2024

Name_____

Triple 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.

PMT

AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

GCSE
CHEMISTRY

F

Foundation Tier Paper 2

Wednesday 12 June 2019 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

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

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

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Do not write outside the box

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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

Do not write outside the box

0 1 This question is about drinking water.

There are two main steps in producing drinking water from fresh water.

0 1 . 1 Draw **one** line from each step to the reason for the step.

[2 marks]

Step	Reason for step
	Desalination
Filtration	Improve taste
	Increase pH
Sterilisation	Kill bacteria
	Remove solids

0 1 . 2 Which **two** substances are used to sterilise fresh water?

[2 marks]

Tick (✓) **two** boxes.

- Ammonia ☐
- Chlorine ☐
- Hydrogen ☐
- Nitrogen ☐
- Ozone ☐

Turn over ►



Do not write outside the box

A large amount of aluminium sulfate was accidentally added to the drinking water supply at a water treatment works.

0 1 . 3 Scientists tested a sample of the drinking water to show that it contained dissolved solids.

Which **two** methods show the presence of dissolved solids in the sample of drinking water?

[2 marks]

Tick (✓) **two** boxes.

- Add damp litmus paper to the sample. ☐
- Evaporate all water from the sample. ☐
- Measure the sample's boiling point. ☐
- Test the sample with a glowing splint. ☐



Do not write outside the box

0 1 . 4 Scientists tested two water samples from the drinking water supply.

The scientists tested one sample for aluminium ions and the other sample for sulfate ions.

Draw **one** line from each ion to the compound needed to identify the ion.

[2 marks]

Ion	**Compound needed to identify ion**
	Barium chloride
Aluminium ion	Copper sulfate
	Silver nitrate
Sulfate ion	Sodium hydroxide
	Sulfuric acid

0 1 . 5 How could pure water be produced from drinking water that contained dissolved solids?

[1 mark]

Tick (✓) **one** box.

- Chromatography ☐
- Cracking ☐
- Distillation ☐
- Sedimentation ☐

9

Do not write outside the box

0 2 Some central heating boilers use methane as a fuel.

Carbon monoxide detectors are placed near central heating boilers.

0 2 . 1 Which **three** properties of carbon monoxide make it necessary to use carbon monoxide detectors?

Choose answers from the box.

[3 marks]

acidic	**alkaline**	**colourless**	**corrosive**
insoluble	**odourless**	**toxic**	

1 _____

2 _____

3 _____

0 2 . 2 Complete the sentence.

[1 mark]

Methane produces carbon monoxide when burning in a limited supply of

_____.

0 2 . 3 8 g of methane has a volume of 12 dm^3 at room temperature and pressure.

Calculate the mass of 36 dm^3 of methane.

[2 marks]

_____

_____

_____

_____

Mass = _____ g

Do not write outside the box

0 2 . 4 Most methane is obtained from natural gas, which is a fossil fuel.

Methane can also be produced renewably.

Which **two** are renewable sources of methane?

[2 marks]

Tick (✓) **two** boxes.

- Animal waste ☐
- Food in landfill ☐
- Nitrogen in the air ☐
- Non-biodegradable plastics ☐
- Scrap iron ☐

8

Turn over for the next question

Do not write outside the box

0 3 Hydrogen is a raw material in the Haber process.

Hydrogen is produced from methane.

The word equation for the reaction is:

methane + steam ⇌ carbon monoxide + hydrogen

0 3 . 1 How can you tell that the reaction is reversible?

[1 mark]

0 3 . 2 The forward reaction is endothermic.

Name the type of energy change in the reverse reaction.

[1 mark]

0 3 . 3 A nickel catalyst is used in this reaction.

Why is a catalyst used in this reaction?

[2 marks]

Tick (✓) **two** boxes.

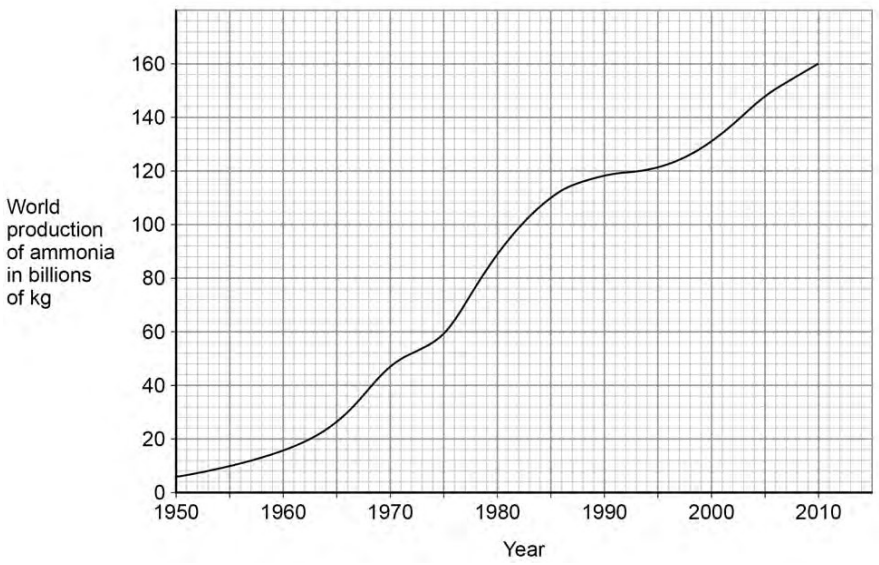
- To increase the temperature ☐
- To produce less carbon monoxide ☐
- To reduce costs ☐
- To use less energy ☐
- To use less methane ☐

Do not write outside the box

0 3 . 4 The Haber process also uses nitrogen to produce ammonia.

Figure 1 shows how the world production of ammonia changed between 1950 and 2010.

Figure 1



Describe how the world production of ammonia changed between 1950 and 2010.

[2 marks]

Do not write outside the box

Most of the ammonia produced is used to make fertilisers.

0 3 . 5 Why did the world production of ammonia change between 1950 and 2010?

[2 marks]

Tick (✓) **two** boxes.

- The demand for food changed. ☐
- The demand for fuels changed. ☐
- The nitrogen percentage in air changed. ☐
- The number of cars changed. ☐
- The world population changed. ☐

Table 1 shows data about four fertilisers, **A**, **B**, **C** and **D**.

Table 1

Fertiliser	Percentage by mass of nitrogen (%)	Percentage by mass of phosphorus (%)	Percentage by mass of potassium (%)
A	35.0	0.0	0.0
B	21.2	0.0	0.0
C	21.2	23.5	0.0
D	0.0	0.0	52.3

Do not write outside the box

0 3 . 6 Which combination of fertilisers **A**, **B**, **C** and **D** provides **all** of the elements needed for an NPK fertiliser?

Use **Table 1.**

[1 mark]

Tick (✓) **one** box.

A and **C** ☐

A and **D** ☐

B and **C** ☐

C and **D** ☐

0 3 . 7 Which fertiliser is **not** made using ammonia?

Use **Table 1.**

[1 mark]

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

10

Do not write outside the box

0 4 Titan is a moon of the planet Saturn.

Table 2 shows the percentages of some gases in the atmosphere of Titan and in the atmosphere of the Earth.

Table 2

Gas	Percentage of gas in atmosphere (%)	
	Titan	Earth
Nitrogen	98	78
Oxygen	Zero	21
Methane	1.4	0.0002
Argon	0.14	0.9
Carbon dioxide	0.0001	0.04

0 4 . 1 Which **two** gases are present in smaller percentages on the Earth than on Titan?

[1 mark]

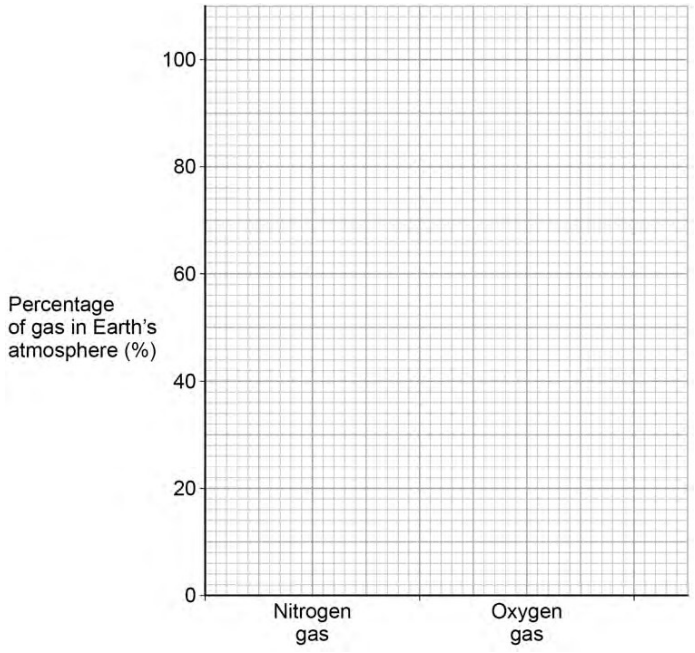
_____ and _____

Do not write outside the box

0 4 . 2 Complete the bar chart in **Figure 2** to show the percentages of nitrogen gas and oxygen gas in the Earth's atmosphere.

[2 marks]

Figure 2



0 4 . 3 Why are algae less likely to photosynthesise on Titan than Earth?

Use **Table 2.**

[1 mark]

Tick (✓) **one** box.

Titan's atmosphere contains too little argon. ☐

Titan's atmosphere contains too little carbon dioxide. ☐

Titan's atmosphere contains too little methane. ☐

Titan's atmosphere contains too little nitrogen. ☐

Turn over ►

Do not write outside the box

0 4 . 4 Titan is warmer than the other moons of Saturn because of the greenhouse effect.

How do greenhouse gases trap energy from the sun?

[1 mark]

Tick (✓) **one** box.

All wavelengths of radiation are reflected back to the surface of Titan. ☐

Long wavelength radiation is reflected back to the surface of Titan. ☐

Short wavelength radiation is reflected back to the surface of Titan. ☐

As well as methane, the atmosphere of Titan contains small amounts of propene gas. Methane is an alkane and propene is an alkene.

0 4 . 5 Bromine water is an orange solution used to identify alkenes.

Draw **one** line from each gas to its effect on bromine water.

[2 marks]

Gas	Effect on bromine water
	Forms a blue solution
Methane	Forms a colourless solution
	Forms a green solution
Propene	Forms a white precipitate
	No effect

Do not write outside the box

0 4 . 6 Propene reacts with water (steam) to make propanol.

The ratio of the masses of propene and water that react is:

propene : water

7 : 3

Calculate the mass of propene that reacts with 21 g water.

[2 marks]

Mass = _____ g

9

Turn over for the next question

Do not write outside the box

0 5 **Figure 3** shows a surfer on a surfboard.

Figure 3



Some surfboards are made from addition polymers.

Addition polymers are made from small alkene molecules.

0 5 . 1 Which type of bonding is present in small alkene molecules?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

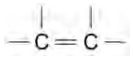
Metallic ☐

Do not write outside the box

0 5 . 2 What is the functional group in these small alkene molecules?

[1 mark]

Tick (✓) **one** box.



☐

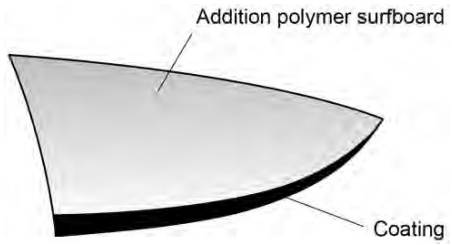
—COOH ☐

—OH ☐

Figure 4 shows the structure of part of an addition polymer surfboard.

The outer surface of the surfboard is coated.

Figure 4



The coating is made from soda-lime glass fibres surrounded by a plastic.

0 5 . 3 What type of material is the coating of the surfboard?

[1 mark]

Tick (✓) **one** box.

Alloy ☐

Ceramic ☐

Composite ☐

Nanotube ☐

Do not write outside the box

0 5 . 4 Complete the sentence.

Choose answers from the box.

[2 marks]

air	**ammonia**	**copper**
limestone	**sand**	

The materials used to make the soda-lime glass fibres are sodium carbonate, _____ and _____.

0 5 . 5 Suggest **two** reasons why surfboards are coated.

[2 marks]

1 _____

_____

2 _____

_____

Some surfboards are made from wood.

Table 3 contains information about the materials in an addition polymer surfboard and a wooden surfboard.

Table 3

	Addition polymer surfboard	**Wooden surfboard**
Relative strength	14	38
Cost (£ per m^3)	140	390
Density (kg/m^3)	50	150
Disposal at end of life	Difficult to recycle	Can be used as fuel

Do not write outside the box

0 5 . 6 Suggest **two** advantages and **two** disadvantages of using addition polymers rather than wood to make surfboards.

Use **Table 3.**

[4 marks]

Advantages of addition polymers _____

_____

_____

_____

Disadvantages of addition polymers _____

_____

_____

_____

0 5 . 7 Calculate the volume of wood in a wooden surfboard of mass 5.25 kg

Use **Table 3** and the equation:

$$\text{Density in kg/m}^3 = \frac{\text{Mass in kg}}{\text{Volume in m}^3}$$

[3 marks]

_____

_____

_____

_____

Volume = _____ m^3

14



Do not write outside the box

0 6 This question is about the corrosion of metals.

The corrosion of iron is called rusting.

0 6 . 1 Plan an investigation to show that both water and air are needed for iron to rust.

You should include the results you expect to obtain.

