AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.2.5

Polymers

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**5**
Available paper years	**2020–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

5.2.2.5 Polymers

Answer 01 · Mark scheme

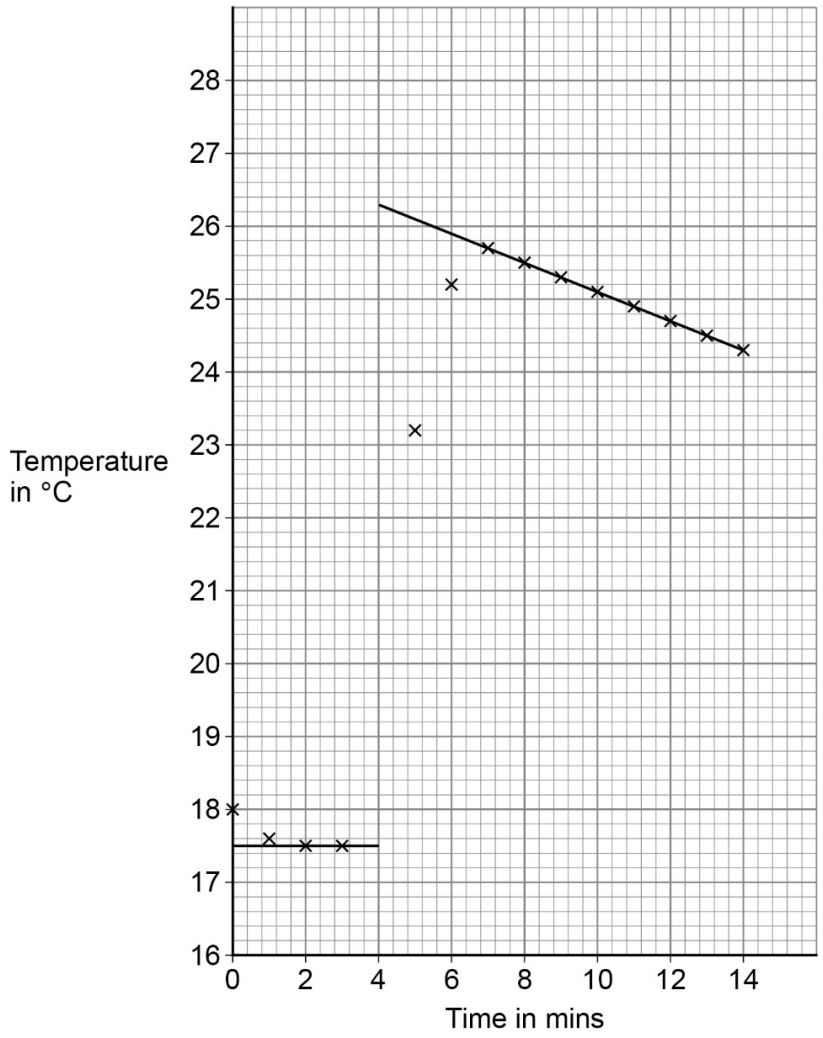
November 2020 | 8464/C/1H | Original Q5

05.1	temperature (change)		1	AO2 5.4.1.2 5.5.1.1 RPA 10

05.2	to reach a constant temperature	allow to reach room temperature	1	AO3 5.4.1.2 5.5.1.1 RPA 10

5.2.2.5 Polymers

Answer 01 · Mark scheme

05.3	line of best fit after 7 minutes extends line back to 4 minutes	 ignore extension of line beyond 4 minutes	1 1	AO2 5.4.1.2 5.5.1.1 RPA 10
	the diagram below scores **2** marks  			

