

[1 mark]

Question 1 continues on the next page

Do not write outside the box

Sodium chloride dissolves in water to form sodium chloride solution.

0 1 . 4 Draw **one** line from each substance to the description of the substance.

[2 marks]

Substance	Description of substance
Sodium chloride solution	Compound
Water	Element
	Hydrocarbon
	Mixture

0 1 . 5 Name the process used to obtain solid sodium chloride from sodium chloride solution.

[1 mark]

Do not write outside the box

0 1 . 6 Two processes used to obtain potable water from fresh water are:

- filtering
- sterilising.

Give **one** reason why each process is used.

[2 marks]

Filtering _____

_____

Sterilising _____

_____

0 1 . 7 Which type of water is the easiest to obtain potable water from?

[1 mark]

Tick (✓) **one** box.

Ground water ☐

Salt water ☐

Waste water ☐

0 1 . 8 Which of the following is the first stage of waste water treatment?

[1 mark]

Tick (✓) **one** box.

Aerobic biological treatment of effluent ☐

Anaerobic digestion of sewage sludge ☐

Screening and removal of grit ☐

11

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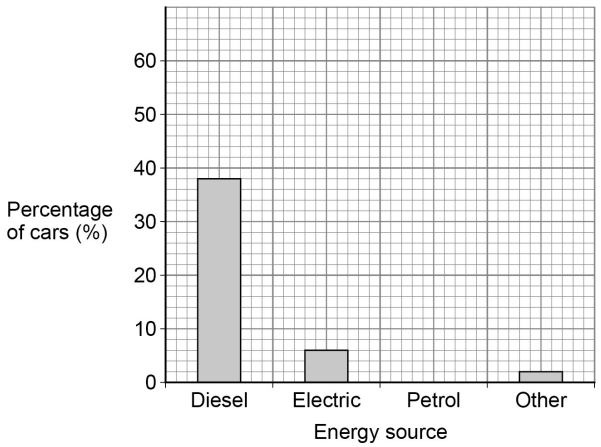
ANSWER IN THE SPACES PROVIDED

0 2 Cars cause atmospheric pollution.

0 2 . 1 **Figure 2** shows the percentage of cars in the UK using different energy sources.

Figure 2



The percentage of cars using petrol is 54%.

Draw the bar for petrol on **Figure 2.**

[1 mark]

Question 2 continues on the next page

Some car emissions contain nitrogen dioxide.

Table 1 shows the concentration of nitrogen dioxide in the air in three different areas for 1 week.

Table 1

	Concentration of nitrogen dioxide in the air in arbitrary units		
Day	**City centre**	**Countryside**	**Motorway**
Monday	35	8	22
Tuesday	37	8	23
Wednesday	37	8	23
Thursday	34	8	23
Friday	37	8	23
Saturday	29	7	20
Sunday	22	6	17

0 2 . 2 Which column of data has the greatest range?

[1 mark]

Tick (✓) **one** box.

City centre ☐

Countryside ☐

Motorway ☐

Do not write outside the box

0 2 . 3 Explain why the concentration of nitrogen dioxide in the air is lower on Sunday.

[2 marks]

0 2 . 4 Calculate the mean value for the concentration of nitrogen dioxide in the air in the city centre for the days from Monday to Friday.

Use **Table 1.**

[2 marks]

Mean value for concentration of nitrogen dioxide = _____ arbitrary units

Question 2 continues on the next page

Do not write outside the box

Nitrogen dioxide is removed from car emissions by catalytic converters.

0 2 . 5 Which **two** of the following are correct statements about catalysts?

[2 marks]

Tick (✓) **two** boxes.

Catalysts are included in the chemical equation for a reaction. ☐

Catalysts are **not** used up in a reaction. ☐

Catalysts decrease the surface area of the reactants. ☐

Catalysts increase the concentration of the reactants. ☐

Catalysts lower the activation energy of a reaction. ☐

0 2 . 6 The catalyst in catalytic converters contains platinum.

Platinum is an unreactive metal obtained from the Earth's crust.

Complete the sentence.

Choose the answer from the box.

[1 mark]

finite resource	**formulation**	**renewable resource**

Platinum is a _____ .

Do not write outside the box

0 2 . 7 Emissions from cars that burn fossil fuels contain carbon dioxide.

What is used to test for carbon dioxide?

[1 mark]

Tick (✓) **one** box.

Burning splint ☐

Glowing splint ☐

Limewater ☐

10

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

0 3 An increase in greenhouse gases in the Earth's atmosphere causes an increase in global temperature.

0 3 . 1 An increase in global temperature is a major cause of climate change.

Give **two** effects of global climate change.

[2 marks]

1 _____

_____

2 _____

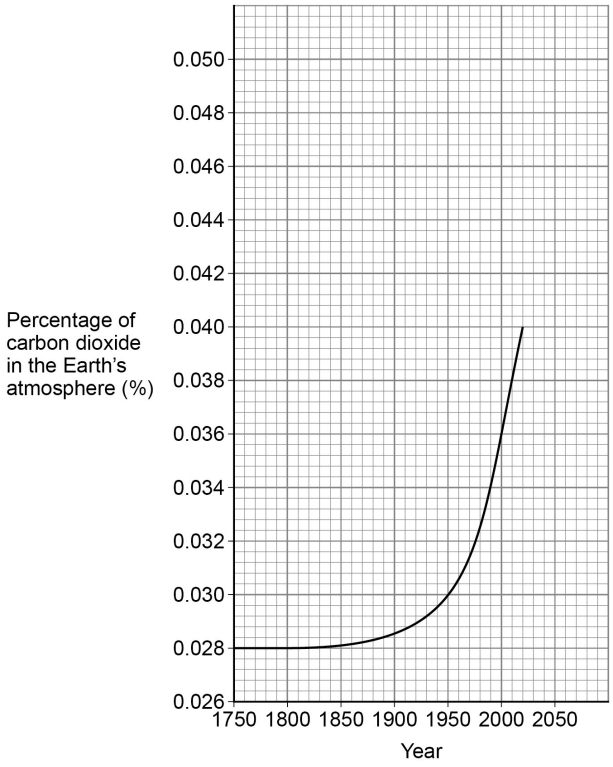
_____

Question 3 continues on the next page

Carbon dioxide is a greenhouse gas.

Figure 3 shows the percentage of carbon dioxide in the Earth's atmosphere from 1750.

Figure 3



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0 3 . 2 Describe the trend in the percentage of carbon dioxide in the Earth's atmosphere from 1750 to 2000.

Use **Figure 3.**

[2 marks]

0 3 . 3 Determine the change in the percentage of carbon dioxide in the Earth's atmosphere from 1950 to 2000.

Use **Figure 3.**

[2 marks]

Percentage of carbon dioxide in 1950 _____

Percentage of carbon dioxide in 2000 _____

Change in percentage of carbon dioxide = _____ %

0 3 . 4 Give **one** reason why the percentage of carbon dioxide in the atmosphere is changing.