Use apparatus and materials from the list:

- test tubes
- stoppers
- iron nails
- tap water
- boiled water
- drying agent
- oil.

[6 marks]



Do not write outside the box

A student investigated how the mass of three iron nails, **A**, **B** and **C**, increased after rusting.

Table 4 shows the student's results.

Table 4

Nail	Mass of nail before rusting in g	Mass of nail after rusting in g	Increase in mass of nail in g
A	1.22	1.30	0.08
B	1.25	1.36	**X**
C	1.24	1.33	0.09

0 6 . 2 Calculate **X** in **Table 4**.

[1 mark]

X = _____ g

0 6 . 3 Calculate the mean increase in mass of the three iron nails, **A**, **B** and **C**.

Use **Table 4** and your answer to Question **06.2**

[1 mark]

Mean increase in mass = _____ g

8

Turn over ►



2 1

Do not write outside the box

0 7 Some students investigated the rate of decomposition of hydrogen peroxide.

The equation for the reaction is:

hydrogen peroxide → water + oxygen

0 7 . 1 Complete the sentence.

Choose an answer from the box.

[1 mark]

a burning splint	**a glowing splint**
damp litmus paper	**limewater**

The students tested the gas produced to show that it was oxygen.

The students used _____ .

Student **A** investigated the effect of the particle size of a manganese dioxide catalyst on the rate of the reaction.

This is the method used.

1. Measure 25 cm^3 hydrogen peroxide solution into a conical flask.
2. Add some fine manganese dioxide powder to the conical flask.
3. Measure the volume of oxygen produced every 30 seconds for 10 minutes.
4. Repeat steps 1 to 3 two more times.
5. Repeat steps 1 to 4 with coarse manganese dioxide lumps.



2 2

Do not write outside the box

0 7 . 2 The method student **A** used did **not** give repeatable results.

How could student **A** make the results repeatable?

[1 mark]

Tick (✓) **one** box.

Student **A** should make measurements every 2 minutes. ☐

Student **A** should measure the mass of manganese dioxide. ☐

Student **A** should use 50 cm^3 hydrogen peroxide. ☐

Student **A** should use a beaker instead of a conical flask. ☐

Student **B** used a method which gave repeatable results.

0 7 . 3 How could student **B** improve the accuracy of these results?

[1 mark]

Tick (✓) **one** box.

Calculate a mean but do not include any anomalous results. ☐

Calculate a mean but do not include the first set of results. ☐

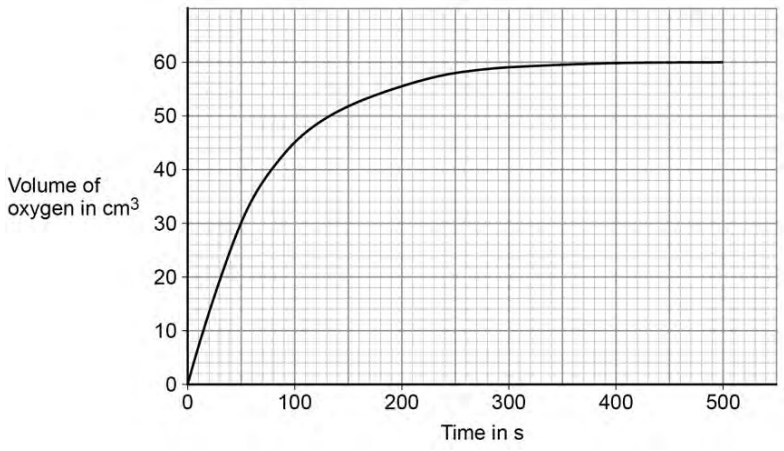
Record the results in a table and plot the results on a bar chart. ☐

Record the results in a table and plot the results on a line graph. ☐

Do not write outside the box

Figure 5 shows student **B**'s results for coarse manganese dioxide lumps.

Figure 5



0 7 . 4 Calculate the mean rate of reaction between 30 and 250 seconds for coarse manganese dioxide lumps.

Use **Figure 5** and the equation:

$$\text{Mean rate of reaction} = \frac{\text{Volume of oxygen formed}}{\text{Time taken}}$$

Give your answer to 3 significant figures.

[4 marks]

Volume of oxygen formed _____

Time taken _____

_____

_____

_____

_____

Mean rate of reaction = _____ cm^3/s

Do not write outside the box

0 7 . 5 Fine manganese dioxide powder produces a higher rate of reaction than coarse manganese dioxide lumps.

Sketch on **Figure 5** the results you would expect for student **B**'s experiment with fine manganese dioxide powder.

[2 marks]

0 7 . 6 Hydrogen peroxide molecules collide with manganese dioxide particles during the reaction.

Why does fine manganese dioxide powder produce a higher rate of reaction than coarse manganese dioxide lumps?

[1 mark]

Tick (✓) **one** box.

Fine manganese dioxide powder has a larger surface area. ☐

Fine manganese dioxide powder has larger particles. ☐

Fine manganese dioxide powder produces less frequent collisions. ☐

Turn over for the next question

10

Do not write outside the box

0 8 This question is about crude oil and hydrocarbons.

Figure 6 shows a fractionating column used to separate crude oil into fractions.

Figure 6

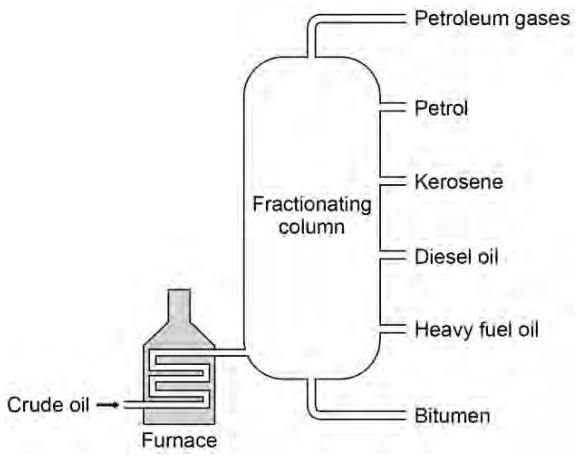


Table 5 gives information about some of the fractions.

Table 5

Fraction	Boiling point range in °C
Petroleum gases	Below 30
Petrol	40–110
Kerosene	180–260
Diesel oil	260–320
Heavy fuel oil	320–400
Bitumen	400–450

Do not write outside the box

0 8 . 1 Suggest a suitable temperature for the furnace in **Figure 6.**

[1 mark]

_____ °C

0 8 . 2 Explain why diesel oil collects above heavy fuel oil but below kerosene in the fractionating column.

Use **Table 5.**

[2 marks]

_____

_____

_____

_____

0 8 . 3 Suggest **two** reasons why bitumen is **not** used as a fuel.

[2 marks]

1 _____

_____

2 _____

_____

Question 8 continues on the next page



Do not write outside the box

0 8 . 4 Petrol contains mainly alkanes.

Which of the following compounds is an alkane?

[1 mark]

Tick (✓) **one** box.

C_2H_4 ☐

C_4H_8 ☐

C_6H_{14} ☐

C_8H_{16} ☐

Large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

0 8 . 5 Describe the conditions needed to crack hydrocarbon molecules from the diesel oil fraction.

[2 marks]

_____

_____

_____

_____



Do not write outside the box

0 8 . 6 Explain why large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

[2 marks]

0 8 . 7 Complete the equation for the cracking of $C_{15}H_{32}$

[1 mark]

$$C_{15}H_{32} \rightarrow C_{12}H_{26} + _____$$

11

Turn over for the next question

Do not write outside the box

0 9 This question is about lithium carbonate.

Lithium carbonate is used in medicines.

Figure 7 shows a tablet containing lithium carbonate.

Figure 7



0 9 . 1 Lithium carbonate contains lithium ions and carbonate ions.

A student tested the tablet for lithium ions and for carbonate ions.

The student used:

- a metal wire
- dilute hydrochloric acid
- limewater.

Plan an investigation to show the presence of lithium ions **and** of carbonate ions in the tablet.

You should include the results of the tests for the ions.

[6 marks]

Do not write outside the box

0 9 . 2 The tablet also contains other substances.

The substances in tablets are present in fixed amounts.

What name is given to mixtures like tablets?

[1 mark]

0 9 . 3 The tablet has a mass of 1.20 g and contains 700 mg of lithium carbonate.

Calculate the percentage by mass of lithium carbonate in this tablet.

[3 marks]

Percentage by mass of lithium carbonate = _____ %

10

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

1 0 This question is about rate of reaction.

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

The equation for the reaction is:

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

1 0 . 1 Which state symbol in the equation for the reaction does **not** represent one of the three states of matter?

[1 mark]

_____

The student determined the rate of production of hydrogen gas.

1 0 . 2 What **two** pieces of measuring apparatus could the student use to find the rate of production of hydrogen gas?

[2 marks]

1 _____

2 _____

Question 10 continues on the next page

Turn over ►

Do not write outside the box

Table 6 shows the results of the investigation.

Table 6

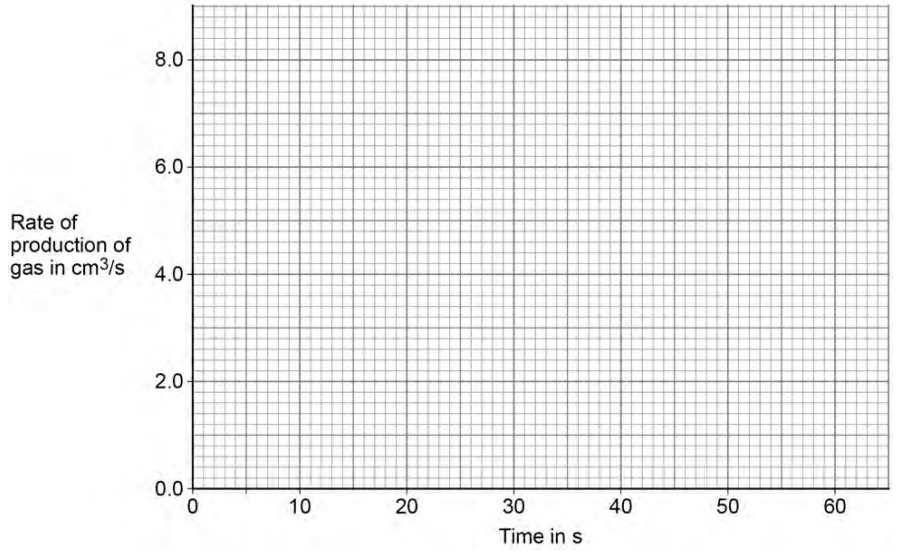
Time in s	Rate of production of gas in cm^3/s
10	6.9
20	3.9
30	2.0
40	0.9
50	0.3
60	0.0

1 0 . 3 Plot the data from **Table 6** on **Figure 8**.

You should draw a line of best fit.

[3 marks]

Figure 8



Do not write outside the box

1 0 . 4 Give **three** conclusions that can be drawn about the rate of reaction between magnesium and dilute hydrochloric acid in this investigation.

Use data from **Figure 8** and **Table 6**.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

1 0 . 5 The student repeated the investigation using dilute hydrochloric acid at a higher temperature.

All the other variables were kept the same.

Which **two** statements are correct?

[2 marks]

Tick (✓) **two** boxes.

More bubbles were produced in the first 10 seconds. ☐

The activation energy for the reaction was higher. ☐

The magnesium was used up more quickly. ☐

The reaction finished at the same time. ☐

The total volume of gas collected was greater. ☐

11

END OF QUESTIONS

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When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	Filtration – Improve taste Sterilisation – Kill bacteria Desalination Increase pH Remove solids	an extra line from a step to a reason for that step negates that mark	1 1	AO1 4.10.1.2
01.2	chlorine ozone		1 1	AO1 4.10.1.2
01.3	evaporate all water from the sample measure the sample's boiling point		1 1	AO2 4.8.1.1 4.10.1.2
01.4	Aluminium ion – Copper sulfate Sulfate ion – Sodium hydroxide Barium chloride Silver nitrate Sulfuric acid	an extra line from an ion to a compound needed negates that mark	1 1	AO1 4.8.3.2 4.8.3.5
01.5	distillation		1	AO1 4.10.1.2
Total			9	

Question 2

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>02.1</td><td>colourless
odourless
toxic

if more than three answers are given, apply the list principle as follows:
<table><tr><th>Number of answers</th><th>Number correct</th><th>Number incorrect</th><th>Mark awarded</th></tr><tr><td rowspan="3">4</td><td>3</td><td>1</td><td>2</td></tr><tr><td>2</td><td>2</td><td>1</td></tr><tr><td>1</td><td>3</td><td>0</td></tr><tr><td rowspan="3">5</td><td>3</td><td>2</td><td>1</td></tr><tr><td>2</td><td>3</td><td>0</td></tr><tr><td>1</td><td>4</td><td>0</td></tr></table></td><td>any order</td><td>1
1
1</td><td>AO1
4.9.3.2</td></tr>
<tr><td>02.2</td><td>oxygen</td><td>allow air / O_2</td><td>1</td><td>AO2
4.9.3.1</td></tr>
<tr><td>02.3</td><td>$\frac{36}{12} \times 8$

= 24 (g)</td><td>an answer of 24 (g) scores 2 marks</td><td>1

1</td><td>AO2
4.9.2.2</td></tr>
<tr><td>02.4</td><td>animal waste
food in landfill</td><td></td><td>1
1</td><td>AO1
4.9.2.2
4.10.1.1</td></tr>
<tr><td>Total</td><td></td><td></td><td>8</td><td></td></tr>
</table>