5.2.2.5 Polymers

Answer 01 · Mark scheme

05.4	(maximum **and** minimum values at 4 minutes) 26.3 (°C) **and** 17.5 (°C) (temperature change at 4 minutes) = 8.8 (°C)	allow ecf from **05.3**	1 1	AO3 5.4.1.2 5.5.1.1 RPA 10
05.5	the reaction finished / stopped (so) energy is lost to surroundings / atmosphere **or** (so the) solution cools (back to room temperature)	allow maximum temperature has been reached allow heat for energy	1 1	AO3 5.4.1.2 5.5.1.1 RPA 10
05.6	aluminium / zinc / iron / beryllium metal **Q** is less reactive (than magnesium) **or** metal **Q** is lower in reactivity series	allow Al / Zn / Fe / Be do **not** accept copper, silver MP2 dependent on a correct answer to MP1 allow converse	1 1	AO3 AO2 5.4.1.2 5.5.1.1 RPA 10

5.2.2.5 Polymers

Answer 01 · Mark scheme

05.7	(unit conversion) 30.0 cm^3 = 0.030 dm^3 **or** 0.500 dm^3 = 500 cm^3		1	AO2 5.3.2.1 5.4.1.2 5.5.1.1
	(moles = $\frac{30}{500}$ × 0.1 =) 0.006 **or** (moles = $\frac{0.030}{0.50}$ × 0.1 =) 0.006	allow correct use of incorrect / no unit conversion	1	
	mass = 0.006 × 159.5	allow correct use of incorrect value for number of moles	1	
	= 0.957 (g)	allow 0.96 (g)	1	

Total			**14**

5.2.2.5 Polymers

Answer 01 · Mark scheme

November 2020 | 8464/C/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.2.2.5 Polymers

Answer 02 · Mark scheme

June 2022 | 8464/C/1H | Original Q5

Question 5

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

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

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

5.2.2.5 Polymers

Answer 02 · Mark scheme

June 2022 | 8464/C/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	covalent bonds (between atoms) in the chain intermolecular forces between the chains covalent bonds are strong **and** intermolecular forces are weak		1 1 1	AO1 5.2.2.5
Total Question 5			**9**	

Answer 03 · Mark scheme

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	completely ionised in aqueous solution	allow completely ionised (when dissolved) in water allow fully dissociated in aqueous solution	1	AO1 5.4.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	low concentration of (nitric) acid dissolved in water	allow low concentration of solute / solid / gas dissolved in water	1	AO1 5.4.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	decreases by a factor of 100		1	AO2 5.4.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	$H^+ + OH^- \rightarrow H_2O$	ignore state symbols	1	AO1 5.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	1 : 2		1	AO2 5.3.2.3

5.2.2.5 Polymers

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	red		1	AO3 5.3.2.4 5.4.2.2 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	(for each mass of magnesium carbonate) repeat the experiment (discard anomalous results) **and** calculate the mean		1	AO3 5.5.1.1 RPA10
	measure the highest temperature		1	

Total Question 4	**8**

5.2.2.5 Polymers

Answer 04 · Mark scheme

June 2025 | 8464/C/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(model **A**) does not show the 3D arrangement (of the ions / particles)	allow (model **A**) only shows the 2D arrangement (of the ions / particles) allow (model **A**) does not show lattice arrangement (of the ions / particles) allow (model **A**) only shows two ions / particles	1	AO3 5.2.1.3
	(model **A**) does not show the relative sizes of the ions / particles		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$Al_2(SO_4)_3$		1	AO2 5.1.1.1 5.2.1.2 5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	aluminium has more delocalised electrons per atom than sodium	allow aluminium has more outer shell electrons per atom than sodium	1	AO2 5.1.1.7 5.2.1.5 5.2.2.8

Answer 04 · Mark scheme

Question	Answers	Mark	AO / Spec. Ref.
07.4	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	3–4	AO1 5.2.1.4 5.2.2.5 5.2.2.6
	Level 1: Relevant features are identified and differences noted.	1–2	
	No relevant content	0	

	Indicative content
	
	Similarities
	• both have covalent bonding
	  ○ both form bonds by sharing electrons
	
	• both have atoms that form 4 bonds
	  ○ in silicon dioxide each silicon atom forms 4 bonds, in poly(ethene) each carbon atom forms 4 bonds
	
