

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

GCSE COMBINED SCIENCE: TRILOGY

H

Higher Tier
Chemistry Paper 2H

Time allowed: 1 hour 15 minutes

Materials

For this paper you must have:

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

Instructions

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

Information

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

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



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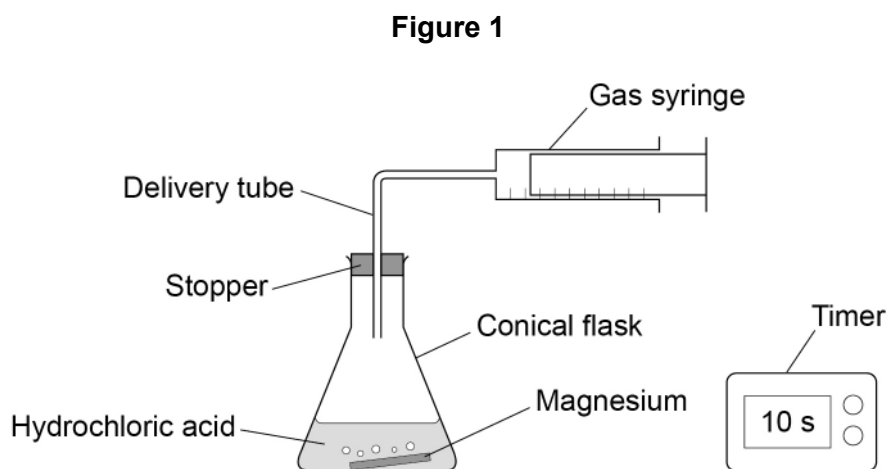
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ANSWER IN THE SPACES PROVIDED**



0 1

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

Figure 1 shows the apparatus.



This is the method used.

1. Pour 50 cm³ of hydrochloric acid into a conical flask.
2. Add a piece of magnesium.
3. Insert stopper and delivery tube and start a timer.
4. Collect the gas produced in a gas syringe.
5. Record the volume of gas produced every 20 seconds for 2 minutes.
6. Repeat steps 1 to 5 with higher concentrations of hydrochloric acid.

0 1 . 1

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

[2 marks]

Independent variable _____

Control variable _____

Question 1 continues on the next page

Turn over ►



Table 1 shows the results from the first experiment using hydrochloric acid with a low concentration.

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Table 1

Time in seconds	0	20	40	60	80	100	120
Volume of gas in cm³	0	48	72	90	97	98	98

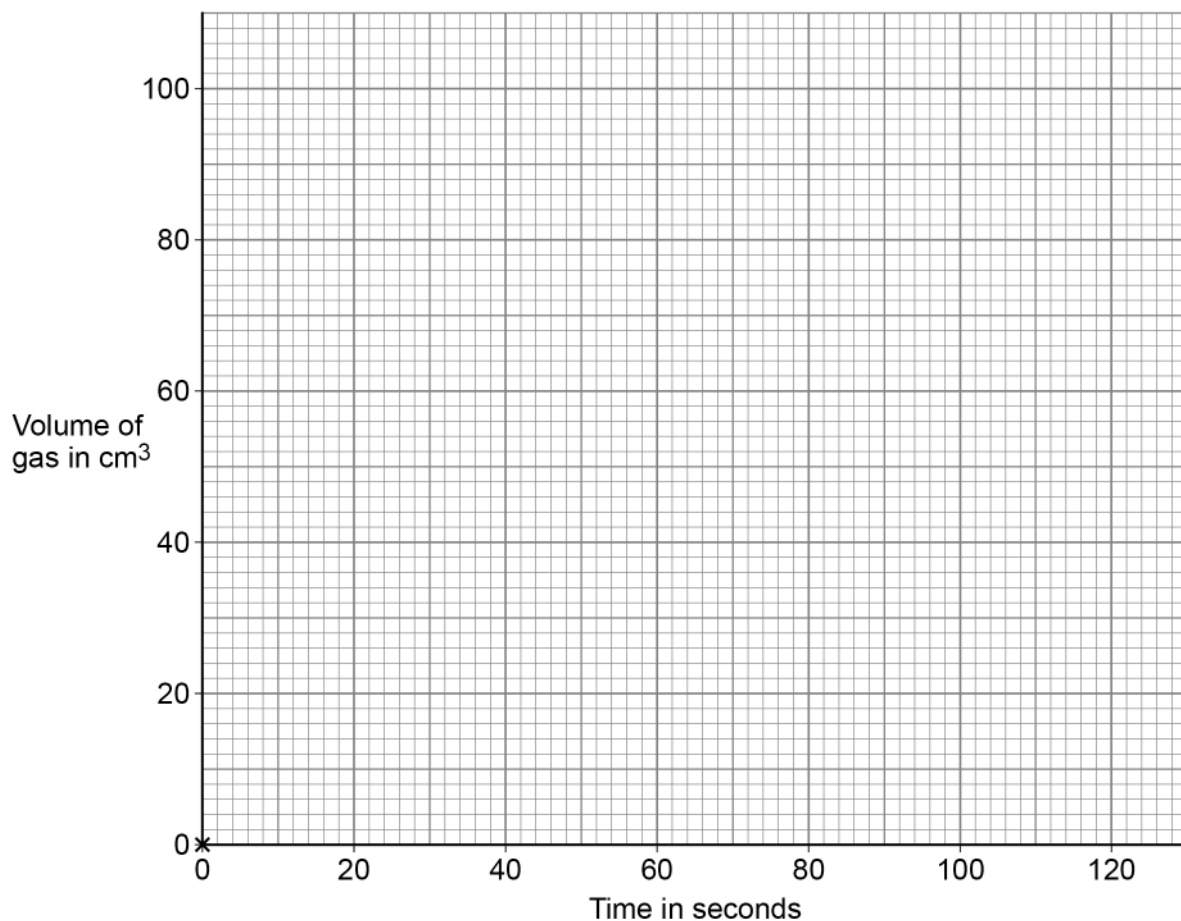
0 1 . 2 Complete **Figure 2**.