Question 3

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>03.1</td><td>(equation contains a) ⇌ (symbol)</td><td>allow description of arrow / symbol</td><td>1</td><td>AO1
4.6.2.1</td></tr>
<tr><td>03.2</td><td>exothermic</td><td></td><td>1</td><td>AO1
4.6.2.2</td></tr>
<tr><td>03.3</td><td>to reduce costs

to use less energy</td><td></td><td>1

1</td><td>AO3
4.6.1.4</td></tr>
<tr><td>03.4</td><td>(the world production of ammonia) increased

(the increase was) not steady / linear</td><td>

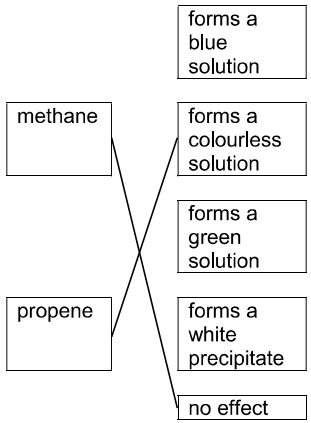
do not accept decreases
ignore levels off</td><td>1

1</td><td>AO2
4.10.4.1</td></tr>
<tr><td>03.5</td><td>the demand for food changed

the world population changed</td><td></td><td>1

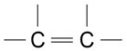
1</td><td>AO2
AO3
4.10.4.2</td></tr>
<tr><td>03.6</td><td>C and D</td><td></td><td>1</td><td>AO3
4.10.4.2</td></tr>
<tr><td>03.7</td><td>D</td><td></td><td>1</td><td>AO3
4.10.4.2</td></tr>
<tr><td>Total</td><td></td><td></td><td>10</td><td></td></tr>
</table>

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	nitrogen **and** methane	in either order, both required for mark allow phonetic spellings allow N_2 for nitrogen allow CH_4 for methane	1	AO2 4.9.1.1
04.2	nitrogen bar to 78% oxygen bar to 21%	ignore width of bars ignore additional bars	1 1	AO2 4.9.2.2
04.3	Titan's atmosphere contains too little carbon dioxide.		1	AO3 4.9.1.3
04.4	long wavelength radiation is reflected back to the surface of Titan.		1	AO1 4.9.2.1
04.5		an extra line from a gas to an effect on bromine water negates that mark	1 1	AO1 4.7.1.4
04.6	$\frac{7 \times 21}{3}$ = 49 (g)	an answer of 49 (g) scores **2** marks.	1 1	AO2 4.7.2.2
Total			**9**	

MARK SCHEME – GCSE CHEMISTRY – 8462/2F – JUNE 2019

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	covalent		1	AO1 4.2.1.4
05.2			1	AO1 4.7.2.1 4.7.2.2
05.3	composite		1	AO2 4.10.3.3
05.4	limestone sand	either order	1 1	AO1 4.10.3.3
05.5	any **two** from: (makes the board) • strong • hard • tough • waterproof • durable • aesthetic reasons • rigid • less friction • protection	ignore corrosion / erosion / rotting / rusting allow long lasting allow streamlined / smooth allow prevents damage	2	AO3 4.10.3.3
05.6	(advantages of addition polymers) low(er) cost low(er) density (disadvantages of addition polymers) weak(er) hard(er) to dispose of	 allow cheap(er) allow light(er) allow (more) likely to break ignore references to recycling or use as a fuel	 1 1 1 1	AO3 4.10.1.1 4.10.2.1

05.7	$150 = \frac{5.25}{\text{volume}}$ (volume =) $\frac{5.25}{150}$ (volume =) 0.035 (m^3)	an answer of 0.035 (m^3) scores **3** marks. allow **2** marks for an answer of 0.105 (m^3) (addition polymer)	1 1 1	AO2 4.10.1.1
Total			**14**	

Question 6

Question	Answers		Mark	AO/ Spec. Ref
06.1	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		5–6	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	AO1
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	AO1 4.10.3.1
	No relevant content		0	
	Indicative content **Plan – allow diagrams to indicate content** • three test tubes containing nails • test tube 1 – open test tube with water • test tube 2 – stoppered test tube with drying agent • test tube 3 – test tube with boiled water • test tube 3 – sealed with oil • leave for several days • observe results **Results** • test tube 1 – nail rusts • test tube 2 – nail does not rust • test tube 3 – nail does not rust			
06.2	0.11 (g)		1	AO2 4.10.3.1
06.3	$\left(\frac{0.08 + \mathbf{X} + 0.09}{3}\right)$			AO2 4.10.3.1
	= 0.09 (g)	allow 0.09(3333….) allow ecf **from 06.2**	1	
Total			**9**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	a glowing splint		1	AO1 4.8.2.2
07.2	student **A** should measure the mass of manganese dioxide.		1	AO3 4.6.1.1 4.6.1.2
07.3	calculate a mean but do not include any anomalous results.		1	AO3 4.6.1.1 4.6.1.2
07.4		an answer of 0.173 (cm^3/s) scores **4** marks		AO2 4.6.1.1
	(volume of oxygen formed =) (58 - 20 =) 38 (cm^3)	allow values between 36 (cm^3) and 40 (cm^3) inclusive	1	
	(time taken = 250 – 30 =) 220 (s)		1	
	$\frac{38}{220}$ **or** 0.1727 (cm^3/s)	allow a correct calculation using an incorrectly determined value for volume and / or time	1	
	= 0.173 (cm^3/s)	allow a correctly calculated answer given to 3 significant figures from an incorrect attempt at the rate equation	1	
07.5	line starts at the origin **and** steeper than existing line		1	AO2 4.6.1.1
	final volume same as existing line	allow a tolerance of ± ½ a small square	1	
07.6	fine manganese dioxide powder has a larger surface area		1	AO3 4.6.1.2 4.6.1.3
Total			**10**	

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	a temperature between 400 (°C) and 500 (°C) inclusive	allow a temperature range entirely within 400 (°C) and 500 (°C) inclusive	1	AO3 4.7.1.2
08.2	(diesel oil has a) lower boiling point / range than heavy fuel oil (but diesel oil has a) higher boiling point / range than kerosene	ignore quoted values for boiling points ignore references to melting points ignore references to intermolecular forces or chain length allow temperature of vaporisation / condensation for boiling points throughout allow the boiling range (of diesel oil) is between those of heavy fuel oil and kerosene for **2** marks.	1 1	AO2 4.7.1.2
08.3	any **two** from: • (too) viscous • not (very) flammable • boiling point (too) high	ignore references to cost allow references to difficulty of flow allow references to difficulty of ignition / burning do **not** accept bitumen takes more energy to burn allow not (very) volatile	2	AO2 4.7.1.3
08.4	C_6H_{14}		1	AO2 4.7.1.1

08.5	high temperature any **one** from: • steam • catalyst	ignore references to pressure allow a quoted temperature above 320 °C ignore hot / heat ignore name of catalyst allow alumina allow aluminium oxide allow porous pot allow zeolite	1 1	AO1 4.7.1.4
08.6	greater demand (for smaller molecules) any **one** from: (because smaller molecules are) • more useful • better fuels • used to make alkenes • used to make polymers	allow converse argument for larger molecules allow a named polymer ignore plastics	1 1	AO1 4.7.1.4
08.7	C_3H_6		1	AO2 4.1.1.1 4.7.1.4
Total			**11**	

Question 9

Question	Answers		Mark	AO/ Spec. Ref
09.1	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		5–6	AO1 4.8.2.3 4.8.3.1 4.8.3.3
	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	
	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 lithium: • crush tablets or dissolve tablet (in water or acid) • clean wire • place on wire • place in (roaring / blue / non-luminous) flame • observe flame colour • crimson flame carbonate: • add hydrochloric acid • effervescence / fizzing • bubble gas through limewater • limewater becomes cloudy			
09.2	formulation(s)		1	AO1 4.8.1.2

		an answer of 58.3333333 (%) correctly rounded to at least 2 significant figures scores **3** marks		AO2 4.8.1.2
09.3	1.20 g = 1200 mg **or** 700 mg = 0.700 g		1	
	$\frac{700}{1200} \times 100$ **or** $\frac{0.700}{1.20} \times 100$	allow correct use of incorrectly or not converted values from step 1	1	
	= 58.3 (%)	allow 58.3333333 (%) correctly rounded to at least 2 significant figures	1	
Total			**10**	

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	(aq)	allow aqueous / aq	1	AO1 4.2.2.1 4.2.2.2
10.2	(gas) syringe	allow measuring cylinder (and water trough) allow balance	1	AO1 4.6.1.1
	stopclock / stopwatch	allow timer / clock / watch	1	
10.3	all points plotted correctly	allow a tolerance of ± ½ a small square allow at least 3 points plotted correctly for **1** mark.	2	AO2 4.6.1.1
	line of best fit	allow correctly drawn line of best fit for incorrectly plotted points	1	
10.4	(rate) decreases	allow slows down	1	AO3 4.6.1.1
	(rate decreases) more slowly as time increases	allow (rate decreases) at a non-linear rate	1	
	(rate) becomes zero at 60 s	allow the reaction stops at 60 s allow ecf from question **10.3**	1	
10.5	more bubbles were produced in the first 10 seconds		1	AO2 4.6.1.2
	the magnesium was used up more quickly		1	
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
CHEMISTRY

F

Foundation Tier Paper 2

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed)

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

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

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Do not write outside the box

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

0 1 . 1 How long ago was the Earth formed?

[1 mark]

Tick (✓) **one** box.

4.6 billion years ago ☐

4.6 million years ago ☐

4.6 thousand years ago ☐

Table 1 shows the percentages of gases in the atmospheres of Mars and Earth today.

Table 1

Gas	Percentage of gas in atmosphere (%)	
	Mars	**Earth**
Carbon dioxide	95.97	0.04
Nitrogen	1.89	78.09
Oxygen	0.15	20.95
Other gases	1.99	**X**

0 1 . 2 Calculate the percentage **X** of other gases in the Earth's atmosphere.

Use **Table 1**.

[1 mark]

_____

X = _____ %

Do not write outside the box

The atmosphere of the early Earth is thought to have been similar to the atmosphere of Mars today.

The percentages of nitrogen and of oxygen in the Earth's atmosphere today have changed from the percentages in the Earth's early atmosphere.

0 1 . 3 Draw **one** line from each gas to the change in the percentage of that gas.

Use **Table 1**.

[2 marks]

Gas	Change in percentage of gas
Nitrogen	Increased by about 4 times
	Increased by about 21%
	Increased by about 40 times
Oxygen	Increased by about 96%

0 1 . 4 The percentage of carbon dioxide in the Earth's early atmosphere decreased.

Which **two** processes caused this decrease?

[2 marks]

Tick (✓) **two** boxes.

- Carbon dioxide dissolving in sea water ☐
- Combustion of fossil fuels ☐
- Farming of animals ☐
- Formation of sedimentary rocks ☐
- Volcanoes releasing carbon dioxide ☐

Turn over ►

Do not write outside the box

0 1 . 5 Photosynthesis also decreased the percentage of carbon dioxide in the Earth's early atmosphere.

Photosynthesis increased the percentage of another gas.

Complete the word equation for photosynthesis.

[2 marks]

_____ + water → glucose + _____

0 1 . 6 Complete the sentence.

[1 mark]

Scientists are not certain about the percentages of gases in the Earth's early atmosphere because there is a lack of _____.

9

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 This question is about water.

A student investigated the concentration of salt in sea water.

This is the method used.

1. Filter the sea water to remove sand.
2. Measure the mass of an empty evaporating dish.
3. Measure 50 cm^3 of sea water into the evaporating dish.
4. Heat the evaporating dish and sea water.
5. Evaporate the sea water to dryness.
6. Measure the mass of the evaporating dish and salt.

0 2 . 1 What equipment should the student use to measure:

- the mass of the evaporating dish
- the volume of sea water?

[2 marks]

Mass of evaporating dish _____

Volume of sea water _____

Do not write outside the box

0 2 . 2 **Table 2** shows the student's results.

Table 2

	Mass in g
Evaporating dish	30.44
Evaporating dish and salt	30.49

The student used 50 cm^3 of sea water.

Calculate the mass of salt in 1000 cm^3 of this sea water.

[3 marks]

Mass of salt = _____ g

0 2 . 3 The salt must be completely dry.

Which **two** extra steps are needed to show that the salt is completely dry?

[2 marks]

Tick (✓) **two** boxes.

- Filter the sea water again. ☐
- Heat the evaporating dish and salt again. ☐
- Measure the 50 cm^3 of sea water again. ☐
- Measure the mass of the empty evaporating dish again. ☐
- Measure the mass of the evaporating dish and salt again. ☐

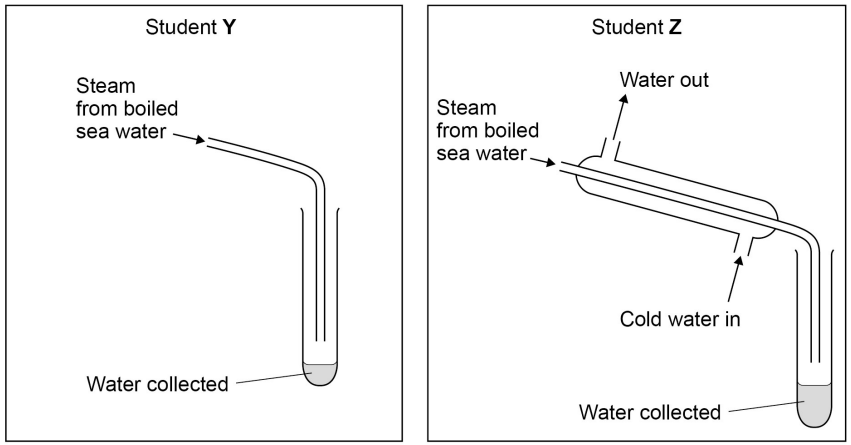
Turn over ►

Do not write outside the box

Two students, **Y** and **Z**, distil sea water to collect water.