	• both substances have strong (covalent) bonds
	
	Differences
	• silicon dioxide has atoms that form 2 bonds
	  ○ in silicon dioxide each oxygen atom forms 2 bonds
	• poly(ethene) has atoms that form 1 bond
	  ○ in poly(ethene) each hydrogen atom forms 1 bond
	
	• silicon dioxide only has covalent bonds
	• poly(ethene) has intermolecular forces between polymer molecules
	
	• silicon dioxide is a giant structure
	• poly(ethene) has very large molecules
	
	For **Level 2** a comparison and reference to magnitude, structure and bonding is required		

Total Question 7	**8**

5.2.2.5 Polymers

Answer 05 · Mark scheme

June 2025 | 8464/C/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(a resource that) will run out	allow (a resource that) is non-renewable	1	AO1 5.7.1.1 5.10.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(a compound / molecule) made up of carbon and hydrogen (atoms) only		1	AO1 5.7.1.1

Answer 05 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(volume of petrol =) $90 \times 159 \times \frac{31.3}{100}$ **or** (volume of petrol =) $14310 \times \frac{31.3}{100}$ **or** (volume of petrol =) 90×49.767 **or** (volume of petrol =) 28.17×159	allow **1** mark for 90×159 **or** $159 \times \frac{31.3}{100}$ **or** $90 \times \frac{31.3}{100}$	2	AO2 5.7.1.1 5.7.1.2
	= 4479.03		1	
	= 4480 (dm^3)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses 90 barrels, 159 dm^3 and a fraction percentage	1	

5.2.2.5 Polymers

Answer 05 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	lubricants		1	AO1 5.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	steam cracking		1	AO1 5.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	(test) add bromine water (result) (bromine) changes (from orange) to colourless	 allow (bromine) is decolourised	 1 1	AO2 5.7.1.4

Total Question 3	**10**

5.2.2.5 Polymers

Answer 02 · Examiner comments — June 2022 | 8464/C/1H | Original Q5

Question 5 (Standard/high and high demand)

05.1 This question discriminated well with a third of students recognising the structure of a fullerene.

05.2 Students struggled to suggest a property of the fullerene molecule, with just over 30% gaining a mark.

05.3 More than half the students scored one mark or more in their explanation of why metals are added to aluminium to produce an alloy. However students found developing an explanation challenging. The most commonly awarded mark was for the alloy being harder or stronger. In some responses there was confusion about layers sliding over each other when many talked about ‘metals’ or ‘molecules’ rather than ‘atoms’. The marking point stating that atoms of other metals have different sizes was the least often awarded.

Answer 02 · Examiner comments — June 2022 | 8464/C/1H | Original Q5

05.4 This question required students to use correct scientific terminology. This question discriminated well with 30% of students gaining at least one mark though many students seemed to know that the bonds in the chains were strong and between chains were weak, but they did not name them correctly and therefore failed to score.

Answer 03 · Examiner comments

Question 4 (standard & standard/high demand)

04.1 Many students stated that strong acids completely ionise but omitted to include that this happens in water or in aqueous solution. 10% of students gave the correct definition.

04.2 Less than 5% of students gave a correct explanation for 'dilute aqueous solution'. Very few students made reference to being dissolved in water or used the term (low) concentration.

Common incorrect responses made reference to reducing the concentration of the acid or stating that there would be a small volume of acid per unit volume or small volume of acid in aqueous solution. A number of students stated that a high concentration of substance/acid had been dissolved.

04.3 This question proved challenging. To deduce the change in the hydrogen ion concentration students need to know that as the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of 10. A third of students gained the mark with approximately equal numbers choosing the alternative responses.

04.4 Nearly one-fifth of students were able to recall an ionic equation to represent the neutralisation between an acid and an alkali. This question had the highest not attempted rate at 12.5%, which was nearly double that of any other question. A common response was 'acid + alkali → salt' suggesting that students were not familiar with the ions present in acid or alkaline solutions or that this involved neutralisation to produce water.