[1 mark]

0 3 . 5 Predict the percentage of carbon dioxide in the Earth's atmosphere in 2050.

You should extend the graph line on **Figure 3.**

[2 marks]

Percentage of carbon dioxide in 2050 = _____ %

9

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0 4 This question is about the atmospheres of Earth and Mars.

0 4 . 1 Earth's early atmosphere may have been like the atmosphere of Mars today.

Why are scientists **not** certain about the percentage of gases in the Earth's early atmosphere?

[1 mark]

0 4 . 2 What was formed from the water vapour in the Earth's early atmosphere?

[1 mark]

Tick (✓) **one** box.

- Crude oil ☐
- Limestone ☐
- Natural gas ☐
- Oceans ☐

Do not write outside the box

0 4 . 3 The Earth's atmosphere today consists mainly of nitrogen and oxygen.

Draw **one** line from each gas to what produced the gas.

[2 marks]

Gas	What produced the gas
Nitrogen	Animals
Oxygen	Oceans
	Algae
	Fossils
	Volcanoes

Question 4 continues on the next page

Do not write outside the box

Table 2 shows the percentage of some gases in the atmospheres of Earth and Mars.

Table 2

Gas	Percentage of gas in atmosphere (%)	
	Earth	Mars
Argon	0.9	1.9
Carbon dioxide	0.04	95
Nitrogen	78	2.6
Oxygen	21	0.2

0 4 . 4 Why are animals **not** able to live on Mars?

[1 mark]

Tick (✓) **one** box.

- The atmosphere of Mars does not contain enough argon. ☐
- The atmosphere of Mars does not contain enough nitrogen. ☐
- The atmosphere of Mars does not contain enough oxygen. ☐

0 4 . 5 There is more carbon dioxide on Mars than on Earth.

Which **other** gas is found in larger quantities on Mars than on Earth?

[1 mark]

_____

Do not write outside the box

0 4 . 6 Calculate how many times more nitrogen than oxygen there is in the atmosphere of Earth.

Use **Table 2.**

Give your answer to 2 significant figures.

[3 marks]

Number of times more nitrogen than oxygen (2 significant figures) = _____

9

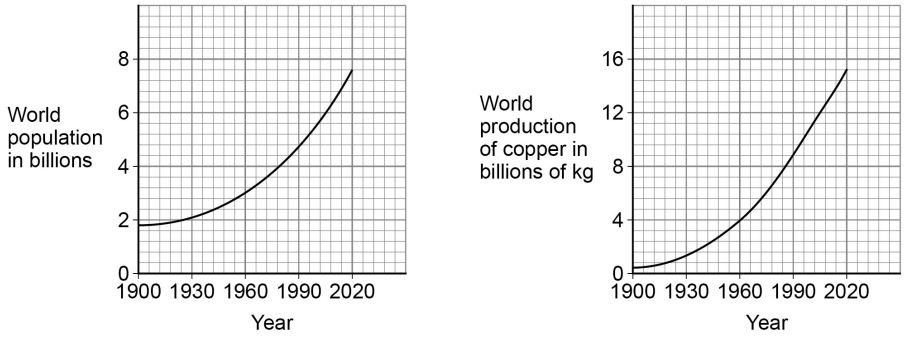
Turn over for the next question

Do not write outside the box

0 5 Industries use the Earth's resources to produce useful products.

0 5 . 1 **Figure 4** shows the world population and the world production of copper between 1900 and 2020.

Figure 4



How does the change in the world population compare with the world production of copper?

[1 mark]

Tick (✓) **one** box.

As population decreased, copper production increased. ☐

As population increased, copper production decreased. ☐

As population increased, copper production increased. ☐

Do not write outside the box

Copper is produced from copper ore and from recycling waste copper.

0 5 . 2 The energy needed to produce 1 kg of copper from copper ore is 70 MJ.

The energy needed to produce 1 kg of recycled copper is 27 MJ.

Calculate the energy saved if 100 kg of copper is produced from recycled copper and **not** from copper ore.

[3 marks]

Energy saved = _____ MJ

0 5 . 3 Producing copper from recycling waste copper reduces emissions of sulfur dioxide.

Why is reducing emissions of sulfur dioxide important?

[1 mark]

0 5 . 4 Copper is used to make coins.

A coin of mass 8 g contains 75% copper.

Calculate the mass of copper in the coin.

[2 marks]

Mass of copper = _____ g

Turn over ►

Do not write outside the box

0 5 . 5 Iron and glass are both produced from the Earth's resources.

Some processes can reduce the use of limited resources.

Draw **one** line from the description of the process to the name of the process.

[2 marks]

Description of process	Name of process
Scrap steel is added to iron from a blast furnace	Extraction
A glass bottle is refilled	Quarrying
	Reacting
	Recycling
	Reusing

Do not write outside the box

0 5 . 6 Life cycle assessments are used to assess the environmental impact of producing iron nails and glass bottles.

There are four stages, **A**, **B**, **C** and **D**, in a life cycle assessment.

The stages are **not** in the correct order.

Stage **A** Disposal

Stage **B** Extracting and processing raw materials

Stage **C** Manufacturing and packaging

Stage **D** Use and operation

What is the correct order of stages **A**, **B**, **C**, and **D**?

[1 mark]

Tick (✓) **one** box.

C, **D**, **B**, **A** ☐

D, **B**, **C**, **A** ☐

B, **C**, **D**, **A** ☐

10

Turn over for the next question

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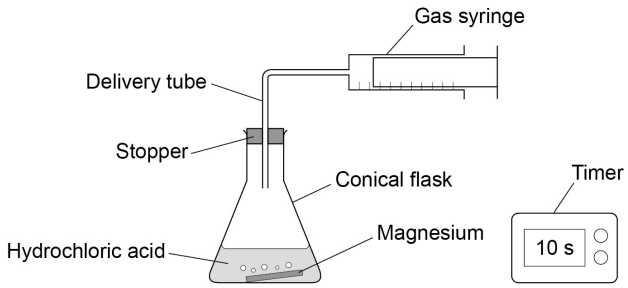
ANSWER IN THE SPACES PROVIDED

0 6 A student investigated the reaction between magnesium and excess hydrochloric acid.

Figure 5 shows the apparatus.

Figure 5



This is the method used.

1. Pour 50 cm^3 of hydrochloric acid into a conical flask.
2. Add a piece of magnesium.
3. Insert stopper and delivery tube and start a timer.
4. Collect the gas produced in a gas syringe.
5. Record the volume of gas produced every 20 seconds for 2 minutes.
6. Repeat steps 1 to 5 with higher concentrations of hydrochloric acid.

0 6 . 1 Give the independent variable and **one** control variable in this investigation.