Figure 1 shows the apparatus used by each student to collect the water.

Figure 1



0 2 . 4 Students **Y** and **Z** boil the same volume of sea water for the same period of time.

Explain why student **Y** collects a smaller volume of water than student **Z**.

[2 marks]

0 2 . 5 Water obtained by distillation does **not** need to be sterilised and is safe to drink.

Suggest why.

[1 mark]

Do not write outside the box

Fresh water needs to be sterilised before it is safe to drink.

0 2 . 6 How is fresh water sterilised?

[2 marks]

Tick (✓) **two** boxes.

- Using ammonia ☐
- Using chlorine ☐
- Using chromatography ☐
- Using filtration ☐
- Using ozone ☐

0 2 . 7 A student tests the pH of fresh water using universal indicator solution.

When added to the fresh water, the colour of the universal indicator solution is green.

What is the pH of this fresh water?

[1 mark]

pH = _____

13

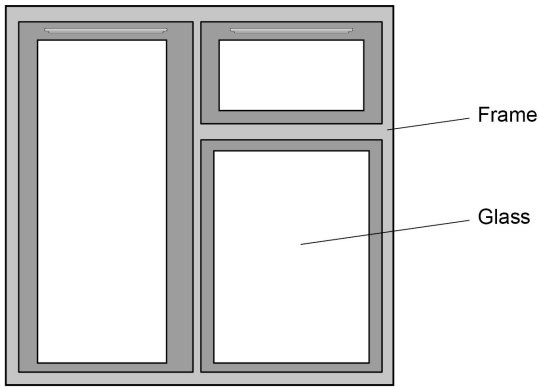
Turn over for the next question

Do not write outside the box

0 3 This question is about substances used to make windows and window frames.

Figure 2 shows a window.

Figure 2



0 3 . 1 Glass is made by heating sand with **two** other materials.

Which **two** other materials are used to make glass?

[2 marks]

Tick (✓) **two** boxes.

- Clay ☐
- Graphite ☐
- Limestone ☐
- Sodium carbonate ☐
- Sodium hydroxide ☐

Do not write outside the box

Window frames need to be:

- easy to install
- resistant to damage.

The polymers poly(chloroethene) and HDPE are used to make window frames.

Table 3 shows information about poly(chloroethene) and HDPE.

Table 3

Property	Poly(chloroethene)	HDPE
Density in g/cm^3	1.4	0.92
Relative strength	72	25

0 3 . 2 Suggest **one** advantage of using poly(chloroethene) compared with HDPE to make window frames.

Give **one** reason for your answer.

Use **Table 3**.

[2 marks]

Advantage _____

_____

Reason _____

_____

0 3 . 3 Suggest **one** advantage of using HDPE compared with poly(chloroethene) to make window frames.

Give **one** reason for your answer.

Use **Table 3**.

[2 marks]

Advantage _____

_____

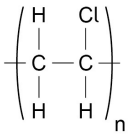
Reason _____

_____

Do not write outside the box

0 3 . 4 **Figure 3** shows the displayed structural formula of poly(chloroethene).

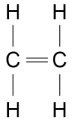
Figure 3



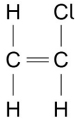
Which monomer is used to make poly(chloroethene)?

[1 mark]

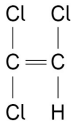
Tick (✓) **one** box.



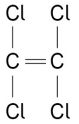
☐



☐



☐



☐

Do not write outside the box

0 3 . 5 Chlorine gas is used to produce poly(chloroethene).

Describe a test to identify chlorine gas.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 3 . 6 Wood can be used instead of polymers to make window frames.

- Polymers are unreactive.
- Polymers are produced from crude oil.
- Wood breaks down in wet conditions.
- Wood is produced from trees.

Suggest **one** advantage of using polymers and **one** advantage of using wood to make window frames.

[2 marks]

Advantage of polymers _____

_____

Advantage of wood _____

_____

Question 3 continues on the next page

Do not write outside the box

Window frames can also be made from an alloy of aluminium.

0 3 . 7 6.00 kg of the alloy is used to make a window frame.

Table 4 shows the mass of each element in 6.00 kg of the alloy.

Table 4

Element	Mass in kg
Aluminium	5.94
Magnesium	0.04
Silicon	0.02

Calculate the percentage of aluminium in 6.00 kg of the alloy.

[2 marks]

_____

_____

Percentage of aluminium = _____ %

0 3 . 8 Why is an alloy used instead of pure aluminium to make window frames?

[1 mark]

_____

_____

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 4 This question is about reactions between gases.

When hydrogen gas is heated with iodine gas, hydrogen iodide gas is produced.

The equation for this reversible reaction is:

hydrogen + iodine ⇌ hydrogen iodide

This reversible reaction reaches equilibrium in a sealed container.

0 4 . 1 How does the equation show that the reaction is reversible?

[1 mark]

0 4 . 2 Which **two** statements are correct when the reaction reaches equilibrium?

[2 marks]

Tick (✓) **two** boxes.

- The forward reaction and reverse reaction are both exothermic. ☐
- The gases have escaped from the container. ☐
- The hydrogen no longer reacts with iodine. ☐
- The mass of each substance does not change. ☐
- The rates of the forward reaction and reverse reaction are equal. ☐

Do not write outside the box

0 4 . 3 The initial mixture of hydrogen and iodine in the sealed container is purple.

Hydrogen iodide is colourless.

How will the colour of the mixture in the sealed container have changed when equilibrium is reached?

[1 mark]

Tick (✓) **one** box.

The mixture will have become a deeper purple. ☐

The mixture will have become a paler purple. ☐

The mixture will have become colourless. ☐

0 4 . 4 The rate of reaction between gases is affected by changing the pressure.

Complete the sentences.

[3 marks]

When the pressure of the reacting gases is increased,

the rate of reaction _____.

This is because at higher pressures the distance

between the particles _____.

This means that the frequency of collisions _____.

0 4 . 5 Give **one** other way of changing the rate of reaction between gases.

You should **not** refer to pressure in your answer.

[1 mark]

_____

_____

8

Do not write outside the box

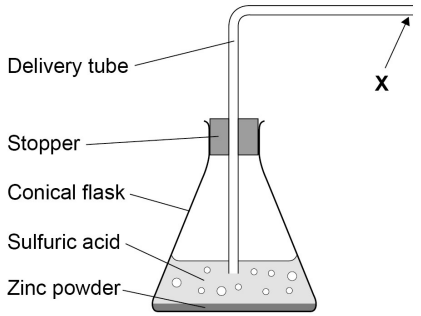
0 5 A student investigated the rate of the reaction between zinc and sulfuric acid.

This is the method used.

1. Pour 40 cm^3 of sulfuric acid into a conical flask.
2. Add 2.0 g of zinc powder to the conical flask.
3. Put the stopper in the conical flask.
4. Measure the volume of hydrogen gas collected every 30 seconds for 5 minutes.

Figure 4 shows part of the apparatus used.

Figure 4



Do not write outside the box

0 5 . 1 **X** shows where a piece of equipment is connected to measure the volume of hydrogen gas collected.

Complete **Figure 4** to show the equipment used.

[1 mark]

0 5 . 2 The student made an error setting up the delivery tube shown in **Figure 4**.

Describe the error **and** the problem this error would cause.

[2 marks]

Error made _____

_____

Problem caused _____

_____

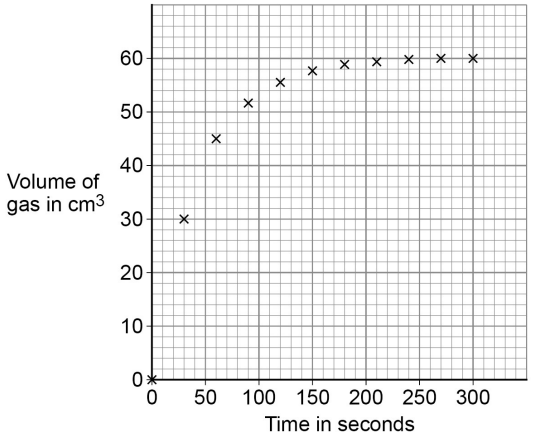
Question 5 continues on the next page

Do not write outside the box

The student then set up the apparatus correctly.

Figure 5 shows the student's results.

Figure 5



0 5 . 3 Complete **Figure 5** by drawing a line of best fit.

[1 mark]

Do not write outside the box

0 5 . 4 Determine the mean rate of reaction between 0 seconds and 60 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas formed}}{\text{time taken}}$$

Use data from **Figure 5**.

Give the unit.

Choose the answer from the box.

[4 marks]

cm^3/s	**g/s**	**s/cm^3**	**s/g**

Mean rate of reaction = _____ Unit _____

0 5 . 5 The student repeated the investigation using sulfuric acid of a higher concentration.

The student plotted the results and drew a line of best fit.

How would the line of best fit for higher concentration compare with the line of best fit for lower concentration?

[1 mark]

Tick (✓) **one** box.

The line of best fit for higher concentration would have a less steep slope. ☐

The line of best fit for higher concentration would have a steeper slope. ☐

The lines of best fit would have slopes with the same steepness. ☐

9

Do not write outside the box

0 6 Potash alum is a chemical compound.

Potash alum contains potassium ions, aluminium ions and sulfate ions.

0 6 . 1 Which **two** methods can be used to identify the presence of potassium ions in potash alum solution?

[2 marks]

Tick (✓) **two** boxes.

Flame emission spectroscopy ☐

Flame test ☐

Measuring boiling point of solution ☐

Paper chromatography ☐

Using litmus paper ☐

0 6 . 2 Sodium hydroxide solution is used to test for some metal ions.

Sodium hydroxide solution is added to a solution of potash alum until a precipitate forms.

Complete the sentence.

Choose the answer from the box.

[1 mark]

blue	**brown**	**green**	**white**

The colour of the precipitate formed is _____.

Do not write outside the box

0 6 . 3 Complete the sentence.

Choose the answer from the box.

[1 mark]

barium chloride solution	**limewater**
red litmus paper	**silver nitrate solution**

Sulfate ions can be identified using dilute hydrochloric acid

and _____.

0 6 . 4 A solution of potash alum has a concentration of 258 g/dm^3

Calculate the mass of potash alum needed to make 800 cm^3 of a solution of potash alum with a concentration of 258 g/dm^3

Give your answer to 3 significant figures.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

Mass (3 significant figures) = _____ g

8

Do not write outside the box

0 7 This question is about organic compounds.

0 7 . 1 Butane is an alkane with small molecules.

Complete the sentence.

Choose the answer from the box.

[1 mark]

fertiliser	**formulation**	**fuel**

Butane can be used as a _____.

0 7 . 2 Poly(propene) is a polymer.

What is the name of the monomer used to produce poly(propene)?

[1 mark]

Tick (✓) **one** box.

- Propane ☐
- Propanoic acid ☐
- Propanol ☐
- Propene ☐

Do not write outside the box

Ethene and steam react to produce ethanol.

The equation for the reversible reaction is:

ethene + steam ⇌ ethanol

0 7 . 3 The reaction produces a maximum theoretical mass of 400 kg of ethanol from 243 kg of ethene and 157 kg of steam.

A company produces 380 kg of ethanol from 243 kg of ethene and 157 kg of steam.

The percentage yield of ethanol is less than 100%

Calculate the percentage yield of ethanol.

Use the equation:

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

[2 marks]

Percentage yield = _____ %

0 7 . 4 What are **two** possible reasons why the percentage yield of ethanol is less than 100%?

[2 marks]

Tick (✓) **two** boxes.

- Ethanol is the only product of the reaction. ☐
- Ethanol is very unreactive. ☐
- Some ethanol changes back into ethene and steam. ☐
- Some ethanol escapes from the apparatus. ☐
- Some ethanol reacts with steam. ☐

Do not write outside the box

0 7 . 5 Ethanol burns in oxygen.

Balance the equation for the reaction.

[1 mark]

$$C_2H_5OH + ___ O_2 \rightarrow 3H_2O + 2CO_2$$

0 7 . 6 Two processes for producing ethanol are:

- fermentation
- hydration (reacting ethene with steam).

Table 5 shows information about the processes.

Table 5

Feature	Process	
	Fermentation	**Hydration**
Raw material	sugar	crude oil
Energy usage	low	high
Rate of reaction	slow	fast
Purity of ethanol	15%	98%

Give **two** advantages and **two** disadvantages of using fermentation to produce ethanol.