You should:

- plot the data from **Table 1** (the point 0,0 has been plotted for you)
- draw a line of best fit.

[3 marks]

Figure 2



0 1 . 3 How does the **rate** of this reaction change with time?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

The rate decreases.

The rate stays the same.

The rate increases.

0 1 . 4 The student repeated the experiment using hydrochloric acid with a higher concentration.

Which statement is correct?

[1 mark]

Tick (✓) **one** box.

The activation energy for the reaction was higher.

The magnesium reacted more quickly.

The reaction finished at the same time.

The total volume of gas collected was smaller.

Question 1 continues on the next page

Turn over ►



0 1 . 5

Temperature also affects the rate of the reaction.

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

You should refer to particles and collisions.

[3 marks]

10



0 2

Crude oil is a resource found in rocks.

Most of the compounds in crude oil are hydrocarbons.

0 2 . 1

Complete the sentence.

[1 mark]

Crude oil is formed by the decomposition of _____.

0 2 . 2

Alkanes are hydrocarbons.

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

[1 mark]

Question 2 continues on the next page

Turn over ►

0 **2** **3** **Figure 3** shows two alkane molecules.

Figure 3

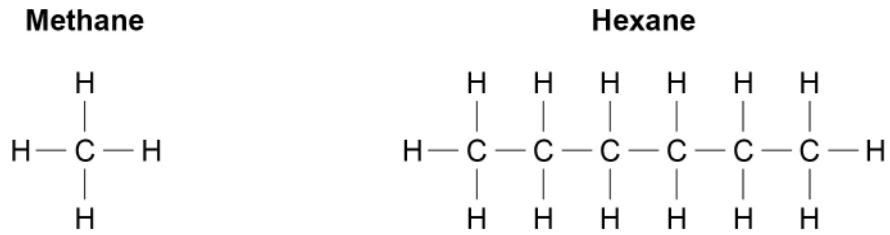


Table 2 shows the melting points and boiling points of methane and hexane.

Table 2

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

Compare the structure and properties of methane and hexane.

[6 marks]



Hydrocarbons are cracked to produce more useful alkanes and alkenes.

0 2 . 4 Decane ($C_{10}H_{22}$) is cracked to produce **two** products.

Complete the equation for the reaction.

[1 mark]



0 2 . 5 C_2H_4 is an alkene.

What is the test for alkenes?

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

[2 marks]

Test _____

Result _____

11

Turn over for the next question

Turn over ►



0 3

The methods used to produce potable water depend upon available sources of water.

0 3 . 1

Suggest how copper sulfate can be used as a test for the presence of water.

[3 marks]

The boiling point is used to check the purity of a sample of water.

0 3 . 2

In chemistry, what is meant by a 'pure substance'?

[1 mark]



0 3 . 3 The boiling point of a 250 g sample of water was 100.60 °C.

The boiling point of pure water in a data book is 100.00 °C.

Each 1% of impurity increases the boiling point of water by 0.12 °C.

Calculate the mass of the impurity in the sample of water.

[3 marks]

Mass of the impurity = _____ g

0 3 . 4 Explain how distillation is used to obtain potable water from salty water.