04.5 Most students were able to deduce the correct ratio of moles from the equation. The most common distractor was 2:1 where the correct ratio was reversed.

04.6 Just over half of students recognised that universal indicator would turn red in the acidic solution produced when magnesium carbonate and excess nitric acid were reacted. Green was the most common distractor which was not correct as excess acid was used in the reaction.

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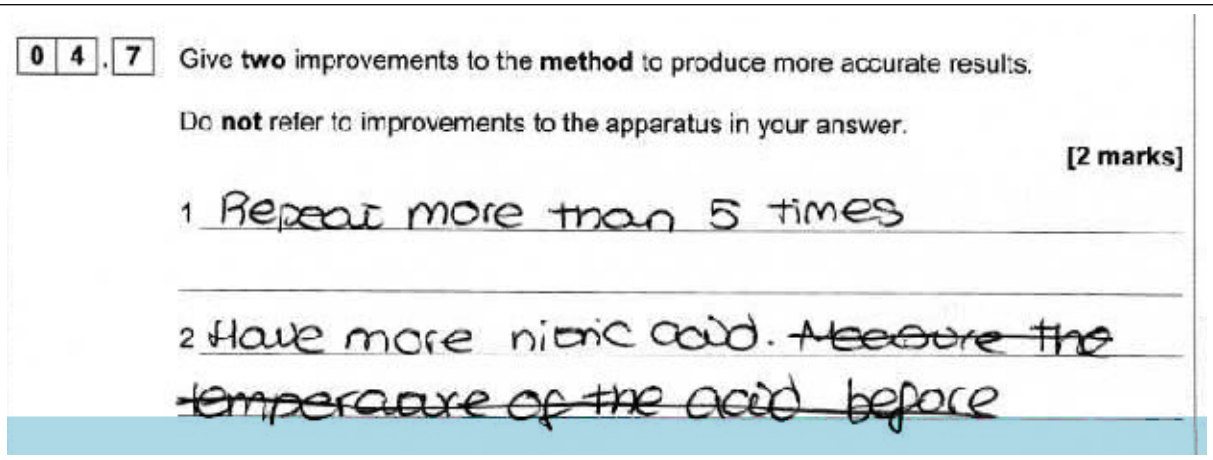
5.2.2.5 Polymers

Answer 03 · Examiner comments

04.7 This question required improvements to the method, so references to changing the volume or concentration of solution were insufficient. Many students wrote that the experiment should be repeated but to be creditworthy they needed to include that the mean should be calculated. 'Measuring until the temperature stopped increasing' was taken as equivalent to 'measure the highest temperature'. However, 'measuring until the temperature is constant' is insufficient as this may not be the highest temperature or the mixture may have cooled to room temperature.

Just under a quarter of students gained 1 mark and 1% gained 2 marks.



This student did not gain any credit: repeating the experiment on its own is insufficient as the mean is not calculated (after anomalous results are discarded).

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Answer 04 · Examiner comments

Question 7 (Standard, Standard/High and High demand)

07.1 Very few students gained full credit in this question. The most common creditworthy statement was 'A shows the 2D arrangement' or 'B shows the 3D arrangement'. Many referred to atom, molecule or subatomic particle instead of ion; some students thought that the + and – charges meant the spheres were protons and electrons. There were many descriptions of what the models showed rather than a comparison of how they represented ionic bonding. Relative size of the ions seems to be a difficult concept; some wrote about not seeing the actual size of the particles in A whereas you could in B.

07.2 Very few knew how to construct a formula from the constituent ions. Those who were successful in writing the formula of aluminium sulfate either used the lowest common multiple or 'swap and drop' methods. Many answers placed the two ions together and reported the remaining charge, rather than forming a neutral formula. $AlSO_4$ was the most common incorrect answer.

07.3 Many students recognised that 'more delocalised electrons' was why aluminium metal conducts electricity better than sodium metal. However, this answer needed 'per atom' to be creditworthy. Some students answered in terms of properties, bond strength and reactivity.

