AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.3.1.1

Conservation of mass and balanced chemical equations

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**16**
Available paper years	**2018–2025**

Using this booklet

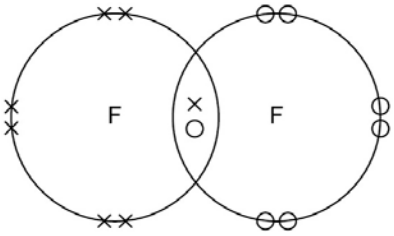
1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

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.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 01 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	g	do **not** accept upper case (G) do **not** accept gas	1	AO1 5.1.2.6
04.2		one shared pair anywhere in overlap between two circles **or** on intersection 6 other electrons on each atom allow dots **or** crosses **or** mixture for all marks ignore any inner shell electrons	1 1	AO1 5.1.2.6 5.2.1.4 AO2 5.1.2.6 5.2.1.4
04.3	18		1	AO2 5.1.1.5 5.1.2.6
04.4	$AlBr_3$ **2** Al + **3** Br_2 (→ 2 $AlBr_3$)	ignore state symbols ignore charges ignore brackets as eg $Al(Br)_3$ allow **1** mark for balancing their equation with an incorrect product	 1 1	AO2 5.1.1.1 5.1.2.6

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 01 · Mark scheme

June 2018 | 8464/C/1H | Original Q4

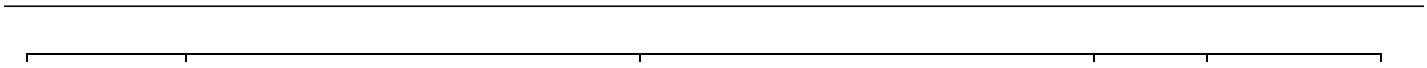
04.5		**max 2** if outer shell / level not mentioned 'it' refers to chlorine allow converse reasons for bromine being less reactive		
	chlorine is a smaller atom **or** has fewer energy levels **or** outer shell closer to nucleus	ignore chlorine has fewer electrons	1	AO1 5.1.2.6
	chlorine has less shielding **or** has the greater attraction between the nucleus and the outer shell **or** incoming electron		1	AO1 5.1.2.6
	therefore chlorine can gain an electron (into the outer shell) more easily		1	AO2 5.1.2.6
		if no other marks awarded allow **1** mark for correct trend in reactivity in Group 7 do **not** accept reference to incorrect particles eg chloride atom		

Total			**9**

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 01 · Mark scheme

June 2018 | 8464/C/1H | Original Q4



5.3.1.1 Conservation of mass and balanced chemical equations

Answer 02 · Mark scheme June 2018 | 8464/C/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	condenses		1	AO1 5.7.1.2
01.2	the fractions have different boiling points		1	AO1 5.7.1.2 5.7.1.3
01.3	propane	do **not** accept propene	1	AO2 5.7.1.1
01.4	C_nH_{2n+2}		1	AO1 5.7.1.1
01.5	CH_4 + **2** $O_2 \rightarrow CO_2$ + **2** H_2O	allow multiples	1	AO2 5.1.1.1 5.7.1.3
01.6	bromine water		1	AO1 5.7.1.4
01.7	to assess the environmental impact (of the stages in the life of a product)	allow to see the effect / harm / damage on the Earth / environment / planet ignore references to energy, pollution, carbon footprint, carbon dioxide, sustainability	1	AO1 5.10.2.1

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 02 · Mark scheme

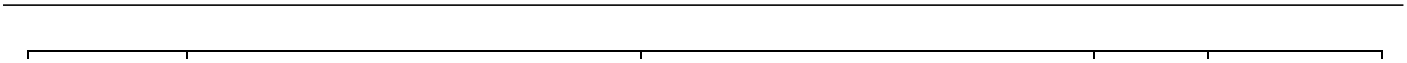
June 2018 | 8464/C/2H | Original Q1

Question	Answers	Mark	AO / Spec. Ref.
01.8	**Level 2:** Scientifically relevant features are identified; the ways in which they are similar / different is made clear and the magnitude of the similarity / difference noted.	3–4	AO3
	Level 1: Relevant features are identified and differences noted.	1–2	AO2
	No relevant content	0	
	Indicative content • burning 10 000 bags produces 10 kg more of carbon dioxide than landfill • putting 10 000 bags in landfill produces 0.02 kg more of solid residue than burning. • putting 10 000 bags in landfill produces 50% more sulfur dioxide than burning • burning 10 000 bags produces 25 kg of carbon dioxide, but landfill only produces15 kg • putting 10 000 bags in landfill produces 0.07 kg of solid residue but burning only produces 0.05 kg • landfill produces less carbon dioxide than burning • landfill produces more solid residue than burning • burning produces less sulfur dioxide than landfill		5.10.2.1 5.10.2.2 5.9.2.2
Total			**11**