[4 marks]

Question 3 continues on the next page

Turn over ►



0	3	.	5
---	---	---	---

Obtaining potable water from salty water is more expensive than obtaining potable water from ground water.

Explain why.

Refer to the processes used in both methods in your answer.

[2 marks]

13



Turn over for the next question

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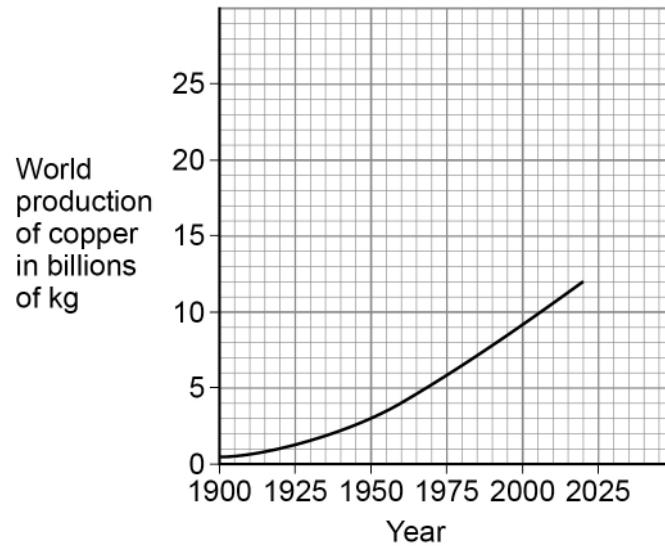


0 4

Industries use the Earth's natural copper resources to produce useful products.

Figure 4 shows the world production of copper from 1900 to 2020.

Figure 4



0 4 . 1

Describe the trend shown by the graph in **Figure 4**.

[2 marks]

0 4 . 2

Suggest **one** reason for the trend in **Figure 4**.

[1 mark]



0	4	.	3
---	---	---	---

Suggest **one** reason why the trend cannot be used to accurately predict the future world production of copper.

[1 mark]

Question 4 continues on the next page

Turn over ►



0 4 . 4

High-grade copper resources are now difficult to find.

Phytomining is used to extract copper from low-grade ores.

There are five stages, **A**, **B**, **C**, **D** and **E**, in phytomining.

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

Stage **A** Copper compounds from ash are dissolved in acid.

Stage **B** Plants absorb metal compounds.

Stage **C** Plants are burned.

Stage **D** Plants are harvested.

Stage **E** Solution of copper compound is electrolysed.

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

[1 mark]

Tick (✓) **one** box.

B, C, D, E, A

B, D, C, A, E

D, B, C, E, A

D, C, B, A, E



0 4 . 5

Give **two** disadvantages of phytomining compared with traditional mining methods.

Do **not** refer to cost in your answer.

[2 marks]

1 _____

2 _____

0 4 . 6

In one year, 8.89×10^9 kg of copper was produced.

41.0% of this copper was produced from recycled copper.

The energy needed to produce 1 kg of copper from copper ore is 70.4 MJ.

The energy needed to produce 1 kg of recycled copper is 27.2 MJ.

Calculate the difference in energy used if all the copper was produced from recycling.

Give your answer to 3 significant figures.

[5 marks]

Difference in energy used (3 significant figures) = _____ MJ

12

Turn over ►



0 5

Atmospheric pollution is emitted by cars.

Some car emissions contain nitrogen dioxide.

0 5**1**

Describe how nitrogen dioxide (NO₂) is produced in the engine of a car that burns fossil fuels.

[3 marks]

Table 3 shows the concentration of nitrogen dioxide in the air in three different areas for 1 week.

Table 3

Concentration of nitrogen dioxide in the air in micrograms per m³			
Day	City centre	Countryside	Motorway
Monday	35	8	22
Tuesday	37	8	23
Wednesday	37	8	23
Thursday	34	8	23
Friday	37	8	23
Saturday	29	7	20
Sunday	X	6	17



0 5 . 2

The mean value for nitrogen dioxide in the air for the whole week in the city centre is 33 micrograms per m³.

Calculate the value (**X**) for the concentration of nitrogen dioxide in the air in the city centre on Sunday.

[2 marks]

X = _____ micrograms per m³

0 5 . 3

Each value in **Table 3** has an uncertainty of ± 2 micrograms per m³.

Explain why this uncertainty is **most** significant for countryside data.

[2 marks]

Question 5 continues on the next page

Turn over ►

Nitrogen dioxide is removed from car emissions by catalytic converters.

0 5 . 4 In a catalytic converter nitrogen dioxide (NO₂) reacts to produce nitrogen and oxygen.