[4 marks]

Advantage of fermentation 1 _____

Advantage of fermentation 2 _____

Disadvantage of fermentation 1 _____

Disadvantage of fermentation 2 _____

11

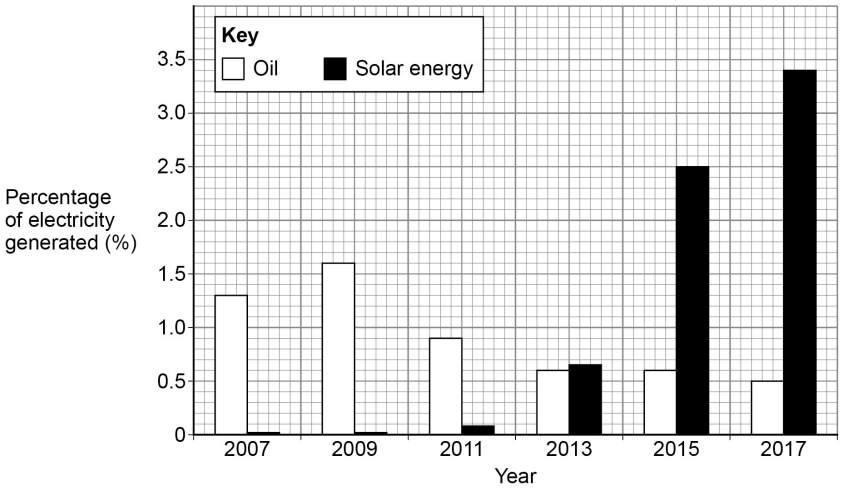
Do not write outside the box

0 8 This question is about fuels and energy.

Figure 6 shows the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Figure 6



0 8 . 1 Describe the changes in the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Use data from **Figure 6** in your answer.

[3 marks]

Turn over ►

Do not write outside the box

0 8 . 2 Oil contains carbon and some sulfur.

When oil is burned, the products of combustion may be released into the atmosphere.

Explain the environmental effects of releasing these products of combustion into the atmosphere.

[6 marks]

Do not write outside the box

0 8 . 3 Suggest **one** reason why using solar energy is a more sustainable way of generating electricity than burning oil.

[1 mark]

0 8 . 4 Solar energy may **not** be able to replace the generation of electricity from fossil fuels completely.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

12

Turn over for the next question

Do not write outside the box

0 9 This question is about alkanes.

Table 6 shows information about some alkanes.

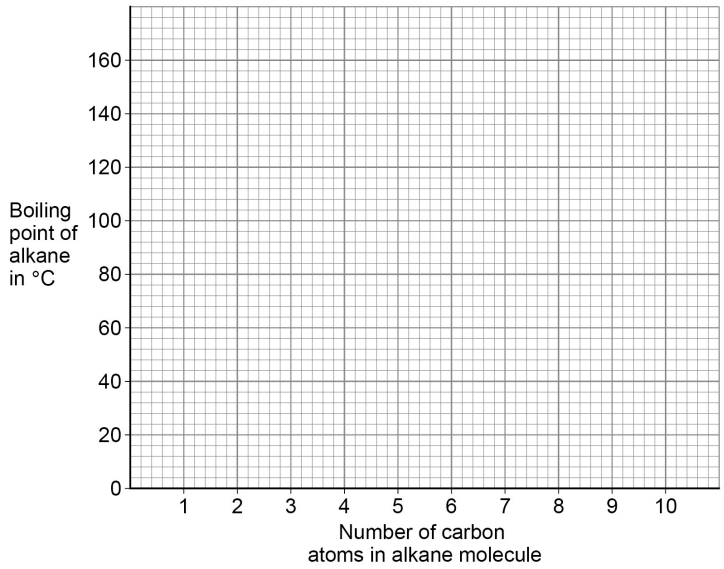
Table 6

Number of carbon atoms in alkane molecule	Boiling point of alkane in °C
4	0
5	36
6	69
7	**X**
8	126
9	151

0 9 . 1 Plot the data from **Table 6** on **Figure 7.**

[2 marks]

Figure 7



Do not write outside the box

0 9 . 2 Predict the boiling point **X** of the alkane with seven carbon atoms in a molecule.

Use **Table 6** and **Figure 7**.

[1 mark]

X = _____ °C

0 9 . 3 **Figure 7** is **not** suitable to show the boiling point of the alkane with three carbon atoms in a molecule.

Suggest **one** reason why.

[1 mark]

0 9 . 4 What is the state at 20 °C of the alkane with four carbon atoms in a molecule?

Use **Table 6**.

[1 mark]

Question 9 continues on the next page

Turn over ►

Do not write outside the box

Table 6 is repeated below.

Table 6

Number of carbon atoms in alkane molecule	Boiling point of alkane in °C
4	0
5	36
6	69
7	**X**
8	126
9	151

The alkane with nine carbon atoms in a molecule is called nonane.

0 9 . 5 Complete the formula of nonane.

[1 mark]

C_9H___

0 9 . 6 Nonane will condense lower in a fractionating column during fractional distillation than the other alkanes in **Table 6**.

Explain why.

You should refer to the temperature gradient in the fractionating column.

[2 marks]

8

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Turn over for the next question

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1 0 This question is about paper chromatography.

A food colouring contains a dye.

1 0 . 1 Plan an investigation to determine the R_f value for the dye in this food colouring.

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

Your plan should include the use of:

- a beaker
- a solvent
- chromatography paper.

[6 marks]

Do not write outside the box

1 0 . 2 Two students investigated a dye in a food colouring using paper chromatography.

Each student did the investigation differently.

The R_f values they determined for the **same** dye were different.

How did the students' investigations differ?

[1 mark]

Tick (✓) **one** box.

- Different length of paper used ☐
- Different period of time used ☐
- Different size of beaker used ☐
- Different solvent used ☐

1 0 . 3 Paper chromatography involves a stationary phase.

What is the stationary phase in paper chromatography?

[1 mark]

Tick (✓) **one** box.

- Beaker ☐
- Dye ☐
- Paper ☐
- Solvent ☐

8

END OF QUESTIONS

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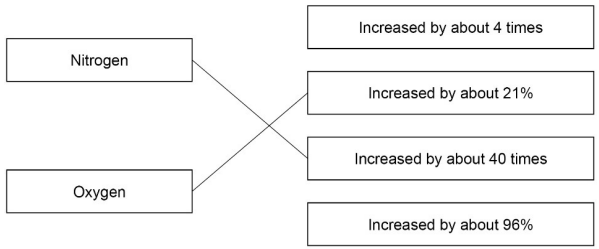
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Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	4.6 billion years ago		1	AO1 4.9.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	0.92 (%)		1	AO2 4.9.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	 do **not** accept more than one line from a box on the left		1 1	AO1 AO2 4.9.1.1 4.9.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	carbon dioxide dissolving in sea water formation of sedimentary rocks		1 1	AO1 4.9.1.2 4.9.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	carbon dioxide (+ water →) (→ glucose +) oxygen	allow CO_2 allow O_2	1 1	AO1 4.9.1.3

Question 1 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	evidence / proof		1	AO1 4.9.1.2

Total			**9**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(mass) balance (volume) measuring cylinder	allow scales allow burette / pipette	1 1	AO1 4.10.1.2 RPA 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	(mass of salt = 30.49 – 30.44 =) 0.05 (g salt) (mass of salt in 1000 cm^3 =) $\frac{1000}{50} \times 0.05$ = 1.0 (g) **alternative approach**: (volume ratio = $\frac{1000}{50}$) = 20 (1) (mass of salt in 1000 cm^3) = (30.49 – 30.44) × 20 (1) = 1.0 (g) (1)	 allow correct use of incorrectly determined mass of salt allow correct use of incorrectly determined volume ratio	1 1 1	AO2 4.10.1.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	heat the evaporating dish and salt again measure the mass of the evaporating dish and salt again		1 1	AO3 4.10.1.2 RPA 8

Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	 (no condenser) (more) steam escapes **or** less steam condenses (because) cooling / condensing is less efficient **or** (because) a (liebig) condenser is not used	allow converse for condenser allow water vapour for steam allow (because) cooling / condensing is slower allow (because) cold water is not used for cooling / condensing	 1 1	 AO1 AO3 4.1.1.2 4.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	(distilled) water is pure	allow microbes are destroyed (by distillation)	1	AO3 4.8.1.1 4.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	using chlorine using ozone		1 1	AO1 4.10.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	pH 7		1	AO2 4.4.2.4 4.10.1.2 RPA8

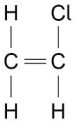
Total			13

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	limestone sodium carbonate		1 1	AO1 4.10.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(advantage) stronger (reason) less easily damaged		1 1	AO3 AO2 4.10.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(advantage) lower density (reason) lighter (to install)		1 1	AO3 AO2 4.10.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4			1	AO2 4.7.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	(add damp) litmus paper (litmus paper) is bleached **or** (litmus paper) turns white	ignore (litmus paper) turns red	1 1	AO1 4.8.2.4

Question 3 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	(polymers) last a long time	ignore references to cost allow break down slowly	 1	 AO3
	(wood) renewable	allow trees can be replanted allow aesthetic reasons	1	AO1 4.10.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	(percentage of aluminium =) $\frac{5.94}{6.00} \times 100$ = 99 (%)		1 1	AO2 4.10.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.8	(alloy is) harder (than pure aluminium)	allow (alloy is) stronger (than pure aluminium) ignore references to cost	1	AO2 4.2.2.7 4.10.3.2

Total			14

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(equation contains the symbol) ⇌	allow description of arrow / symbol	1	AO1 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	the mass of each substance does not change		1	AO3
	the rates of the forward reaction and reverse reaction are equal		1	AO1 4.6.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	the mixture will have become a paler purple		1	AO3 4.6.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4		must be in this order		AO1 4.6.1.2 4.6.1.3
	increases		1	
	decreases		1	
	increases		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	change the temperature **or** add a catalyst	ignore references to pressure	1	AO1 4.6.1.2 4.6.1.3

Total			**8**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(diagram) gas syringe **or** inverted measuring cylinder over water		1	AO3 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(error) (delivery) tube is in (sulfuric) acid		1	AO3 4.6.1.2 RPA5
	(problem) (sulfuric) acid will travel up tube **or** no hydrogen / gas will be collected		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	line of best fit	must include 0, 0	1	AO2 4.6.1.1 4.6.1.2 RPA5

Question 5 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(volume of gas =) 45 (cm^3)	allow a tolerance of ± ½ a small square allow volume from drawn curve	1	AO2 4.6.1.1 4.6.1.2 RPA5
	(rate =) $\frac{45}{60}$	allow correct use of incorrectly determined volume at 60 seconds	1	
	= 0.75		1	
	cm^3/s		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	the line of best fit for higher concentration would have a steeper slope		1	AO1 4.6.1.1 4.6.1.2 RPA5

Total			**9**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	flame emission spectroscopy flame test		1 1	AO1 4.8.3.1 4.8.3.7 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	white		1	AO2 4.8.3.2 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	barium chloride (solution)		1	AO1 4.8.3.5 RPA7

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(conversion) (800 cm^3 = $\frac{800}{1000}$ =) 0.8 (dm^3) (mass =) 0.8 × 258 (g) = 206.4 (g) = 206 (g) **alternative approach:** (conversion) (258 g/dm^3 = $\frac{258}{1000}$ =) 0.258 (g/cm^3) (1) (mass =) 0.258 × 800 (g) (1) = 206.4 (g) (1) = 206 (g) (1)	allow correct use of incorrect / no volume conversion allow an answer correctly calculated to 3 significant figures from an incorrect calculation which uses the values in the question allow correct use of incorrect / no concentration conversion allow an answer correctly calculated to 3 significant figures from an incorrect calculation which uses the values in the question	1 1 1 1	AO2 4.3.2.5
Total			**8**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	fuel		1	AO1 4.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	propene		1	AO2 4.7.2.1 4.7.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(percentage yield =) $\frac{380}{400}$ × 100 = 95 (%)		1 1	AO2 4.3.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	some ethanol changes back into ethene and steam some ethanol escapes from the apparatus		1 1	AO2 4.3.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	C_2H_5OH + **3** O_2 → 3 H_2O + 2 CO_2	allow multiples	1	AO2 4.1.1.1 4.3.1.1 4.7.2.3

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(advantages)			AO3 4.7.2.2 4.7.2.3 4.10.1.1
	(fermentation) low energy usage		1	
	(fermentation) uses renewable raw materials		1	
	(disadvantages)			
	(fermentation) produces impure ethanol		1	
	(fermentation) slow rate of reaction		1	

Total			11

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	use of oil has decreased by 0.8% **or** use of oil has decreased from 1.3% to 0.5%		1	AO2 4.10.1.1
	use of solar energy has increased by 3.4% **or** use of solar energy has increased from 0% to 3.4%	allow any value below 0.05% for 2007	1	
	any **one** from: • use of oil increased from 2007 to 2009 • no change in oil use between 2013 and 2015 • no change in solar energy use between 2007 and 2009 • use of solar energy increased most between 2013 and 2015 • between 2007 and 2011 more oil was used **and** between 2013 and 2017 more solar energy was used	allow use of oil was highest in 2009	1	
		if no other mark is awarded, allow **1** mark for oil decreased **and** solar energy increased		

Question 8 continued

Question	Answers	Mark	AO/ Spec. Ref
08.2	**Level 3**: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	
	Indicative content • carbon dioxide produced • (which is) a greenhouse gas • (therefore) surface temperature increases • (therefore) global warming • (so) climate change • (so) polar ice caps melt • (so) increasing sea levels • (so) flooding • (so) extreme weather events • (so) reduction in biodiversity • (so) famine / drought • sulfur dioxide produced • (which causes) acid rain • (so) damage to buildings / statues • (so) damage to trees • (so) damage to aquatic animals • (so) respiratory problems in humans • carbon / soot produced • (which are) particulates • (which cause) global dimming • (so) respiratory problems in humans • carbon monoxide produced • (which is) toxic		4.9.2.2 4.9.2.3 4.9.3.1 4.9.3.2

Question 8 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	solar is (a) renewable (source of energy)	allow oil is (a) finite (source of energy)	1	AO3 4.10.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	any **two** from: • sunshine is unreliable • increased demand for energy • lack of space	ignore references to cost	2	AO3 4.9.2.4 4.10.1.1

Total			12

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	all five points plotted correctly	allow a tolerance of ± ½ a small square allow **1** mark for three or four points plotted correctly	2	AO2 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	98 (°C)	allow a value in the range 92 to 104 (°C)	1	AO3 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	the boiling point is lower than 0 (°C)	allow the graph cannot show negative temperatures	1	AO3 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	gas	allow (g)	1	AO2 4.2.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	C_9H_{20}		1	AO2 4.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6		allow converse for the other alkanes		AO2 4.7.1.2
	(nonane) has a higher boiling point		1	
	(so nonane) condenses where the column has a higher temperature	allow (so nonane) collects where the column has a higher temperature	1	

Total			8

Question 10

Question	Answers	Mark	AO/ Spec. Ref
10.1	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.8.1.3 RPA6
	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	
	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 **Method** • draw (pencil) start line on (chromatography) paper • place spot of food colouring on start line • use of suitable solvent • place solvent in beaker / container • place (chromatography) paper in beaker / container • so (chromatography) paper is in solvent • but solvent is below start line • use a lid • wait for solvent to travel up the (chromatography) paper (until near top) • mark solvent front • dry the (chromatography) paper **Measurements** • measure distance between start line and centre of spot • measure distance between start line and solvent front • use of measurements to determine R_f value		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	different solvent used		1	AO3 4.8.1.3 RPA6

Question 10 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.3	paper		1	AO1 4.8.1.3 RPA6

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
CHEMISTRY

F

Foundation Tier Paper 2

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

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

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

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Do not write outside the box

0 1 This question is about water.