07.4 This was an 'extended response' style of question. Such questions are marked holistically. There are overall generic descriptions for the two levels of response at the top of the mark scheme, giving a hierarchy of response. Within each level there are 2 marks.

Students were asked to compare the structure and bonding of silicon dioxide and poly(ethene). In the indicative content the first 4 black bullet points in the 'differences' relate to bonding, the last 2 to structure.

At Level 1, students needed to identify some relevant features. To enter Level 2 a comparison, reference to magnitude and reference to the structure and bonding of silicon dioxide or poly(ethene) were required.

Students found this question challenging and a significant proportion did not attempt it. Neither the structure nor bonding of these two compounds were well known. Silicon dioxide has a giant structure was common, but some did not state whether this was ionic or covalent. Poly(ethene) contains covalent bonds was common but long chain molecules very rare. Few knew the intermolecular forces were between chains of poly(ethene). There were many contradictions such as giant ionic and giant covalent and many wrote that silicon dioxide contained carbon or carbon dioxide bonded to silicon or formed a simple molecule containing 3 atoms. There were many two-paragraph answers and very few comparisons which would have lifted many responses from Level 1 to Level 2 and lots of references to properties.

Students often contradicted themselves, sometimes seemingly when later adding to their answer. The most common contradiction was correctly stating that silicon dioxide had a giant covalent structure and later stating that it had intermolecular forces. A common expression was 'is a covalent bond'.

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5.2.2.5 Polymers

Answer 04 · Examiner comments

June 2025 | 8464/C/1H | Original Q7

0 7 . 4 Silicon dioxide and the polymer poly(ethene) are solid substances.

Compare silicon dioxide with the polymer, poly(ethene).

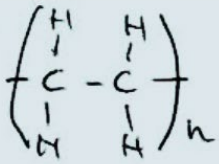
Answer in terms of structure and bonding.

[4 marks]

Silicon dioxide is a allotrope of carbon it is a giant covalent structure. it is held together by strong covalent bonds meaning it has a high melting and boiling point as lot's of energy is needed to break the bonds. Silicon dioxide can transfer electricity as it has delocalised electron.

Poly(ethene) is a Hydrocarbon made up of 2 carbon atoms each bonded to 2 Hydrogen atoms.

Extra space it's a lighter Hydrocarbon which means it has a lower boiling/melting point. It's held together via covalent bonding.



END OF QUESTIONS

This response includes references to magnitude (*giant* structure and *strong* covalent bonds) and sufficient indicative content to access Level 2; strong bonds, both have covalent bonding and giant structure. There are also some incorrect statements. However, there is no comparison (simply a paragraph referring to silicon dioxide and then one for poly(ethene)), so the response does not meet the Level 2 descriptor. They have identified a number of relevant features, so the response was awarded 2 marks, in Level 1.