Complete the equation for the reaction.

You should balance the equation.

[2 marks]



0 5 . 5 The catalyst in a catalytic converter contains platinum.

Platinum is a finite resource.

What is meant by a 'finite resource'?

[1 mark]

0 5 . 6 Emissions from cars contain carbon dioxide.

Explain why carbon dioxide emissions during use and operation are **not** the total carbon footprint for a car.

Refer to the stages of the life cycle assessment of a car in your answer.

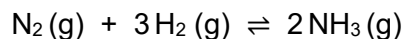
[3 marks]



0 6

Ammonia is produced when a mixture of nitrogen and hydrogen reacts.

The equation for the reaction is:

**0 6 . 1**

Nitrogen is obtained from the air.

The mixture of nitrogen and hydrogen must **not** contain carbon dioxide and oxygen.

Explain how a sample can be tested to show that carbon dioxide is **not** present in the mixture.

[2 marks]

0 6 . 2

A catalyst is used in the reaction.

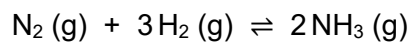
Explain how a catalyst increases the rate of a reaction.

[2 marks]

Question 6 continues on the next page

Turn over ►

The equation for the reaction to produce ammonia is repeated here.



0 6 . 3 The reaction reaches equilibrium.

Explain how an equilibrium is reached.

[2 marks]

0 6 . 4 Suggest how the catalyst affects the equilibrium position.

Give **one** reason for your answer.

[2 marks]

0 6 . 5 What is the effect of increasing the pressure on the reaction to produce ammonia?

[1 mark]

Tick (✓) **one** box.

The yield of ammonia decreases.

The yield of ammonia stays the same.

The yield of ammonia increases.



0 6 . 6

The forward reaction is exothermic.

Explain the effect of increasing the temperature on the yield of ammonia gas produced at equilibrium.

[2 marks]

11**END OF QUESTIONS**

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IB/M/Jun21/8464/C/2H



GCSE
COMBINED SCIENCE: TRILOGY
8464/C/2H

Chemistry Paper 2H

Mark scheme

June 2021

Version: 1.0 Final Mark Scheme



Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

- 2.1** In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.
- 2.2** A bold **and** is used to indicate that both parts of the answer are required to award the mark.
- 2.3** Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.
- 2.4** Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do **not** accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

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	Answers	Extra information	Mark	AO / Spec.
01.1	independent concentration (of hydrochloric acid)		1	AO1 5.6.1 RPA11
	control any one from: <ul style="list-style-type: none"> • temperature (of hydrochloric acid) • volume of (hydrochloric) acid • length of magnesium • surface area of magnesium 	allow same mass of magnesium allow same form of magnesium ignore amount	1	
01.2	all points correctly plotted	allow a tolerance of $\pm \frac{1}{2}$ a small square allow 1 mark for 4 or 5 points correctly plotted	2	AO2 5.6.1 RPA11
	line of best fit	must include 0,0	1	
01.3	the rate decreases		1	AO3 5.6.1 RPA11
01.4	the magnesium reacted more quickly		1	AO3 5.6.1.2

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	plankton or (ancient) biomass	allow microscopic plants / animals	1	AO1 5.7.1.1
02.2	propane	allow C ₃ H ₈	1	AO1 5.7.1.1

Question	Answers	Mark	AO / Spec. Ref.
02.3	Level 2: Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	4–6	AO3
	Level 1: Relevant features are identified and differences noted.	1–3	AO1 AO2
	No relevant content	0	
	Indicative content <ul style="list-style-type: none"> • methane has 1 carbon atom, hexane has 6 • methane has 4 hydrogen atoms, hexane has 14 • both contain C – H bonds • only hexane contains C – C bonds • both are hydrocarbons • hexane has a higher melting point than methane (or converse) • hexane has a higher boiling point than methane (or converse) • methane is a gas at room temperature • hexane is a liquid at room temperature • both are small molecules • hexane has larger molecules than methane • weak forces between molecules • forces between hexane molecules stronger than between methane molecules • hexane is more viscous than methane • both are flammable • methane is more flammable than hexane (or converse) • possible products of combustion from both are: carbon, carbon monoxide, carbon dioxide, water • neither conduct electricity 		5.2.2.4 5.7.1.1 5.7.1.3