A student investigated pure water.

The student measured:
- the boiling point of pure water
- the pH of pure water.

0 1 . 1 Complete the sentences.

Choose answers from the box.

[2 marks]

0	4	7	10	25	100

Pure water has a boiling point of _____ °C.

Pure water has a pH of _____.

0 1 . 2 What could the student use to measure the pH of pure water?

[1 mark]

_____

_____

Do not write outside the box

A different student investigated sea water.

Sea water contains dissolved solids.

This is the method used.

1. Measure a 50 cm^3 sample of the sea water.
2. Heat the sample until all the water has evaporated.
3. Measure the mass of solid that remains.
4. Repeat steps 1 to 3 three more times.

0 1 . 3 Which **two** pieces of equipment were needed in this investigation?

[2 marks]

Tick (✓) **two** boxes.

- Balance ☐
- Measuring cylinder ☐
- Ruler ☐
- Thermometer ☐
- Timer ☐

Question 1 continues on the next page

Do not write outside the box

0 1 . 4 **Table 1** shows the results.

Table 1

Sea water sample	Mass of solid that remained in grams
1	1.73
2	1.70
3	1.75
4	1.78

Calculate the mean mass of solid that remained.

[2 marks]

Mean mass = _____ g

0 1 . 5 A 50 cm^3 sample of sea water from a different source contained 1.50 g of dissolved solids.

Calculate the mass of dissolved solids in 1000 cm^3 of this sea water.

[2 marks]

Mass = _____ g

Do not write outside the box

Sodium chloride is a dissolved solid in sea water.

Sodium chloride contains sodium ions and chloride ions.

0 1 . 6 Complete the sentence.

Choose the answer from the box.

[1 mark]

crimson	**lilac**	**yellow**

The student tested sea water for sodium ions using a flame test.

The colour of the flame was _____.

0 1 . 7 Complete the sentence.

Choose the answer from the box.

[1 mark]

brown	**green**	**white**

The student tested sea water for chloride ions by adding nitric acid and silver nitrate solution.

The colour of the precipitate formed was _____.

11

Turn over for the next question

Do not write outside the box

0 2 This question is about hydrocarbons in crude oil.

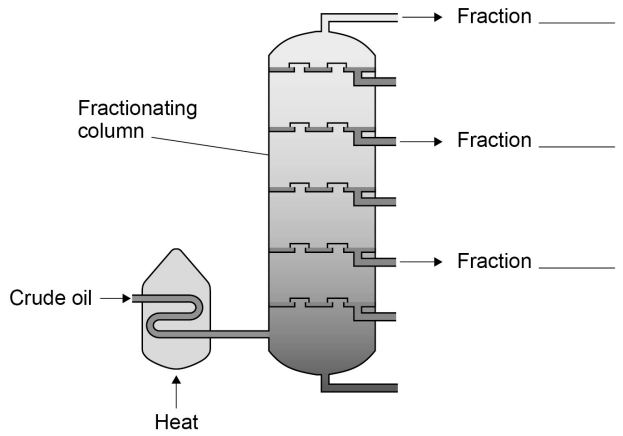
0 2 . 1 **Table 2** shows information about three fractions obtained from crude oil.

Table 2

Fraction	Boiling point range in °C
A	200–300
B	100–150
C	Below 30

Figure 1 shows the fractionating column used to separate fractions **A**, **B** and **C**.

Figure 1



The temperature of the fractionating column is:

- 30 °C at the top
- 400 °C at the bottom.

Complete **Figure 1** to show where fractions **A**, **B** and **C** are collected.

[1 mark]

Do not write outside the box

0 2 . 2 **Table 3** shows information about three fractions obtained from crude oil.

Table 3

Fraction	Range of number of carbon atoms in each molecule
Petrol	5–12
Diesel oil	15–19
Heavy fuel oil	20–40

Complete the sentences.

Choose answers from the box.

[2 marks]

lower	the same	higher

Compared to petrol, the viscosity of heavy fuel oil is _____.

Compared to petrol, the flammability of diesel oil is _____.

Question 2 continues on the next page

Do not write outside the box

Table 4 shows the percentage of two fractions obtained from two different sources of crude oil.

Table 4

Source	Percentage (%) of fraction	
	Kerosene	Heavy fuel oil
J	13	30
K	4	44

0 2 . 3 Complete **Figure 2.**

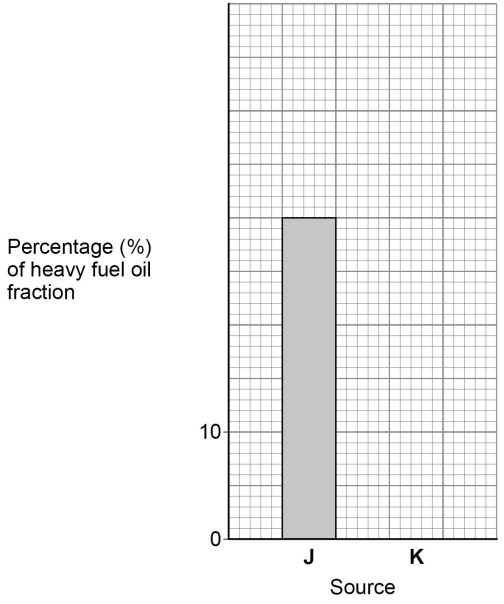
You should:

- complete the *y*-axis scale
- plot the percentage of the heavy fuel oil fraction obtained from source **K.**

Use **Table 4.**

[2 marks]

Figure 2



Do not write outside the box

0 2 . 4 Kerosene is in higher demand than heavy fuel oil.

Suggest why crude oil from source **J** is in higher demand than crude oil from source **K**.

Use **Table 4**.

[1 mark]

Large hydrocarbon molecules can be cracked to produce smaller hydrocarbon molecules including alkanes.

0 2 . 5 Which **two** of the following can be used to crack large hydrocarbon molecules?

[2 marks]

Tick (✓) **two** boxes.

- A catalyst ☐
- A fertiliser ☐
- Air ☐
- Ozone ☐
- Steam ☐

0 2 . 6 Alkanes have the general formula C_nH_{2n+2}

Complete the formula of the alkane molecule containing 11 carbon atoms.

[1 mark]

$C_{11}H$___

Turn over ►

Do not write outside the box

0 2 . 7 C_2H_6 is an alkane.

Which type of bond is found in a C_2H_6 molecule?

[1 mark]

Tick (✓) **one** box.

- A double bond between two carbon atoms. ☐
- A double bond between two hydrogen atoms. ☐
- A single bond between two carbon atoms. ☐
- A single bond between two hydrogen atoms. ☐

0 2 . 8 Which **two** substances are produced when alkanes completely combust?

[2 marks]

Tick (✓) **two** boxes.

- Carbon ☐
- Carbon dioxide ☐
- Carbon monoxide ☐
- Hydrogen ☐
- Water ☐

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 the Earth's atmosphere.

Table 5 shows:

- the estimated percentages of gases in the Earth's early atmosphere
- the percentages of gases in the Earth's atmosphere today.

Table 5

Gas	Estimated percentage (%) in the Earth's early atmosphere	Percentage (%) in the Earth's atmosphere today
Nitrogen	1.8	**X**
Oxygen	0.2	20.95
Carbon dioxide	96.0	0.04
Other gases	2.0	0.92

0 3 . 1 Calculate value **X** in **Table 5**.

[1 mark]

X = _____ %

0 3 . 2 Which **two** other gases may have been in the Earth's early atmosphere?

[2 marks]

Tick (✓) **two** boxes.

- Ammonia ☐
- Coal ☐
- Limestone ☐
- Methane ☐
- Poly(ethene) ☐

Do not write outside the box

Algae and plants increased the percentage of oxygen in the Earth's atmosphere.

The same process in algae and plants decreased the percentage of carbon dioxide in the Earth's atmosphere.

0 3 . 3 Which process in algae and plants increased the percentage of oxygen in the Earth's atmosphere?

[1 mark]

Tick (✓) **one** box.

- Fermentation ☐
- Photosynthesis ☐
- Rusting ☐
- Sedimentation ☐

0 3 . 4 Which **two** other processes decreased the percentage of carbon dioxide in the Earth's atmosphere?

[2 marks]

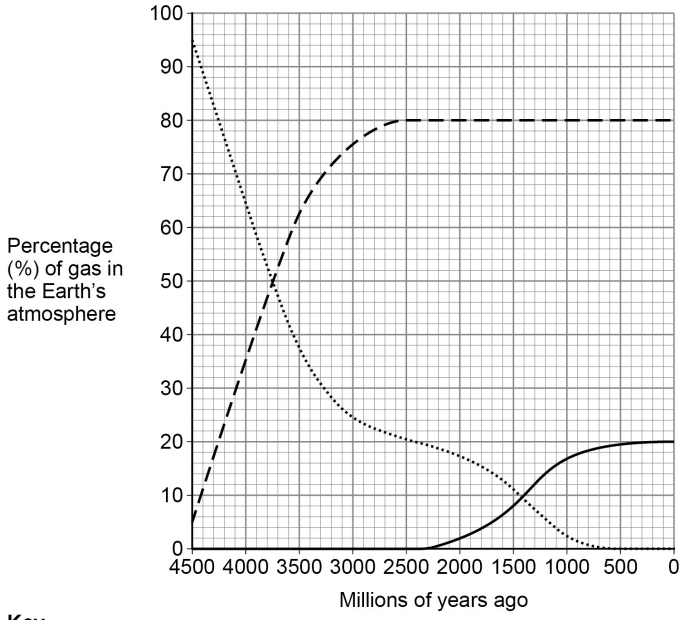
Tick (✓) **two** boxes.

- Burning fossil fuels ☐
- Dissolving carbon dioxide in oceans ☐
- Eruption of volcanoes ☐
- Evolution of animals ☐
- Formation of sedimentary rocks ☐

Do not write outside the box

Figure 3 shows how the percentages of gases in the Earth's atmosphere may have changed since the atmosphere was formed.

Figure 3



0 3 . 5 When was the percentage of oxygen in the Earth's atmosphere 8%?

Use **Figure 3.**

[1 mark]

_____ millions of years ago

0 3 . 6 When did the percentage of nitrogen in the Earth's atmosphere become constant?

Use **Figure 3.**

[1 mark]

_____ millions of years ago

Do not write outside the box

0 3 . 7 Crude oil was formed from an ancient biomass as the Earth's atmosphere evolved.

What did this ancient biomass mainly consist of?

[1 mark]

Tick (✓) **one** box.

- Limestone ☐
- Plankton ☐
- Sand ☐

0 3 . 8 Most of the percentages of the gases in **Figure 3** are estimated values.

Why have scientists used estimated values for the percentages of the gases in **Figure 3**?

[1 mark]

_____

_____

10

Turn over for the next question

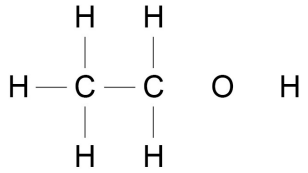
Do not write outside the box

0 4 This question is about ethanol.

0 4 . 1 The formula of ethanol is C_2H_5OH

Complete the displayed structural formula of ethanol.

[1 mark]



0 4 . 2 Which is **one** use of ethanol?

[1 mark]

Tick (✓) **one** box.