[2 marks]

Independent variable _____

Control variable _____

Question 6 continues on the next page

Turn over ►

Table 3 shows the results from the first experiment using hydrochloric acid with a low concentration.

Table 3

Time in seconds	0	20	40	60	80	100	120
Volume of gas in cm^3	0	48	72	90	97	98	98

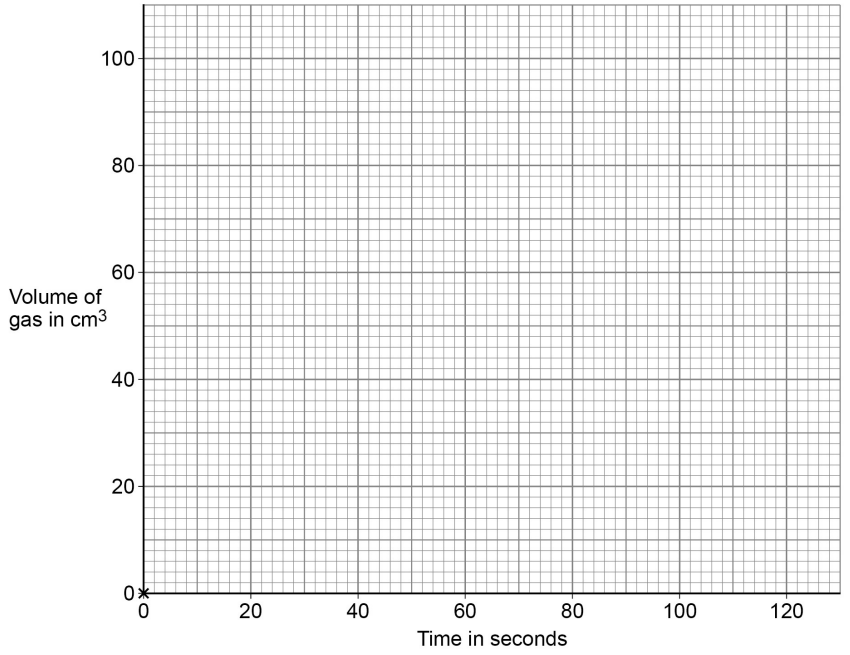
0 6 . 2 Complete **Figure 6.**

You should:

- plot the data from **Table 3** (the point 0,0 has been plotted for you)
- draw a line of best fit.

[3 marks]

Figure 6



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0 6 . 3 How does the **rate** of this reaction change with time?

Use **Table 3.**

[1 mark]

Tick (✓) **one** box.

The rate decreases. ☐

The rate stays the same. ☐

The rate increases. ☐

0 6 . 4 The student repeated the experiment using hydrochloric acid with a higher concentration.

Which statement is correct?

[1 mark]

Tick (✓) **one** box.

The activation energy for the reaction was higher. ☐

The magnesium reacted more quickly. ☐

The reaction finished at the same time. ☐

The total volume of gas collected was smaller. ☐

Question 6 continues on the next page

Do not write outside the box

0 6 . 5 Temperature also affects the rate of the reaction.

Explain how increasing the temperature affects the **rate** of the reaction.

You should refer to particles and collisions.

[3 marks]

10

Do not write outside the box

0 7 Crude oil is a resource found in rocks.

Most of the compounds in crude oil are hydrocarbons.

0 7 . 1 Complete the sentence.

[1 mark]

Crude oil is formed by the decomposition of _____.

0 7 . 2 Alkanes are hydrocarbons.

Give the name of the alkane molecule that has three carbon atoms.

[1 mark]

_____

Question 7 continues on the next page

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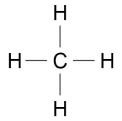
0 7 . 3 **Figure 7** shows two alkane molecules.

Figure 7

Methane



Hexane

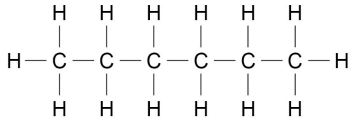


Table 4 shows the melting points and boiling points of methane and hexane.

Table 4

	Melting point in °C	Boiling point in °C
Methane	−183	−162
Hexane	−95	69

Compare the structure and properties of methane and hexane.

[6 marks]

Do not write outside the box

Hydrocarbons are cracked to produce more useful alkanes and alkenes.

0 7 . 4 Decane ($C_{10}H_{22}$) is cracked to produce **two** products.

Complete the equation for the reaction.

[1 mark]

$$C_{10}H_{22} \rightarrow \_\_\_\_\_ + C_2H_4$$

0 7 . 5 C_2H_4 is an alkene.

What is the test for alkenes?

Give the result of the test if an alkene is present.

[2 marks]

Test _____

_____

Result _____

_____

11

END OF QUESTIONS

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

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MARK SCHEME – GCSE COMBINED SCIENCE: TRILOGY – 8464/C/2F – JUNE 2021

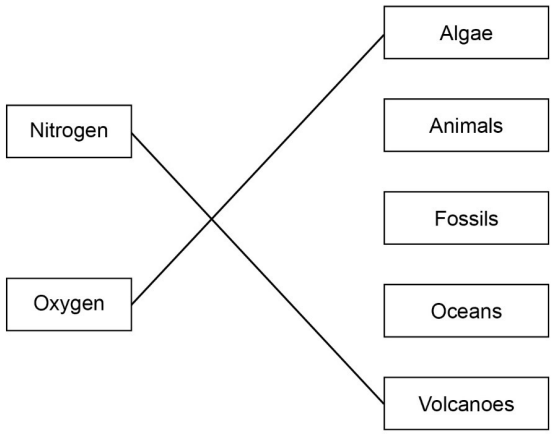
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	(the symbol) ⇌	allow description of reversible sign	1	AO1 5.6.2.1
01.2	white blue	must be in this order	1 1	AO1 5.6.2.2
01.3	to prevent reaction with water vapour (in the air)	allow to prevent reaction with moisture allow to keep water out	1	AO3 5.6.2.2
01.4	**Substance** / **Description of substance** Sodium chloride solution Water Compound Element Hydrocarbon Mixture do **not** accept more than one line from a box on the left		1 1	AO2 5.1.1.2
01.5	evaporation **or** crystallisation		1	AO1 RPA 13
01.6	(filtering) to remove solids (sterilising) to kill bacteria	 allow to kill microbes	1 1	AO1 5.10.1.2

01.7	ground water		1	AO1 5.10.1.3
01.8	screening and removal of grit		1	AO1 5.10.1.3
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	bar drawn to 54 (%)	allow a tolerance of ± ½ a small square	1	AO2 5.9.3.1
02.2	city centre		1	AO3 5.3.1.4 5.9.3.1
02.3	less traffic (because) fewer people working	allow fewer lorries / cars allow (because) no school allow (because) businesses / factories closed	1 1	AO3 5.9.3.1
02.4	(mean =) $\frac{35 + 37 + 37 + 34 + 37}{5}$ = 36 (arbitrary units)		1 1	AO2 5.9.3.1
02.5	catalysts are **not** used up in a reaction catalysts lower the activation energy of a reaction		1 1	AO1 5.6.1.4
02.6	finite resource		1	AO2 5.8.1.2 5.10.1.1
02.7	limewater		1	AO1 5.8.2.3
Total			**10**	