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	add water to anhydrous copper sulfate	allow a description of heating hydrated copper sulfate to produce anhydrous copper sulfate, followed by addition of water	1	AO2
	colour changes from white		1	AO1
	to blue		1	AO1 5.6.2.1
03.2	a single element or compound	allow an element or compound not (mixed) with any other substance ignore only one type of substance	1	AO1 5.8.1.1
03.3	$(\% \text{ impurity} = \frac{0.6}{0.12}) = 5$ (mass impurity =) $\frac{5}{100} \times 250$ = 12.5 (g)		1	AO2 5.8.1.1
			1	
			1	
03.4	heat salty water	allow boil salty water	1	AO1
	(so) water evaporates (as water vapour)		1	5.10.1.2 RPA13
	cool the (water) vapour		1	
	(which) condenses to form potable / liquid water		1	

03.5	distillation requires energy (to boil salty water)	allow distillation requires fuel (to boil salty water)	1	AO1 5.10.1.3 RPA13
	(but) ground water only needs filtering and sterilising		1	
Total			13	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	production of copper is increasing		1	AO2 5.10.1.1
	at an increasing rate		1	
04.2	increase in population / demand	allow more uses for copper	1	AO3 5.10.1.1
04.3	any one from: <ul style="list-style-type: none"> • more use of recycling • copper is a finite resource and may run out • alternative metals may be used in future 	ignore only an estimate	1	AO3 5.10.1.1
04.4	B, D, C, A, E		1	AO1 5.10.1.4
04.5	any two from: <ul style="list-style-type: none"> • (phytomining is) slower to produce copper • large area of land required • insufficient yield to meet demand 	ignore reference to cost ignore references to carbon dioxide ignore references to global warming allow plants grow slowly	2	AO3 5.10.1.4

04.6	(energy use through recycling = $27.2 \times 8.89 \times 10^9 \times \frac{41}{100}$) $= 9.914 \times 10^{10}$		1	AO2 5.10.2.2
	(energy use through extraction = $70.4 \times 8.89 \times 10^9 \times \frac{59}{100}$) $= 3.693 \times 10^{11}$		1	
	(total consumption today = $9.914 \times 10^{10} + 3.693 \times 10^{11}$) $= 4.6844 \times 10^{11}$	allow correct use of an incorrect energy use determined in MP1 and/or MP2	1	
	(energy use if only recycling used = $27.2 \times 8.89 \times 10^9$) $= 2.418 \times 10^{11}$		1	
	(energy saving = $4.6844 \times 10^{11} - 2.418 \times 10^{11}$) $= 2.27 \times 10^{11}$ (MJ)	allow an answer correctly calculated to 3 significant figures which uses the values in the question	1	
Total			12	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	at high temperatures (in the engine)		1	AO1 5.9.3.1
	nitrogen		1	
	reacts with oxygen (to produce nitrogen dioxide)		1	
05.2	(X=) $(33 \times 7) - [(37 \times 3) + 35 + 34 + 29]$	allow $33 \times 7 = (37 \times 3) + 35 + 34 + 29 + X$	1	AO2 5.9.3.1
	= 22 (micrograms per m ³)		1	
05.3	countryside data has smallest values		1	AO3 5.9.3.1
	(so) 2 is a higher proportion / percentage of the value	allow (so) countryside is ± 2 out of a value between 6 to 8	1	
05.4	$2\text{NO}_2 \rightarrow \text{N}_2 + 2\text{O}_2$	allow multiples or halves allow 1 mark for N ₂ and O ₂	2	AO2 5.3.1.1 5.10.1.1
05.5	a resource which will run out	allow a non-sustainable resource	1	AO1 5.10.1.1
05.6	(because carbon dioxide is emitted in) extracting / processing raw materials		1	AO2 5.9.2.4 5.10.2.1
	(and) manufacturing		1	
	(and) disposal at the end of its useful life		1	
Total			13	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	use limewater or use calcium hydroxide solution		1	AO2 5.8.2.3
	(which) does not turn milky / cloudy	allow (which) stays colourless	1	
06.2	provides an alternative pathway		1	AO1 5.6.1.4
	(which has) a lower activation energy		1	
06.3	(when) the apparatus prevents the escape of reactants and products	allow (in a) closed system	1	AO1 5.6.2.3
	(and the) forward and reverse reactions occur at same rate		1	
06.4	equilibrium position stays the same	allow no effect	1	AO3 5.6.1.4 5.6.2.3
	increases the rate of the forward and the reverse reaction by the same amount		1	
06.5	the yield of ammonia increases		1	AO2 5.6.2.4 5.6.2.7

06.6	yield of ammonia decreases		1	AO2 5.6.2.4 5.6.2.6
	(because) system shifts in endothermic direction	allow (because) system shifts to counteract the change allow (because) system shifts to transfer in energy (from the surroundings)	1	
Total			11	