- As a protective coating on aluminium ☐
- In hand gel to kill microbes ☐
- To test for the presence of hydrogen gas ☐

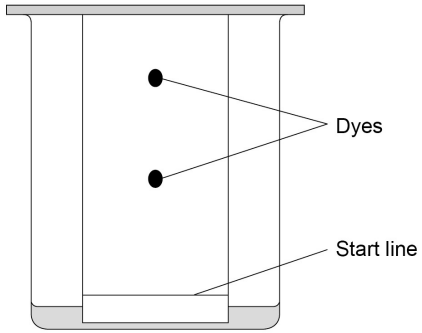
Do not write outside the box

0 4 . 3 Ethanol is used as a solvent in some inks.

A student used paper chromatography to show that an ink contained two different dyes.

Figure 4 shows the apparatus at the end of the investigation.

Figure 4



Describe a method the student could have used for the investigation.

[4 marks]

Do not write outside the box

0 4 . 4 Ethanol can be produced from sugar solution by fermentation.

What must be added to sugar solution to produce ethanol?

[1 mark]

E5 and E10 are types of fuel used in cars.

These fuels contain ethanol and petrol.

Table 6 shows information about E5 and E10.

Table 6

Fuel	Percentage (%) by mass of ethanol	Percentage (%) by mass of petrol
E5	5	95
E10	10	90

0 4 . 5 Calculate the mass of ethanol in 4.4 kg of E5.

Give your answer in grams.

Use **Table 6.**

[3 marks]

Mass = _____ g

Do not write outside the box

0 4 . 6 The ethanol in E5 and E10 is produced from sugar.

Sugar is produced from plants.

Explain why the production of E10 removes more carbon dioxide from the atmosphere than the production of E5.

Use **Table 6**.

[3 marks]

0 4 . 7 **Table 7** shows the energy content of ethanol and petrol.

Table 7

	Energy content in MJ (megajoules) per kg
Ethanol	30.0
Petrol	46.4

Suggest **one** disadvantage of using E10 instead of E5.

Complete the sentence.

[1 mark]

A disadvantage of using E10 is that _____

_____

14

Do not write outside the box

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 5 Ammonia is produced in the Haber process.

The raw materials for the Haber process are nitrogen and hydrogen.

0 5 . 1 Draw **one** line from each raw material to the source of that raw material.

[2 marks]

Raw material	Source of raw material
Nitrogen	Air
Hydrogen	Clay
	Limestone
	Natural gas
	Sand

0 5 . 2 What are the states of nitrogen and of hydrogen when used in the Haber process?

[1 mark]

Tick (✓) **one** box.

State of nitrogen	State of hydrogen	
Gas	Gas	☐
Gas	Liquid	☐
Liquid	Gas	☐
Liquid	Liquid	☐

Do not write outside the box

0 5 . 3 The word equation for the production of ammonia is:

nitrogen + hydrogen ⇌ ammonia

The atom economy of the reaction is 100%.

How does the word equation show that the atom economy is 100%?

[1 mark]

Tick (✓) **one** box.

The reaction is reversible. ☐

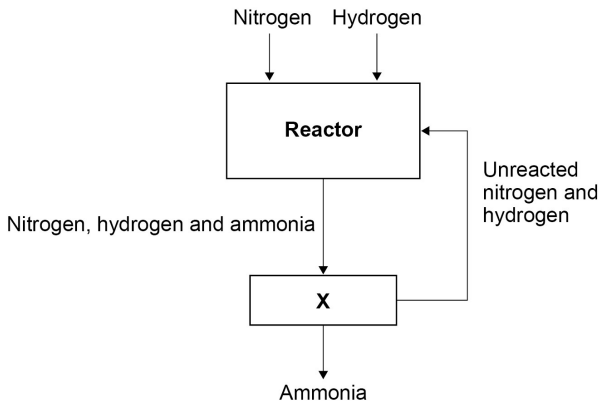
There are two reactants. ☐

There is one product. ☐

Do not write outside the box

0 5 . 4 **Figure 5** represents the Haber process.

Figure 5



A mixture of nitrogen, hydrogen and ammonia enters **X**.

Complete the sentences.

Choose answers from the box.

[2 marks]

evaporated	**filtered**	**liquefied**	**recycled**

In **X**, the mixture is cooled.

The ammonia can be removed from **X** because the ammonia is

_____.

The unreacted nitrogen and hydrogen are

_____.

Turn over ►

Do not write outside the box

Table 8 shows the percentage yield of ammonia at different pressures.

Table 8

Pressure in atmospheres	Percentage (%) yield of ammonia
50	20
100	33
150	44
200	52
250	59
300	64

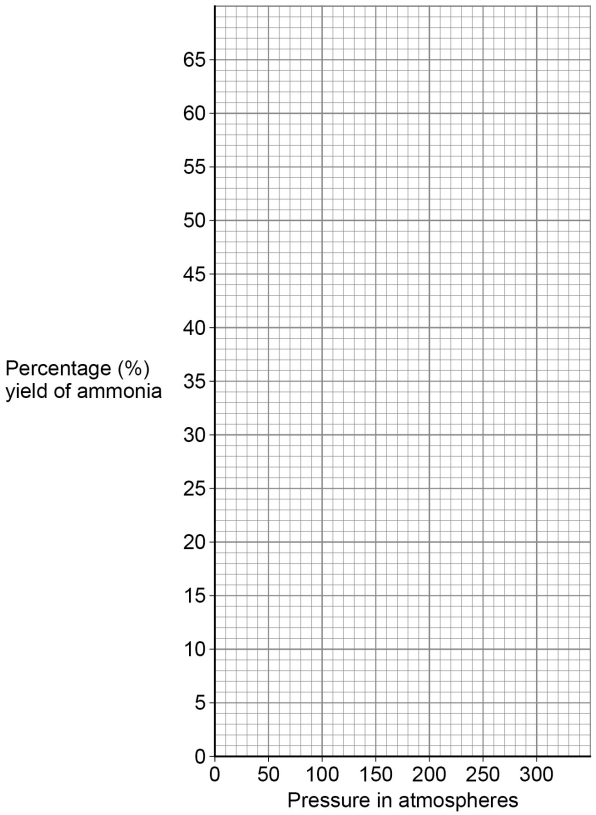
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0 5 . 5 Plot the data from **Table 8** on **Figure 6**.

Draw a line of best fit.

[3 marks]

Figure 6



0 5 . 6 What is the effect of increasing the pressure on the percentage yield of ammonia?

Use **Table 8**.

[1 mark]

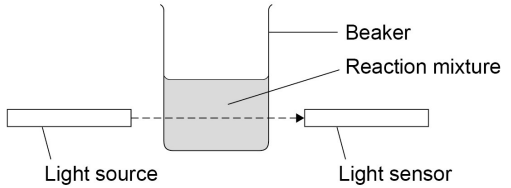
10

Do not write outside the box

0 6 A student investigated the rate of reaction between sodium thiosulfate solution and hydrochloric acid.

Figure 7 shows the apparatus used.

Figure 7



When hydrochloric acid is added to sodium thiosulfate solution, the mixture gradually becomes cloudy.

A smaller percentage of light from the light source reaches the light sensor as the mixture becomes more cloudy.

This is the method used.

1. Measure 50 cm^3 of sodium thiosulfate solution into the beaker.
2. Add 10 cm^3 of hydrochloric acid to the sodium thiosulfate solution.
3. Immediately start a timer.
4. Record the percentage of light from the light source that reaches the light sensor every 20 seconds for 120 seconds.

0 6 . 1 Balance the equation for this reaction.

[1 mark]

$$Na_2S_2O_3 + 2\,HCl \rightarrow ____\ NaCl + H_2O + SO_2 + S$$

Do not write outside the box

0 6 . 2 The mixture becomes cloudy because the sulfur produced is a solid.

What is the state symbol for a solid?

[1 mark]

Tick (✓) **one** box.

(aq) ☐

(g) ☐

(l) ☐

(s) ☐

0 6 . 3 The student monitored the cloudiness of the reaction mixture using a light sensor.

What other piece of equipment could be used to monitor the cloudiness of the reaction mixture?

[1 mark]

Tick (✓) **one** box.

A balance ☐

A cross on a piece of paper ☐

A gas syringe ☐

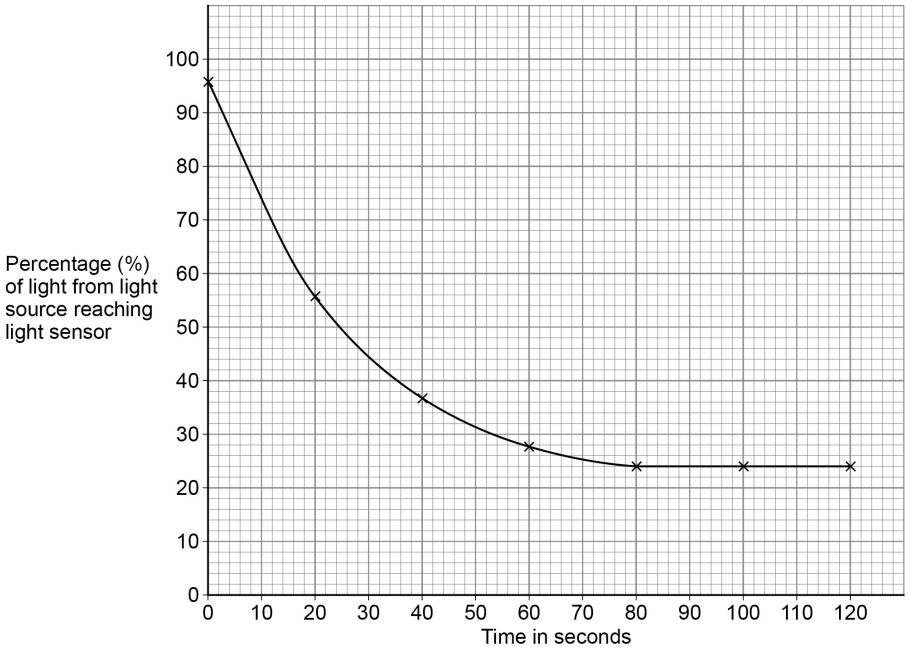
A thermometer ☐

Question 6 continues on the next page

Do not write outside the box

Figure 8 shows the results.

Figure 8



0 6 . 4 What happened to the rate of reaction between 40 and 60 seconds?

Use **Figure 8**.

[1 mark]

Tick (✓) **one** box.

The rate of reaction decreased. ☐

The rate of reaction stayed at zero. ☐

The rate of reaction increased. ☐

Do not write outside the box

0 6 . 5 The student stopped taking measurements after 120 seconds because the percentage of light reaching the sensor stayed constant.

Why did the percentage of light reaching the sensor stay constant?

[1 mark]

Tick (✓) **one** box.

No light was reaching the sensor. ☐

One of the reactants was used up. ☐

The reaction was too vigorous. ☐

0 6 . 6 The student repeated the experiment using sodium thiosulfate solution of a higher concentration.

How would the line of best fit for sodium thiosulfate solution of a higher concentration compare with the line of best fit on **Figure 8**?

[1 mark]

Tick (✓) **one** box.

Initially the line of best fit would be less steep. ☐

Initially the line of best fit would be the same steepness. ☐

Initially the line of best fit would be steeper. ☐

Question 6 continues on the next page

Do not write outside the box

0 6 . 7 The student then investigated the effect of changing the temperature on the rate of reaction.

The student used sodium thiosulfate solution and hydrochloric acid which had been kept in an ice bath.

Which are **two** effects of using reactants kept in an ice bath rather than at room temperature?

[2 marks]

Tick (✓) **two** boxes.

Fewer reactant particles have the activation energy. ☐

The reactant particles collide more frequently. ☐

The reactant particles have more energy. ☐

The reactant particles move more slowly. ☐

There are fewer reactant particles in the same volume. ☐

8

Do not write outside the box

0 7 This question is about fertilisers.

Ammonium nitrate is a fertiliser containing nitrogen.

0 7 . 1 Complete the sentence.

Choose the answer from the box.

[1 mark]

hydrochloric acid	**nitric acid**	**sulfuric acid**

Ammonium nitrate is produced by reacting ammonia with

_____.

0 7 . 2 Ammonium nitrate fertiliser is sold in 600 kg bags.

A farmer spreads 40 bags of ammonium nitrate fertiliser on land with an area of 800 000 m^2.

Calculate the mass of ammonium nitrate fertiliser spread per m^2 of land.

[2 marks]

Mass per m^2 = _____ kg/m^2

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 A scientist works for a company which makes ammonium nitrate fertiliser.

The scientist investigates the effect of different fertilisers on crop growth.

The scientist concludes that the ammonium nitrate fertiliser improves crop growth more than other fertilisers.

Suggest **one** reason why this conclusion might **not** be valid.

[1 mark]

Do not write outside the box

A different fertiliser containing nitrogen has the formula $K_2NH_4PO_4$

0 7 . 4 How many atoms of nitrogen are in the formula $K_2NH_4PO_4$?

[1 mark]

0 7 . 5 Nitrogen and potassium in the fertiliser $K_2NH_4PO_4$ are important for good crop growth.

Which other element in the fertiliser $K_2NH_4PO_4$ is important for good crop growth?

[1 mark]

Tick (✓) **one** box.

- Hydrogen ☐
- Oxygen ☐
- Phosphorus ☐

0 7 . 6 Some fertilisers are mixtures of different compounds in fixed proportions.

What name is given to a mixture of different compounds in fixed proportions?

[1 mark]

7

Turn over for the next question

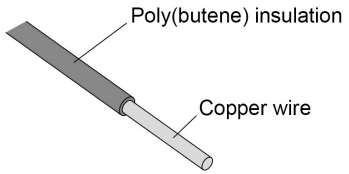
Do not write outside the box

0 8 This question is about copper wire and copper compounds.