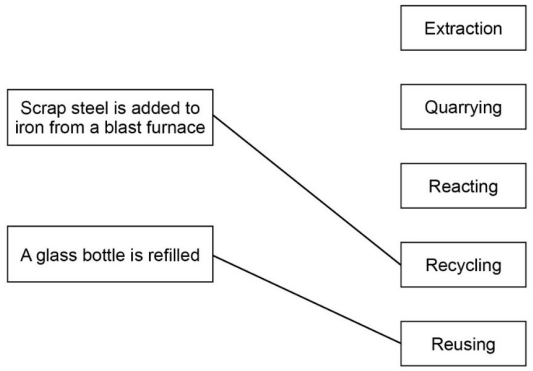
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	any **two** from: • global warming • melting polar ice caps • rising sea levels • flooding • crop failure **or** famine • extremes of weather • loss of habitats	do **not** accept acid rain do **not** accept global dimming do **not** accept references to ozone ignore temperature rise	2	AO1 5.9.2.3
03.2	constant (then) increases	allow no change allow stays same ignore values if given	1 1	AO2 5.9.2.2
03.3	(1950) 0.030 **and** (2000) 0.036 (0.036 – 0.030) = 0.006 (%)	 allow correct use of incorrectly determined percentage reading(s) ignore + or –	1 1	AO2 5.9.2.2
03.4	any **one** from: • combustion of fuel • deforestation • population increase	allow any named activity which burns fuel	1	AO1 5.9.2.2

03.5	extrapolation on graph determine value from extrapolation at 2050	 allow a value in the range 0.044 to 0.050 allow a tolerance of ± ½ a small square	1 1	AO3 5.9.2.2
Total			**9**	

Question		Extra information	Mark	AO / Spec. Ref.
04.1	any **one** from: • occurred (4.6) billion years ago • limited evidence	 ignore nobody was there ignore no proof	1	AO1 5.9.1.2
04.2	oceans		1	AO1 5.9.1.2
04.3	**Gas** **What produced the gas**  do **not** accept more than one line from a box on the left		1 1	AO1 5.9.1.2 5.9.1.3
04.4	the atmosphere of Mars does not contain enough oxygen		1	AO3 5.9.1.3
04.5	argon	allow Ar	1	AO2 5.9.1.1

04.6	$\frac{78}{21}$ = 3.714 = 3.7	 do **not** accept a subsequent step in the calculation allow an answer correctly calculated to 2 significant figures which uses the values in the question	1 1 1	AO2 5.9.1.1
Total			**9**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	as population increased, copper production increased		1	AO3 5.10.1.1
05.2	(copper ore) (70 × 100 =) 7000 (recycled copper) (27×100 =) 2700 (7000 – 2700 =) 4300 (MJ)	 allow correct use of incorrectly determined values for MP1 (copper ore) and/or MP2 (recycled copper)	1 1 1	AO2 5.10.2.2
05.3	any **one** from: • reduces acid rain • reduces respiratory problems (in humans)	 allow sulfur dioxide causes acid rain allow sulfur dioxide causes respiratory problems (in humans)	1	AO1 5.9.3.2
05.4	$\frac{75}{100}$ × 8 = 6 (g)		1 1	AO2 5.10.1.1

05.5	 do **not** accept more than one line from a box on the left	1 1	AO2 5.10.2.2

05.6	**B**, **C**, **D**, **A**		1	AO1 5.10.2.2
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec.
06.1	**independent** concentration (of hydrochloric acid) **control** any **one** from: • temperature (of hydrochloric acid) • volume of (hydrochloric) acid • length of magnesium • surface area of magnesium	 allow same mass of magnesium allow same form of magnesium ignore amount	1 1	AO1 5.6.1 RPA11
06.2	all points correctly plotted line of best fit	allow a tolerance of ± ½ a small square allow 1 mark for 4 or 5 points correctly plotted must include 0,0	2 1	AO2 5.6.1 RPA11
06.3	the rate decreases		1	AO3 5.6.1 RPA11
06.4	the magnesium reacted more quickly		1	AO3 5.6.1.2

06.5	rate increases (because) particles have more energy (so) more frequent collisions	allow reaction happens faster allow (because) particles move faster allow (because) more particles have energy greater than the activation energy	1 1 1	AO1 5.6.1.2 5.6.1.3
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	plankton **or** (ancient) biomass	allow microscopic plants / animals	1	AO1 5.7.1.1
07.2	propane	allow C_3H_8	1	AO1 5.7.1.1

Question	Answers	Mark	AO / Spec. Ref.
07.3	**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	AO3
	Level 1: Relevant features are identified and differences noted.	1–3	AO1 AO2
	No relevant content	0	
	Indicative content • methane has 1 carbon atom, hexane has 6 • methane has 4 hydrogen atoms, hexane has 14 • both contain C – H bonds • only hexane contains C – C bonds • both are hydrocarbons • hexane has a higher melting point than methane (or converse) • hexane has a higher boiling point than methane (or converse) • methane is a gas at room temperature • hexane is a liquid at room temperature • both are small molecules • hexane has larger molecules than methane • weak forces between molecules • forces between hexane molecules stronger than between methane molecules • hexane is more viscous than methane • both are flammable • methane is more flammable than hexane (or converse) • possible products of combustion from both are: carbon, carbon monoxide, carbon dioxide, water • neither conduct electricity		5.2.2.4 5.7.1.1 5.7.1.3

07.4	C_8H_{18}		1	AO2 5.3.1.1 5.7.1.4
07.5	bromine (water) turns (from orange / brown) to colourless	 MP2 is dependent on MP1 allow decolourises ignore clear	1 1	AO1 5.7.1.4
Total			**11**	

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

F

Foundation Tier
Chemistry Paper 2F

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

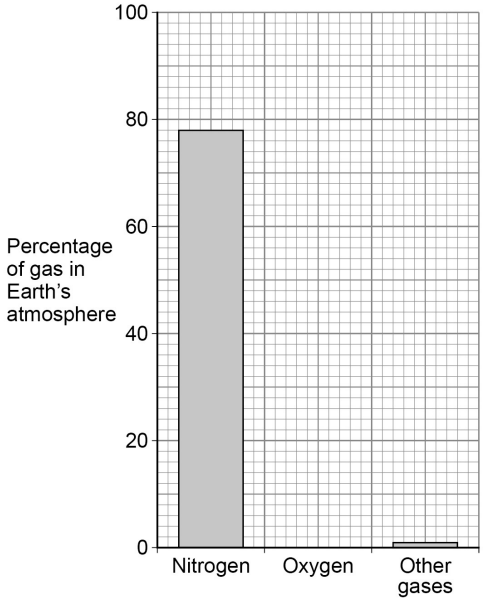
0 1 This question is about the Earth's atmosphere.