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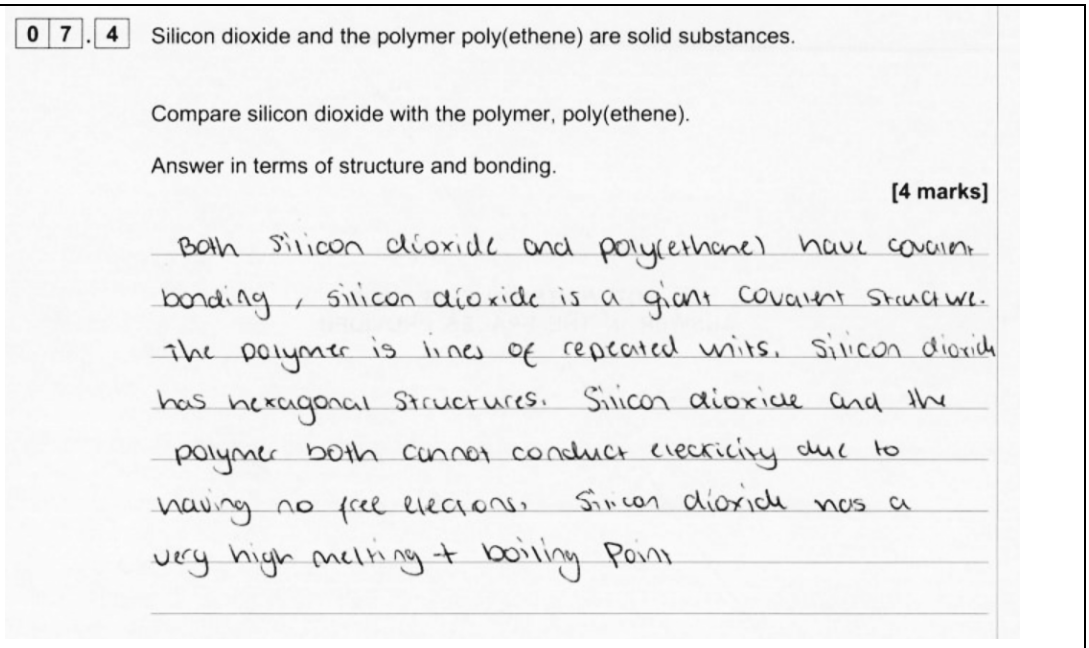
5.2.2.5 Polymers

Answer 04 · Examiner comments June 2025 | 8464/C/1H | Original Q7



0 7 . 4 Silicon dioxide and the polymer poly(ethene) are solid substances.

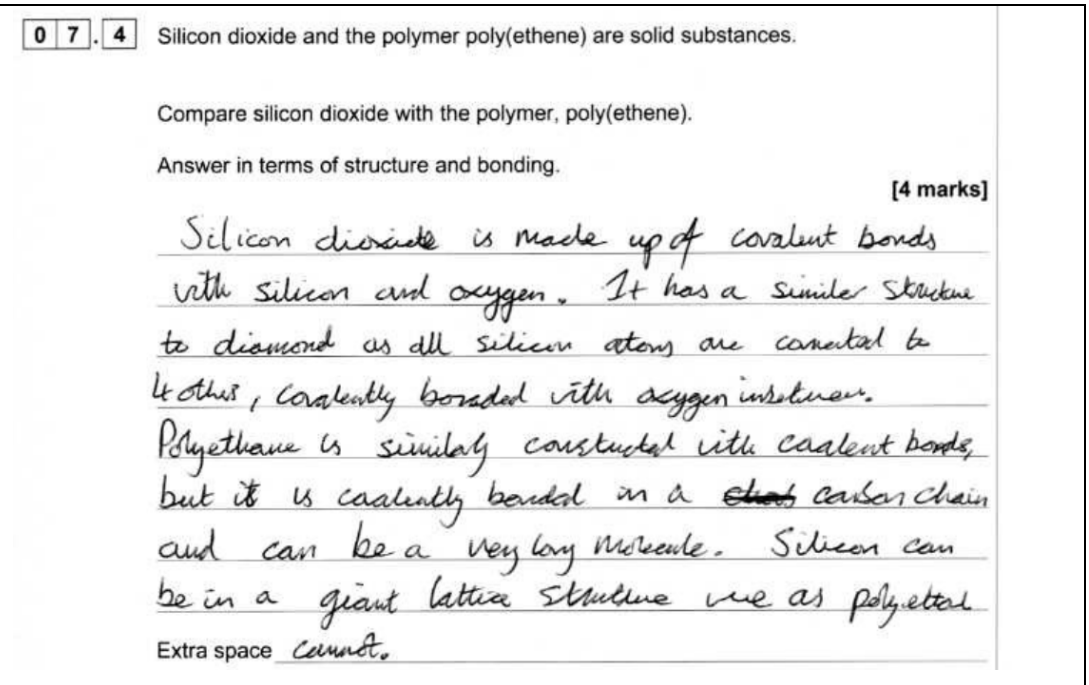
Compare silicon dioxide with the polymer, poly(ethene).