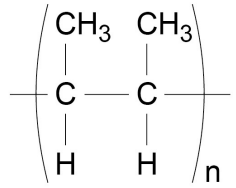
Copper is used to make electrical wires.

Figure 9 shows how copper electrical wire is insulated using an addition polymer called poly(butene).

Figure 9



0 8 . 1 The addition polymer poly(butene) has the displayed structural formula:

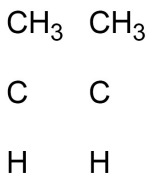


Poly(butene) is produced from the monomer butene.

Complete **Figure 10** to show the displayed structural formula of butene.

[2 marks]

Figure 10



Do not write outside the box

Copper can be obtained by recycling scrap copper wire.

0 8 . 2 Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled.

[1 mark]

0 8 . 3 Describe how scrap copper wire can be recycled to make new copper water pipes.

[2 marks]

0 8 . 4 Suggest **two** reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.

[2 marks]

1

2

Question 8 continues on the next page

Do not write outside the box

Copper sulfate is a compound of copper.

Copper sulfate solution contains copper(II) ions and sulfate ions.

0 8 . 5 A solution can be added to copper sulfate solution to show the presence of copper(II) ions.

Name the solution added.

Give the result of the test.

[2 marks]

Name of solution added

Result

0 8 . 6 Describe **one** test to show the presence of sulfate ions in copper sulfate solution.

Give the result of the test.

[2 marks]

Test

Result

11

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 9 A student investigated the change in mass when hydrated cobalt chloride was heated.

The word equation for the reaction is:

hydrated cobalt chloride ⇌ anhydrous cobalt chloride + water

This is the method used.

1. Add 2.0 g of hydrated cobalt chloride to an empty test tube.
2. Measure the mass of the test tube and contents.
3. Heat the test tube and contents gently for 30 seconds.
4. Allow the test tube and contents to cool.
5. Measure the mass of the test tube and contents.
6. Repeat steps 3 to 5 until the mass of the test tube and contents does not change.

Table 9 shows the results.

Table 9

Total heating time in seconds	Mass of test tube and contents in grams
0	26.5
30	26.2
60	25.9
90	25.6
120	25.6

Do not write outside the box

0 9 . 1 Determine the mass of the empty test tube.

[1 mark]

Mass of empty test tube = _____ g

0 9 . 2 Explain why the mass of the test tube and contents decreased.

[2 marks]

0 9 . 3 Suggest why the test tube and contents were heated until the mass did not change.

[1 mark]

Question 9 continues on the next page

Do not write outside the box

Energy is taken in from the surroundings when hydrated cobalt chloride is heated.

0 9 . 4 When 238 g of hydrated cobalt chloride is heated until the mass does not change, 88.1 kJ of energy is taken in.

The student heated 2.00 g of hydrated cobalt chloride until the mass did not change.

Calculate the energy taken in during this reaction.

Give your answer to 3 significant figures.

[3 marks]

Energy taken in (3 significant figures) = _____ kJ

0 9 . 5 What type of reaction takes place when hydrated cobalt chloride is heated?

[1 mark]

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

1 0 This question is about life cycle assessments (LCAs).

1 0 . 1 Milk bottles can be made from glass or from a polymer.

Table 10 shows information about milk bottles of equal volume.

Table 10

	Glass	**Polymer**
Raw materials	Limestone Sand Sodium carbonate	Crude oil
Energy needed to process raw materials in kilojoules	6750	1710
Energy needed to manufacture bottle in kilojoules	750	90
Mass of bottle in grams	200	20
Mean number of times used during lifetime of bottle	25	1
One disposal method at end of useful life	Recycled to make different glass products	Recycled to make different polymer products

Evaluate the use of glass for milk bottles compared with the use of a polymer for milk bottles.

Use features of life cycle assessments (LCAs) in your answer.

Use **Table 10**.

[6 marks]

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10.2 Milk is also sold in cardboard cartons.

A carton is made using 40 cm^3 of cardboard.

The density of the cardboard is 0.40 g/cm^3.

Calculate the mass of the carton.

Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

[3 marks]

Mass = _____ g

9

END OF QUESTIONS

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Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	100 7	must be in this order	1 1	AO1 4.8.1.1 4.10.1.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	pH probe / meter **or** universal indicator (paper / solution)	 allow wide range indicator (paper / solution)	1	AO1 4.10.1.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	balance measuring cylinder		1 1	AO1 4.10.1.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	(mean =) $\frac{1.73 + 1.70 + 1.75 + 1.78}{4}$ = 1.74 (g)		1 1	AO2 4.10.1.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	(mass =) $\frac{1.5 \times 1000}{50}$ = 30 (g)		1 1	AO2 4.10.1.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	yellow		1	AO1 4.8.3.1 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	white		1	AO1 4.8.3.4 RPA7

Total Question 1		11

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	**C** **B** **A**	must be in this order	1	AO3 4.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	higher lower	must be in this order	1 1	AO2 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	scale labelled at 20, 30, 40, (50) % at 2 cm intervals (**K**) bar drawn to 44%	 allow a tolerance of ± ½ a small square	1 1	AO2 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	contains more kerosene	allow **K** contains less kerosene	1	AO3 4.7.1.3 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	a catalyst steam		1 1	AO1 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	$C_{11}H_{24}$		1	AO2 4.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	a single bond between two carbon atoms		1	AO1 4.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.8	carbon dioxide water		1 1	AO1 4.7.1.3

Total Question 2		12

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	78.09 (%)		1	AO2 4.9.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	ammonia methane		1 1	AO1 4.9.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	photosynthesis		1	AO1 4.9.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	dissolving carbon dioxide in oceans formation of sedimentary rocks		1 1	AO1 4.9.1.2 4.9.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	1500 (millions of years ago)		1	AO2 4.9.1.3

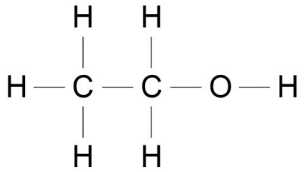
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	2500 (millions of years ago)	allow a value in the range 2500 to 2700 (millions of years ago)	1	AO3 4.9.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	plankton		1	AO1 4.7.1.1 4.9.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.8	(there is) limited evidence	allow the timescale was millions / billions of years	1	AO2 4.9.1.2

Total Question 3		**10**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1			1	AO1 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	in hand gel to kill microbes		1	AO1 4.7.2.3

Question	Answers	Mark	AO / Spec. Ref.
04.3	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	3–4	AO1 4.8.1.3 RPA6
	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 • **draw** pencil **start line** • **place spot of ink on start line** • name suitable solvent • place solvent in beaker • **place paper in solvent so solvent is below start line** • use a lid • **allow solvent / dyes to travel up paper** (until near top) • dry • count spots		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	yeast		1	AO1 4.7.2.3

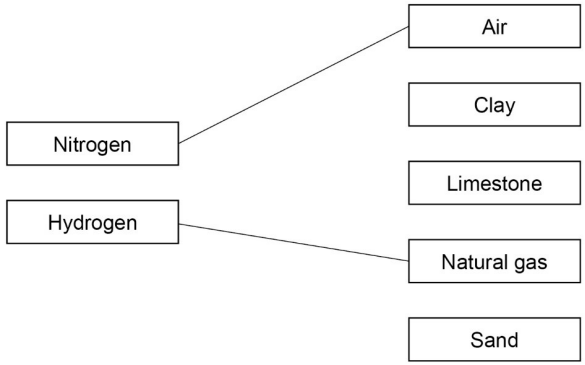
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(mass =) $\frac{4.4 \times 5}{100}$		1	AO2 4.7.1.3 4.7.2.3
	= 0.22 (kg)		1	
	(conversion 0.22 kg =) 220 (g)	allow a correct conversion of an incorrectly calculated mass	1	
	alternative approach: (conversion 4.4 kg =) 4400 g (1)			
	(mass =) $\frac{4400 \times 5}{100}$ (1)	allow correct use of an incorrectly converted mass		
	= 220 (g) (1)			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6		allow converse argument for E5		AO3 4.9.1.3 4.9.2.2 4.9.2.4
	E10 contains more ethanol (produced from sugar than E5)		1	
	(so) more sugar is used	allow (so) more plants are grown	1	
	(so more) carbon dioxide is absorbed by plants (when growing)	allow (so more) carbon dioxide is used in photosynthesis (by plants)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	(E10 has) less energy (in a fixed mass)	allow cannot travel as far (on a full tank of E10)	1	AO3 4.7.1.3 4.7.2.3

Total Question 4		14

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	**Raw material** **Source of raw material**  do not accept more than one line from a box on the left		1 1	AO1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	gas gas		1	AO1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	there is one product		1	AO2 4.3.3.2 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	liquefied recycled	must be in this order	1 1	AO1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	all six points plotted correctly line of best fit	allow a tolerance of ± ½ a small square allow **1** mark for four / five points plotted correctly	2 1	AO2 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(percentage yield) increases		1	AO2 4.10.4.1

Total Question 5		**10**

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Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$Na_2S_2O_3 + 2\,HCl \rightarrow$ **2** $NaCl + H_2O + SO_2 + S$	allow multiples	1	AO2 4.1.1.1 4.3.1.1 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(s)		1	AO1 4.2.2.2 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	a cross on a piece of paper		1	AO1 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	the rate of reaction decreased		1	AO3 4.6.1.1 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	one of the reactants was used up		1	AO3 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	initially the line of best fit would be steeper		1	AO2 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.7	fewer reactant particles have the activation energy the reactant particles move more slowly		1 1	AO2 4.6.1.2 4.6.1.3

Total Question 6		**8**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	nitric acid		1	AO2 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	(mass =) $\frac{40 \times 600}{800\ 000}$ = 0.03 (kg/m^2)		1 1	AO2 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(the scientist might be) biased **or** (there was) no peer review	allow the investigation was not repeated (by others)	1	AO3 4.10.4.2

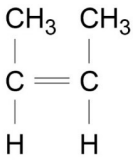
Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	one / 1		1	AO2 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	phosphorus		1	AO2 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	formulation		1	AO1 4.8.1.2 4.10.4.2

Total Question 7		**7**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	C=C bond		1	AO2 4.7.3.1
	2x C-H bonds **and** 2x C-CH_3 bonds	do **not** accept extra bonds	1	
		an answer of  scores **2** marks		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	any **one** from: • (otherwise) the copper (produced) would be impure • (otherwise) the copper (produced) would be a mixture • (otherwise) the insulation would burn / melt (during recycling) • copper and poly(butene) are recycled by different methods	allow (otherwise) the copper (produced) would be contaminated allow (otherwise) poly(butene) could produce toxic fumes	1	AO3 4.10.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	(wire heated until) copper melts		1	AO1 4.10.2.2
	(re)cast / reformed (into pipes)	allow (re)shaped / extruded / (re)moulded	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4		allow converse statements for extracting copper from ores ignore references to cost		AO1 4.10.1.1 4.10.2.2
	any **two** from: (recycling scrap copper) • uses less energy • conserves copper (ore) • (produces) less waste • specified environmental impact	allow less landfill required	2	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5		MP2 dependent on MP1		AO1 4.8.3.2 RPA7
	sodium hydroxide (solution)	allow NaOH for sodium hydroxide	1	
	blue precipitate	allow blue solid	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	(add acidified) barium chloride (solution)	MP2 dependent on MP1 allow $BaCl_2$ for barium chloride allow (add acidified) barium nitrate (solution) do **not** accept add sulfuric acid	1	AO1 4.8.3.5 RPA7
	white precipitate	allow white solid	1	

Total Question 8		11

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	24.5 (g)		1	AO2 4.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	water vapour was produced	allow steam for water vapour allow water was produced as a gas	1	AO2 4.3.1.3 4.6.2.2
	(so) water (vapour) escaped (from the tube)	allow (so) the mass of the water (vapour) was not measured	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	(so that) the reaction was complete	allow (so that) no more water (vapour) was produced	1	AO3 4.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	(energy =) $\frac{2.00}{238} \times 88.1$ = 0.740336134 (kJ) = 0.740 (kJ)	 allow an answer correctly calculated to 3 significant figures from an incorrect calculation which uses all the values in the question	1 1 1	AO2 4.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	endothermic (reaction)	allow reversible (reaction) allow (thermal) decomposition (reaction)	1	AO1 4.6.2.2

Total Question 9		8

Question 10

Question	Answers	Mark	AO / Spec. Ref
10.1	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO3 4.10.1.1 4.10.2.1
	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 **raw materials** • crude oil is finite • quarrying / mining pollute the environment • glass uses more energy to process raw materials **manufacturing** • glass uses more energy to make bottles • glass is heavier so takes more energy to transport **use and operation** • glass bottles are reusable • reuse of glass conserves (natural) resources • reuse of glass consumes energy during washing • reuse of glass consumes water during washing **disposal** • both glass and polymer bottles can be recycled • recycling polymer conserves finite resources • recycling glass and polymer uses less energy than making new glass and polymer • both methods reduce use of landfill **other points** • energy needed may be derived from fossil fuels • use of fossil fuels causes (specified) pollution • total energy for glass (bottle) (7500 kJ) is greater than total energy for polymer (bottle) (1800 kJ) **reasoned judgement**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	mass = density × volume mass = 0.40 × 40 = 16 (g)		1 1 1	AO2 4.10.1.1 4.10.2.1

Total Question 10		**9**