0 1 . 1 The Earth's atmosphere contains 21% oxygen.

Draw the bar for oxygen on **Figure 1**.

[1 mark]

Figure 1



0 1 . 2 What is used to test for oxygen gas?

[1 mark]

Tick (✓) **one** box.

A burning splint ☐

A glowing splint ☐

Damp litmus paper ☐

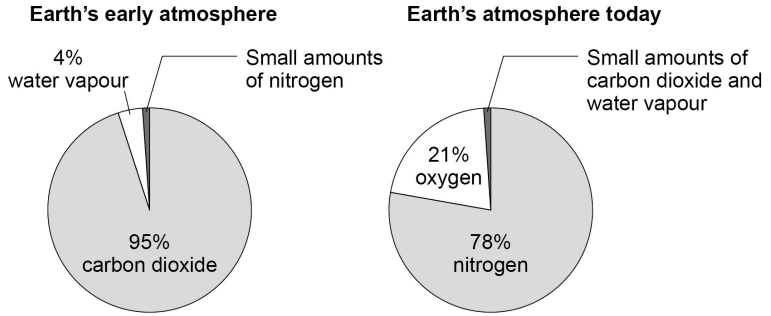
Limewater ☐

Do not write outside the box

The Earth's early atmosphere was very different from the Earth's atmosphere today.

Figure 2 shows the composition of the Earth's early atmosphere and of the Earth's atmosphere today.

Figure 2



0 1 . 3 The percentages of nitrogen and oxygen in the Earth's atmosphere today are different from the Earth's early atmosphere.

Complete the sentences.

Choose answers from the box.

Use **Figure 2.**

Each answer can be used once, more than once or not at all.

[2 marks]

decreased	**increased**	**stayed the same**

Since the Earth's early atmosphere, the percentage of nitrogen in the Earth's atmosphere has _____ .

Since the Earth's early atmosphere, the percentage of oxygen in the Earth's atmosphere has _____ .

Turn over ►

Do not write outside the box

0 1 . 4 The Earth's atmosphere today contains a small amount of carbon dioxide.

Why has the percentage of carbon dioxide decreased since the Earth's early atmosphere?

[2 marks]

Tick (✓) **two** boxes.

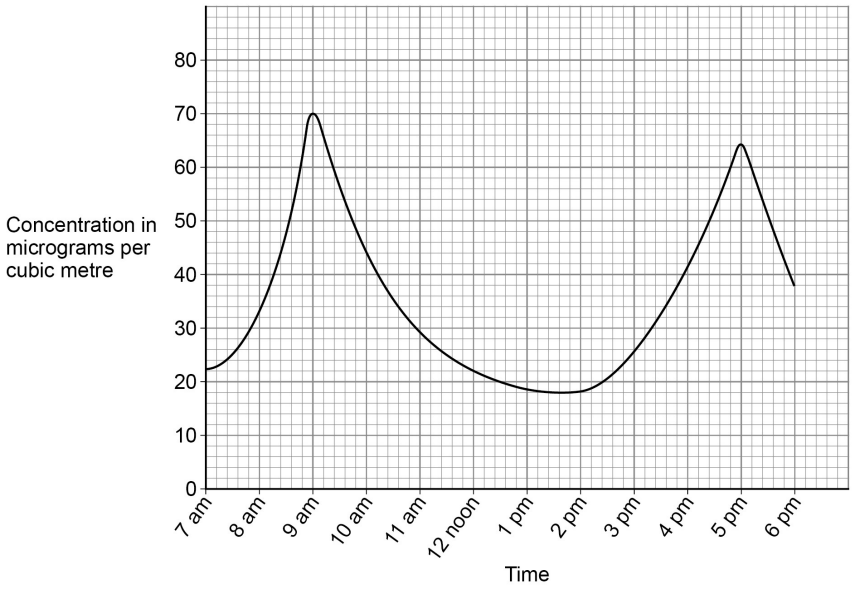
- Dissolved in oceans ☐
- Formation of sedimentary rocks ☐
- Industrialisation ☐
- Respiration ☐
- Volcanic activity ☐

Do not write outside the box

Oxides of nitrogen are produced when nitrogen reacts with oxygen in car engines.

Figure 3 shows the concentration of oxides of nitrogen in the atmosphere during one day in a city.

Figure 3



0 1 . 5 Which **two times** have the highest concentrations of oxides of nitrogen in the atmosphere?

[2 marks]

1 _____

2 _____

0 1 . 6 Suggest why there are the highest concentrations of oxides of nitrogen at these times.

[1 mark]

_____

_____

9

Turn over ►

Do not write outside the box

0 2 This question is about fuels.

Coal deposits were formed from the remains of trees.

0 2 . 1 Name the process in the leaves of trees that uses carbon dioxide.

[1 mark]

_____

0 2 . 2 How is coal formed after trees die?

[1 mark]

Tick (✓) **one** box.

The trees are burned. ☐

The trees are compressed. ☐

The trees are melted. ☐

Coal contains small amounts of sulfur.

0 2 . 3 Name the gas produced when sulfur burns in oxygen.

[1 mark]

_____

0 2 . 4 Give **two** problems caused by the gas produced when sulfur burns in oxygen.

[2 marks]

1 _____

_____

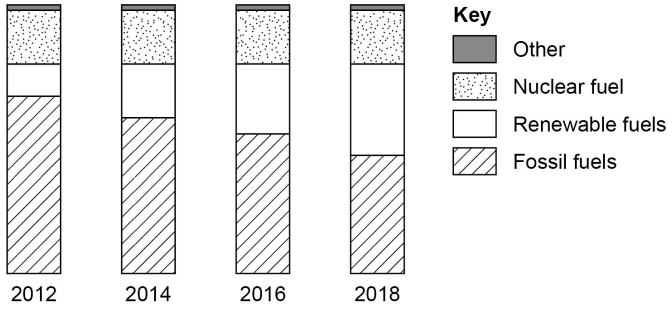
2 _____

_____

Do not write outside the box

0 2 . 5 **Figure 4** shows the relative amount of electricity generated from different fuel sources in the UK from 2012 to 2018.

Figure 4



Describe what happens to the amounts of fuels used to generate electricity in the UK from 2012 to 2018.

[3 marks]

8

Turn over for the next question

Do not write outside the box

0 3 This question is about ammonia and its compounds.

A student heated a sample of ammonium chloride.

The equation for the reaction is:

$$\underset{\text{ammonium chloride}}{NH_4Cl} \rightleftharpoons \underset{\text{ammonia}}{NH_3} + HCl$$

0 3 . 1 One product is ammonia.

What is the name of the product with the formula HCl?