Answer in terms of structure and bonding.

[4 marks]

Both silicon dioxide and poly(ethene) have covalent bonding, silicon dioxide is a giant covalent structure. The polymer is lines of repeated units. Silicon dioxide has hexagonal structures. Silicon dioxide and the polymer both cannot conduct electricity due to having no free electrons. Silicon dioxide has a very high melting + boiling point

In the first two lines of this response there is a reference to magnitude (*giant* structure) and sufficient indicative content; both have covalent bonding and giant structure and a comparison so the response meets the Level 2 descriptor. With a comparison, reference to magnitude and to the structure and bonding of silicon dioxide, this response was awarded 3 marks, in Level 2.



0 7 . 4 Silicon dioxide and the polymer poly(ethene) are solid substances.

Compare silicon dioxide with the polymer, poly(ethene).

Answer in terms of structure and bonding.

[4 marks]

Silicon dioxide is made up of covalent bonds with silicon and oxygen. It has a similar structure to diamond as all silicon atoms are covalent to 4 others, covalently bonded with oxygen inbetween. Polyethene is similarly constructed with covalent bonds, but it is covalently bonded in a ~~chain~~ carbon chain and can be a very long molecule. Silicon can be in a giant lattice structure like as polymers

Extra space cannot.

This response includes references to magnitude (*giant* structure and *very long* molecule) and sufficient indicative content; both have covalent bonding, very long molecule and giant structure and there is a comparison, so the response meets the Level 2 descriptor. With 2 comparisons, a reference to magnitude and to the structure and bonding of silicon dioxide and of poly(ethene), this response was awarded the maximum 4 marks.

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5.2.2.5 Polymers

Answer 04 · Examiner comments

Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

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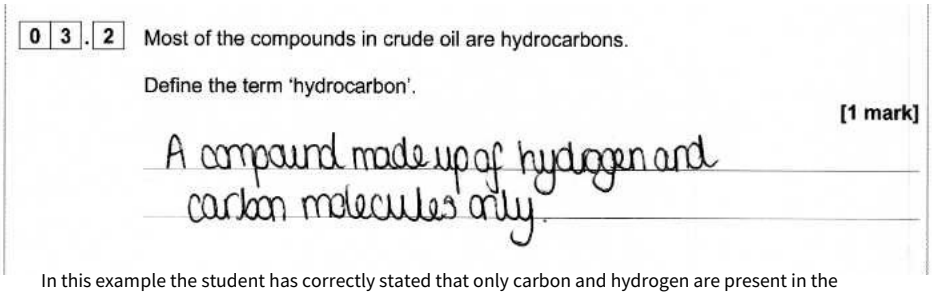
5.2.2.5 Polymers

Answer 05 · Examiner comments June 2025 | 8464/C/2H | Original Q3

Question 3 (Standard and Standard /High demand)

03.1 The majority of students could explain that a finite resource is one that will run out. The most common incorrect responses were linked to either it 'taking a long time to make more' or 'using it up too fast', neither being sufficient for the mark.

03.2 While the majority of students correctly identified hydrogen and carbon, the mark could often not be credited because it was not made clear that these were the *only* atoms present. A significant number of students used the incorrect terminology for describing a compound/molecule or an atom. Subsequently only half of all students were credited the mark.


0 3 . 2 Most of the compounds in crude oil are hydrocarbons.

Define the term 'hydrocarbon'.

[1 mark]

A compound made up of hydrogen and carbon molecules only.

In this example the student has correctly stated that only carbon and hydrogen are present in the compound but have incorrectly called the particles 'molecules' rather than 'atoms', so the mark cannot be awarded.