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 02 · Mark scheme

June 2018 | 8464/C/2H | Original Q1



5.3.1.1 Conservation of mass and balanced chemical equations

Answer 03 · Mark scheme June 2019 | 8464/C/1H | Original Q6

06.1	2 Na + Cl_2 → 2 NaCl		1	AO2 5.1.1.1 5.1.2.5

06.2	(before) silver solid / liquid / metal **or** green (gas) (during) yellow flame **or** white smoke **or** green colour fades / disappears (after) white solid / powder	 allow grey solid / metal allow yellow (gas) allow orange / white flame allow vigorous reaction	 1 1 1	AO1 5.1.2.5

5.3.1.1 Conservation of mass and balanced chemical equations

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

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 03 · Mark scheme

June 2019 | 8464/C/1H | Original Q6

<table>
<tr><th>Question</th><th>Answers</th><th>Mark</th><th>AO/
Spec. Ref</th></tr>
<tr><td rowspan="3">06.4</td><td>Level 2: Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.</td><td>4–6</td><td>AO1
AO2</td></tr>
<tr><td>Level 1: Relevant features are identified and differences noted.</td><td>1–3</td><td></td></tr>
<tr><td>No relevant content</td><td>0</td><td></td></tr>
<tr><td></td><td colspan="3">Indicative content
<table>
<tr><th></th><th>sodium chloride</th><th>hydrogen chloride</th></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="5">differences in bonding</td><td>ionic</td><td>covalent</td></tr>
<tr><td>metal & non-metal</td><td>two non-metals</td></tr>
<tr><td>transferring electrons</td><td>sharing electrons</td></tr>
<tr><td>ions (Na^+ and Cl^-)</td><td>molecules</td></tr>
<tr><td>charged particles</td><td>neutral or no overall charge</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="5">differences in structure</td><td>giant structure or lattice</td><td>small / simple / discrete molecules</td></tr>
<tr><td>electrostatic</td><td>intermolecular forces</td></tr>
<tr><td>(electrostatic forces) are strong</td><td>(intermolecular forces) are weak</td></tr>
<tr><td>act in all directions</td><td>random or between the molecules</td></tr>
<tr><td>regular</td><td>irregular / random</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="3">similarities in bonding</td><td>full shells or stability</td><td>full shells or stability</td></tr>
<tr><td>(transferring) electrons</td><td>(sharing) electrons</td></tr>
<tr><td>strong bonds</td><td>strong (covalent) bonds</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>similarities in structure</td><td>(electrostatic) forces</td><td>(intermolecular) forces</td></tr>
</table>
ignore properties eg melting points, conduct electricity

to access level 2 there must be a comparison of the structure and bonding and magnitude of both sodium chloride and hydrogen chloride.</td></tr>
</table>

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 03 · Mark scheme

Total			**14**

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 04 · Mark scheme June 2019 | 8464/C/2H | Original Q7

07.1		maximum of **3** marks if incorrect reference made to cracking ignore fractional distillation ignore fracking		AO1 5.7.1.2
	heat or vaporise (oil)		1	
	temperature gradient in column	allow column is cooler at the top or allow column is hotter at the bottom	1	
	(vapour) condenses (into fractions)		1	
	depending on boiling point of fraction	allow at different levels	1	

07.2	different amounts of oxygen available	allow complete combustion **and** incomplete / partial combustion	1	AO2 5.9.3.1

07.3	$2\ C_4H_{10} + 9\ O_2 \rightarrow 8\ CO + 10\ H_2O$	allow correct multiples / halves	1	AO2 5.7.1.3 5.9.3.1 5.1.1.1

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 04 · Mark scheme

June 2019 | 8464/C/2H | Original Q7

07.4	short wavelength radiation which enters the atmosphere	because uv / ultra violet radiation which enters the atmosphere	1	AO1.1 5.9.2.1
	is absorbed by materials **and** re-emitted		1	
	as a longer wavelength radiation	as ir / infrared radiation	1	
	(the longer wavelength radiation is trapped by) a greenhouse gas / carbon dioxide / methane which stops radiation escaping (from the atmosphere)	allow so temperature increases	1	

Total			**10**

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 05 · Mark scheme November 2020 | 8464/C/1H | Original Q4

04.1	ZnO (**s**) + HCl (**aq**) → $ZnCl_2$ (**aq**) + H_2O (**l**)	allow **1** mark for 2/3 correct state symbols	2	AO2 5.2.2.2 5.4.2.3 RPA8
04.2	any **one** from: • warm / heat the mixture • increase the concentration of the (hydrochloric) acid	ignore add a catalyst ignore stir ignore powder ignore add more zinc oxide do **not** accept volume / amount of (hydrochloric) acid do **not** accept increase the surface area	1	AO1 5.4.2.2 5.4.2.3 RPA8
04.3	zinc oxide remains **or** solid remains	ignore colour allow zinc oxide is added until in excess	1	AO1 5.3.2.4 5.4.2.2 5.4.2.3 RPA8
04.4	filtration / filter		1	AO1 5.4.2.2 5.4.2.3 RPA8
04.5	heat leave to crystallise / cool	do **not** accept heat to dryness allow leave to evaporate some water	1 1	AO1 5.4.2.2 5.4.2.3 RPA8