[1 mark]

0 3 . 2 Ammonia is a gas.

What is the state symbol for ammonia?

[1 mark]

Tick (✓) **one** box.

(aq) ☐ (g) ☐ (l) ☐ (s) ☐

0 3 . 3 How does the equation show that the reaction is reversible?

[1 mark]

0 3 . 4 Complete the sentence.

[1 mark]

The forward reaction is endothermic,

so the reverse reaction is _____ .

Do not write outside the box

0 3 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

concentration	**rate**	**temperature**

Equilibrium is reached when the forward and reverse reactions happen at exactly the same _____ .

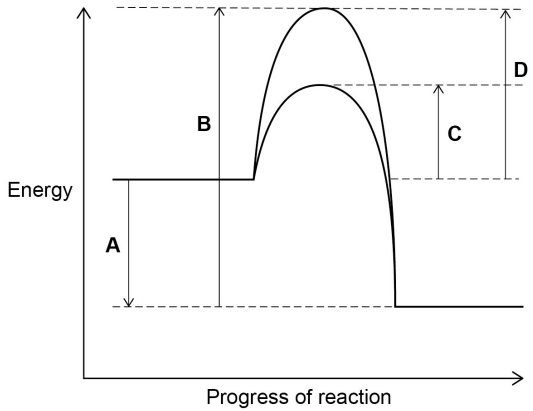
Question 3 continues on the next page

Do not write outside the box

The industrial process to produce ammonia uses a catalyst.

0 3 . 6 **Figure 5** shows the reaction profile for the reaction with and without a catalyst.

Figure 5



Which letter represents the activation energy for the reaction with a catalyst?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Do not write outside the box

0 3 . 7 Give **one** reason why using a catalyst reduces costs.

Do **not** answer in terms of activation energy.

[1 mark]

0 3 . 8 Ammonia is in a mixture that is used as a household cleaner.

What is a mixture that has been designed as a useful product called?

[1 mark]

8

Turn over for the next question

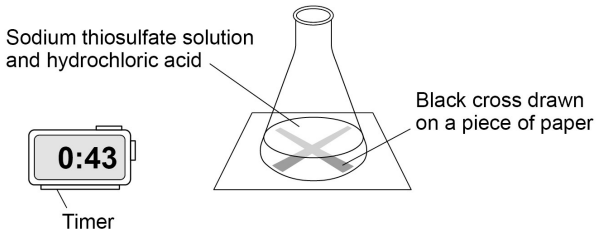
Do not write outside the box

0 4 A student investigates the effect of concentration on the rate of the reaction between sodium thiosulfate solution and hydrochloric acid.

Figure 6 shows the experiment.

The experiment was done in a fume cupboard.

Figure 6



This is the method used.

1. Pour 50 cm^3 of sodium thiosulfate solution into a conical flask.
2. Put the conical flask on a black cross drawn on a piece of paper.
3. Pour 10 cm^3 of hydrochloric acid into the conical flask and start a timer.
4. Stop the timer when the cross can no longer be seen.
5. Repeat the experiment with different concentrations of sodium thiosulfate solution.

Do not write outside the box

0 4 . 1 Draw **one** line from each type of variable to the correct example of the variable in this investigation.

[2 marks]

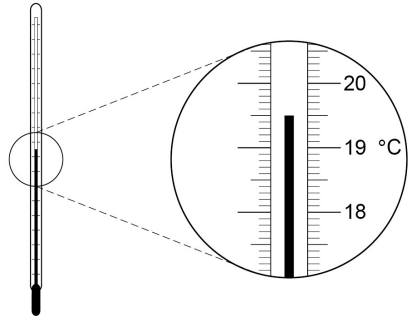
Type of variable	Example of variable
	Concentration of sodium thiosulfate solution
Dependent	Temperature of reaction mixture
	Time taken for the cross to no longer be seen
Independent	Volume of acid
	Volume of the flask

Question 4 continues on the next page

Do not write outside the box

0 4 . 2 The experiment is done at room temperature.

Figure 7



What is the temperature shown on the thermometer in **Figure 7**?

[1 mark]

Temperature = _____ °C

Table 1 shows the student's results.

Table 1

Concentration of sodium thiosulfate solution in mol/dm^3	Time in seconds
0.1	82
0.2	40
0.3	20
0.4	13
0.5	10
0.6	8

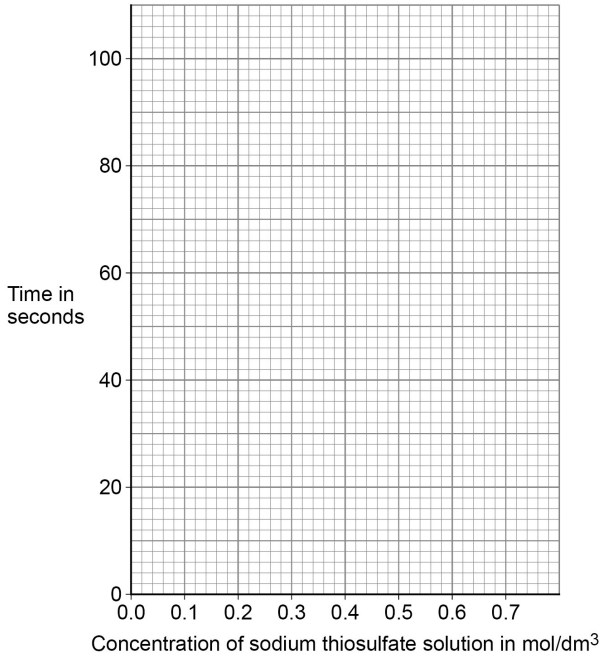
Do not write outside the box

0 4 . 3 Plot the data from **Table 1** on **Figure 8**.

Draw a line of best fit.

[3 marks]

Figure 8



0 4 . 4 Predict the time taken for the cross to no longer be seen at a concentration of 0.7 mol/dm^3

Use your graph in **Figure 8**.

[1 mark]

Time = _____ s

0 4 . 5 Complete the sentence.

[1 mark]

As the concentration of sodium thiosulfate solution increases, the time taken for the cross to no longer be seen _____ .

Turn over ►

Do not write outside the box

0 4 . 6 In one experiment 0.725 g of sulfur is produced in 20 seconds.

Calculate the mean rate of the reaction from 0 to 20 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{mass of sulfur produced in grams}}{\text{time in seconds}}$$

[2 marks]

Mean rate of reaction = _____

0 4 . 7 What is the unit for the mean rate of reaction calculated in Question **04.6**?

[1 mark]

Tick (✓) **one** box.

g ☐ g/s ☐ s ☐ s/g ☐

0 4 . 8 The student did the experiment with 0.15 mol/dm^3 sodium thiosulfate solution and repeated the experiment three more times.

Table 2 shows the results.