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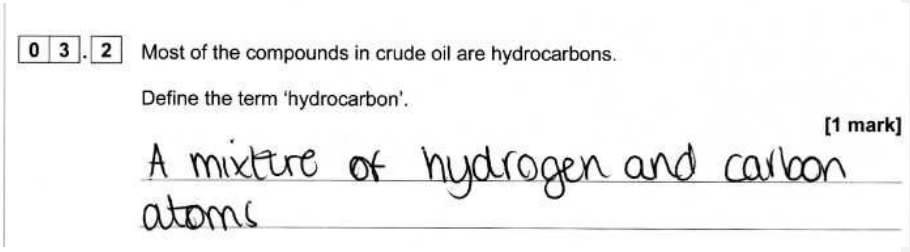
5.2.2.5 Polymers

Answer 05 · Examiner comments June 2025 | 8464/C/2H | Original Q3



0 3 . 2 Most of the compounds in crude oil are hydrocarbons.

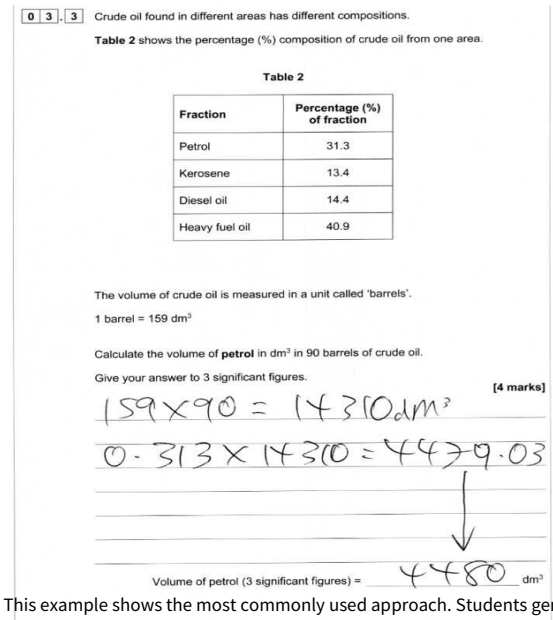
Define the term 'hydrocarbon'.

[1 mark]

A mixture of hydrogen and carbon atoms

In this example the student has incorrectly used the terminology 'mixture' rather than 'compound' and have failed to state that hydrogen and carbon are the **only** atoms there, no marks were awarded.

03.3 The large majority of students attempted this question, and a variety of different approaches were seen, with over half of students gaining all four marks. Students not gaining full marks, were often able to identify which values they needed to use but were not so confident in using them correctly. A significant number failed to give their answer correctly rounded to 3 significant figures.



0 3 . 3 Crude oil found in different areas has different compositions.

Table 2 shows the percentage (%) composition of crude oil from one area.

Table 2

Fraction	Percentage (%) of fraction
Petrol	31.3
Kerosene	13.4
Diesel oil	14.4
Heavy fuel oil	40.9

The volume of crude oil is measured in a unit called 'barrels'.

1 barrel = 159 dm^3

Calculate the volume of **petrol** in dm^3 in 90 barrels of crude oil.

Give your answer to 3 significant figures.

[4 marks]

159 × 90 = 14310 dm^3

0·313 × 14310 = 4479.03

Volume of petrol (3 significant figures) = 4480 dm^3

This example shows the most commonly used approach. Students generally showed good mathematical skills in this question. The total volume of oil in 90 barrels is first calculated, followed by then working out 31.3% of this value. The answer is then correctly rounded to 3 significant figures. 4 marks awarded.

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5.2.2.5 Polymers

Answer 05 · Examiner comments June 2025 | 8464/C/2H | Original Q3

03.4 By selecting lubricants, over half of students answered correctly. The most common incorrect response was fertilisers.

03.5 Less than half of students could recall the correct method. Students who did not gain credit generally confused other processes involving hydrocarbons and often referred to fractional distillation. A significant number just wrote 'steam' which is not a method and therefore did not gain credit.

03.6 Only half of all students gained credit in this question. The majority of students who could recall bromine water as the required test then went on to successfully state the correct colour change, to colourless. Bromine alone was insufficient for the mark, although students were allowed a mark for the correct result if they went down this path. A significant number of students were not able to recall the test and often confused it with limewater leading to a cloudy solution.