Table 2

	Test 1	Test 2	Test 3	Test 4
Time in seconds for the cross to no longer be seen	60.5	63.2	82.3	65.7

Calculate the mean time for this reaction.

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

Give your answer to 3 significant figures.

[3 marks]

Mean time for the reaction (3 significant figures) = _____ s

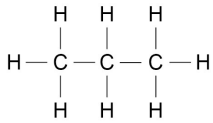
14

Turn over for the next question

0 5 This question is about hydrocarbons.

Figure 9 shows a hydrocarbon.

Figure 9



0 5 . 1 Complete the formula for the hydrocarbon shown in **Figure 9**.

[1 mark]

C____H____

0 5 . 2 What is the name of the hydrocarbon in **Figure 9**?

[1 mark]

0 5 . 3 Which homologous series does the hydrocarbon in **Figure 9** belong to?

[1 mark]

Do not write outside the box

0 5 . 4 30 g of another hydrocarbon contains 24 g of carbon.

Which calculation gives the percentage of carbon in the hydrocarbon?

[1 mark]

Tick (✓) **one** box.

$\frac{24 \times 30}{100}$ ☐

$\frac{100 \times 30}{24}$ ☐

$\frac{24 \times 100}{30}$ ☐

$\frac{24}{30 \times 100}$ ☐

0 5 . 5 **Table 3** shows boiling points of some hydrocarbons.

Table 3

Formula of hydrocarbon	Boiling point in °C
C_2H_6	–89
C_4H_{10}	0
C_6H_{14}	69
C_8H_{18}	125
$C_{10}H_{22}$	174

Describe how the boiling points change as the number of carbon atoms in the hydrocarbon increases.

[1 mark]

Do not write outside the box

Hydrocarbons can be cracked.

0 5 . 6 Give **one** condition used to crack hydrocarbons.

[1 mark]

0 5 . 7 Balance the equation for the cracking of C_6H_{14}

[1 mark]

$$C_6H_{14} \rightarrow C_2H_6 + \_\_\_\_ C_2H_4$$

0 5 . 8 Give **one** reason why hydrocarbons are cracked.

[1 mark]

Do not write outside the box

0 5 . 9 Window frames can be manufactured from wood or plastic.

Table 4 shows the results of a life cycle assessment (LCA) for making one wooden and one plastic window frame.

Both window frames are the same size.

Table 4

Table 4 not reproduced here due to third-party copyright restrictions

Give **three** advantages of using wood instead of plastic in the manufacture of window frames.

[3 marks]

Advantage of wood 1 _____

_____

_____

Advantage of wood 2 _____

_____

_____

Advantage of wood 3 _____

_____

_____

11

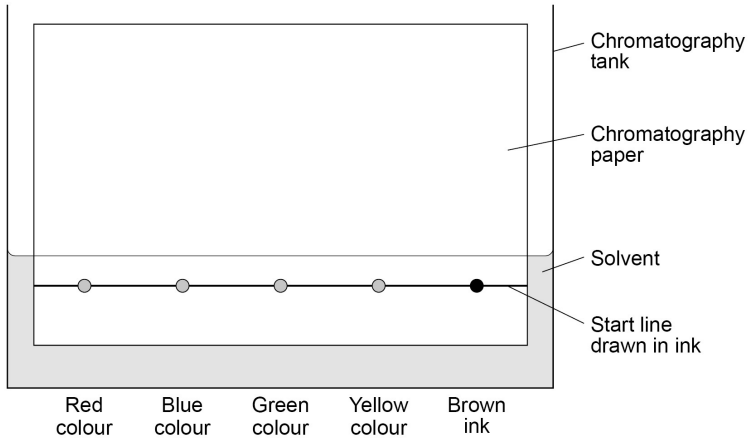
Turn over for the next question

Do not write outside the box

0 6 A student investigated the colours in a brown ink using chromatography.

0 6 . 1 **Figure 10** shows the apparatus used.

Figure 10



Give **two** errors made by the student.

Describe the problem each error would cause.

[4 marks]

Error 1 _____

_____

Problem 1 _____

_____

Error 2 _____

_____

Problem 2 _____

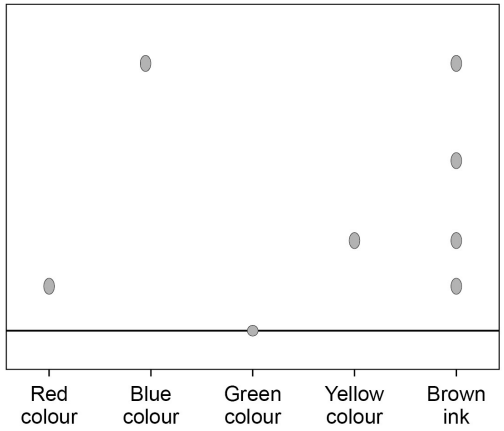
_____

Do not write outside the box

A different student set up the apparatus correctly.

Figure 11 shows the results.

Figure 11



0 6 . 2 Give **two** conclusions the student can make from **Figure 11** about the four colours in the brown ink.

[2 marks]

1 _____

_____

2 _____

_____

Question 6 continues on the next page

Turn over ►

Do not write outside the box

0 6 . 3 Why was the green colour still on the start line at the end of the experiment?

[1 mark]

Tick (✓) **one** box.

The experiment was left for too long. ☐

The green colour was insoluble in the solvent. ☐

The green spot contained too many colours. ☐

The green spot was too small. ☐

0 6 . 4 A student calculated the R_f value of a colour to be 0.24

The colour moved 1.8 cm from the start line.

Calculate the distance the solvent moved.

Use the equation:

$$R_f = \frac{\text{distance moved by colour}}{\text{distance moved by solvent}}$$

[3 marks]

Distance moved by solvent = _____ cm

10

Do not write outside the box

0 7 . 1 Water that is safe to drink is called potable water.

Compare how easily potable water can be obtained from:

- waste water (sewage)
- ground water (fresh water).

[6 marks]

Question 7 continues on the next page

Do not write outside the box

A scientist produced potable water from 150 cm^3 of salty water.

0 7 . 2 Which process can be used to produce potable water from salty water?

[1 mark]

Tick (✓) **one** box.

- Distillation ☐
- Electrolysis ☐
- Filtration ☐
- Sterilisation ☐

0 7 . 3 The salty water contains sodium chloride.

The scientist collected 2.40 g of sodium chloride from 150 cm^3 of salty water.

Calculate the concentration of sodium chloride in grams per dm^3

[3 marks]

Concentration of sodium chloride = _____ g/dm^3

10

END OF QUESTIONS

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

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Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	bar drawn to 21%		1	AO2 5.9.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	a glowing splint		1	AO1 5.8.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	(nitrogen) increased (oxygen) increased		1 1	AO2 5.9.1.2 5.9.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	dissolved in oceans formation of sedimentary rocks		1 1	AO1 5.9.1.2 5.9.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	9 (am) 5 (pm)	allow 0900 allow 1700	1 1	AO2 5.9.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	more cars / buses / lorries on the roads		1	AO3 5.9.3.1

Total Question 1		**9**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	photosynthesis		1	AO1 5.9.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	the trees are compressed		1	AO1 5.9.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	sulfur dioxide	allow SO_2	1	AO1 5.9.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4		allow ecf from question **02.3**		AO1 5.9.3.2
	acid rain	allow specified damage caused by acid rain	1	
	respiratory problems	allow named respiratory problem	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	any **three** from: (from 2012 to 2018) • fossil fuels decreased • renewable fuels increased • nuclear fuel remain constant • other (sources) remain constant		3	AO2 5.10.1.1

Total Question 2		**8**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	hydrogen chloride	allow hydrochloric acid	1	AO1 5.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(g)		1	AO1 5.2.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	⇌	allow reversible sign / arrow	1	AO1 5.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	exothermic		1	AO1 5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	rate		1	AO1 5.6.2.3

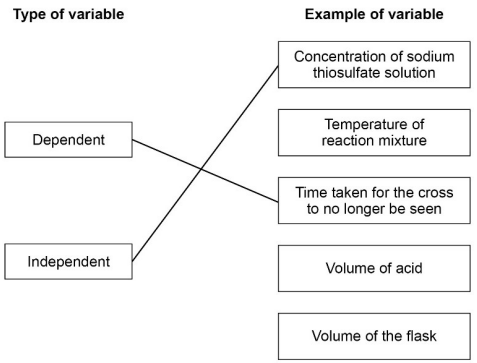
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	C		1	AO1 5.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	any **one** from: • increases rate of reaction • reduces energy required • lower temperature can be used		1	AO1 5.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.8	formulation		1	AO1 5.8.1.2

Total Question 3		**8**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	 do **not** accept more than one line from a box on the left		1 1	AO2 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	19.5 (°C)		1	AO2 5.6.1.2 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	all points correctly plotted line of best fit	allow a tolerance of ± ½ a small square allow **1** mark for 3 / 4 / 5 points correctly plotted	2 1	AO2 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	7 (s)	allow ecf from question **04.3** allow a tolerance of ± ½ a small square	1	AO3 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	decreases		1	AO2 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(mean =) $\frac{0.725}{20}$ = 0.03625	 ignore units	1 1	AO2 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	g/s		1	AO1 5.6.1.1 RPA11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.8	(mean =) $\frac{60.5 + 63.2 + 65.7}{3}$ = 63.13333 (s) = 63.1 (s)	allow for **1** mark $\frac{60.5 + 63.2 + 65.7 + 82.3}{4} = 67.925$ allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question	1 1 1	AO3 AO2 AO2 5.6.1.1 RPA11

Total Question 4		14

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	C_3H_8		1	AO2 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	propane		1	AO1 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	alkane(s)		1	AO1 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	$\frac{24 \times 100}{30}$		1	AO2 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(as the number of carbon atoms increases the) boiling point increases		1	AO2 5.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	any **one** from: • high temperature • steam • high pressure • low / no oxygen (atmosphere) • catalyst	 allow a temperature between 400 °C and 900 °C ignore heat / hot allow aluminium oxide allow alumina allow zeolites allow porous pot	1	AO1 5.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	$C_6H_{14} \rightarrow C_2H_6 + \mathbf{2}C_2H_4$	allow multiples	1	AO2 5.1.1.1 5.3.1.1 5.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.8	any **one** from: • to make smaller molecules • to make more useful molecules • to produce fuels • more demand for smaller molecules • to make (starting materials for) polymers	 allow to make (starting materials for) other chemicals allow to make alkenes	1	AO1 5.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.9	any **three** from: (wood) • uses less energy • uses less coal / oil • produces less waste • is renewable / sustainable		3	AO3 5.10.2.1

Total Question 5		**11**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	any **two** pairs from: (start) line drawn in ink (1) (so ink) will mix with solvent (1) the solvent is above the (start) line (1) (so) colours / ink will dissolve (1) no lid on tank (1) (so) solvent will evaporate (1)	 allow (start) line should be drawn in pencil allow the ink will move up the paper allow the solvent should be below the (start) line	4	AO3 5.8.1.3 RPA12

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	any **two** from: • (the brown ink) contains the blue, yellow and red (colours) • (the brown ink) contains an unknown colour • (the brown ink) does not contain green ink • blue (colour) is the most soluble **or** red (colour) is the least soluble	 allow blue (colour) has the highest R_f value allow red (colour) has the lowest R_f value ignore green colour is insoluble	2	AO3 5.8.1.3 RPA12

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	the green colour was insoluble in the solvent		1	AO2 5.8.1.3 RPA12

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	$0.24 = \frac{1.8}{\text{distance moved by solvent}}$ (distance moved by solvent =) $\frac{1.8}{0.24}$ = 7.5 (cm)		1 1 1	AO2 5.8.1.3 RPA12

Total Question 6		10

Question 7

<table>
<tr><th>Question</th><th>Answers</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td rowspan="4">07.1</td><td>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.</td><td>4–6</td><td rowspan="4">AO1
5.10.1.3</td></tr>
<tr><td>Level 1: Relevant features are identified and differences noted.</td><td>1–3</td></tr>
<tr><td>No relevant content</td><td>0</td></tr>
<tr><td>Indicative content
<table>
<tr><th>ground water</th><th>waste water</th></tr>
<tr><td>easier to obtain</td><td>more difficult to obtain</td></tr>
<tr><td>fewer processes</td><td>more processes</td></tr>
<tr><td>takes less time</td><td>takes more time</td></tr>
<tr><td>filtered through filter beds

to remove insoluble particles</td><td>screening and grit removal

to remove large particles</td></tr>
<tr><td></td><td>sedimentation

to produce sewage sludge and effluent</td></tr>
<tr><td></td><td>aerobic biological treatment of effluent

to reduce solid waste</td></tr>
<tr><td>sterilised

using chlorine, ozone or uv light

to kill bacteria</td><td>and then sterilised

using chlorine, ozone or uv light

to kill bacteria</td></tr>
<tr><td></td><td>sludge is anaerobically digested

by specific bacteria

to remove organic matter</td></tr>
</table></td><td></td></tr>
</table>

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	distillation		1	AO1 5.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(conversion) ($\frac{150}{1000}$ =) 0.15 (dm^3) (concentration =) $\frac{2.40}{0.15}$ = 16 (g/dm^3) **OR** (conversion) $\frac{1000}{150}$ (1) = 6.67 (1) (6.67 × 2.4) = 16 (g/dm^3) (1) **OR** (concentration =) $\frac{2.4}{150}$ (1) = 0.016 (1) (conversion) (0.016 × 1000) = 16 (g/dm^3) (1)	allow correct use of incorrect / no conversion	1 1 1	AO2 5.3.2.5

Total Question 7		10