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 05 · Mark scheme

November 2020 | 8464/C/1H | Original Q4

04.6	(at start) value in range 12–14 (at end) value in range 0–3	must be in this order	1 1	AO1 AO2.2 5.4.2.2 5.4.2.4

04.7	2 NaOH + H_2SO_4 → Na_2SO_4 + 2 H_2O	allow 1 mark for Na_2SO_4 **and** H_2O	2	AO2 5.1.1.1 5.4.2.2

04.8	0.10 mol/dm^3		1	AO3 5.4.2.2 5.4.2.4

Total			**12**

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 05 · Mark scheme

November 2020 | 8464/C/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.3.1.1 Conservation of mass and balanced chemical equations

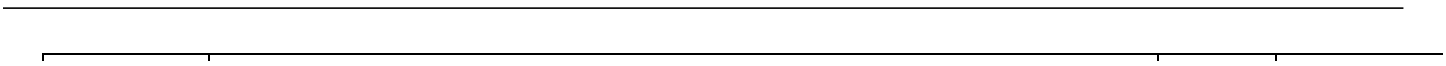
Answer 06 · Mark scheme November 2020 | 8464/C/2H | Original Q1

01.1	$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$	allow multiples	1	AO2 5.1.1.1 5.7.1.3
01.2	(bubble gas through) lime water turns milky / cloudy / white **or** white precipitate forms	MP2 is dependent upon correct response in MP1 allow (bubble gas through) calcium hydroxide (solution)	 1 1	AO1.2 5.8.2.3
01.3	C_3H_6		1	AO2 5.1.1.1 5.7.1.4
01.4	burning / lit splint burns with a (squeaky) pop sound	MP2 is dependent upon correct response in MP1 allow flame do **not** accept glowing splint allow pops	 1 1	AO1 5.8.2.1
01.5	bromine (water) (colour change) orange (to) colourless	do **not** accept bromide allow 1 mark for colourless (to) orange ignore clear	1 1 1	AO1 5.7.1.4
Total			**9**	

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 06 · Mark scheme

November 2020 | 8464/C/2H | Original Q1



5.3.1.1 Conservation of mass and balanced chemical equations

Answer 07 · Mark scheme

November 2021 | 8464/C/1H | Original Q6

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

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 07 · Mark scheme

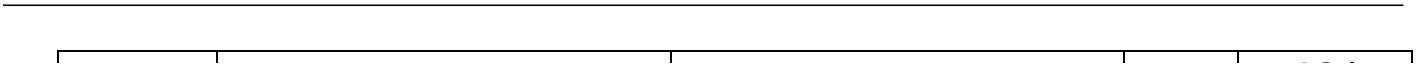
November 2021 | 8464/C/1H | Original Q6

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

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 07 · Mark scheme

November 2021 | 8464/C/1H | Original Q6



5.3.1.1 Conservation of mass and balanced chemical equations

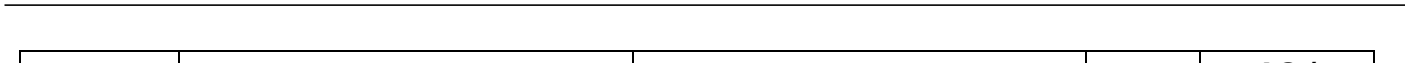
Answer 08 · Mark scheme November 2021 | 8464/C/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	at high temperatures (in the engine) nitrogen reacts with oxygen (to produce nitrogen dioxide)		1 1 1	AO1 5.9.3.1
05.2	(**X**=) (33×7) – [(37×3)+35+34+29] = 22 (micrograms per m^3)	allow 33x7 = (37x3)+35+34+29+**X**	1 1	AO2 5.9.3.1
05.3	countryside data has smallest values (so) 2 is a higher proportion / percentage of the value	 allow (so) countryside is ± 2 out of a value between 6 to 8	1 1	AO3 5.9.3.1
05.4	$2\,NO_2 \rightarrow N_2 + 2\,O_2$	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 (and) manufacturing (and) disposal at the end of its useful life		1 1 1	AO2 5.9.2.4 5.10.2.1
Total			**13**	

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 08 · Mark scheme

November 2021 | 8464/C/2H | Original Q5



5.3.1.1 Conservation of mass and balanced chemical equations

Answer 09 · Mark scheme

June 2022 | 8464/C/1H | Original Q7

Question 7

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

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

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

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 09 · Mark scheme

June 2022 | 8464/C/1H | Original Q7

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

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 09 · Mark scheme

June 2022 | 8464/C/1H | Original Q7

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

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 09 · Mark scheme

June 2022 | 8464/C/1H | Original Q7

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

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

Total Question 7		17

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 10 · Mark scheme

June 2023 | 8464/C/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	$4\,Na + O_2 \rightarrow 2\,Na_2O$	allow multiples	1	AO2 5.1.1.1 5.1.2.5 5.3.1.1 5.4.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	sodium atom loses one electron		1	AO1 5.1.1.7 5.1.2.3
	(and) oxygen atom gains two electrons		1	5.1.2.5 5.2.1.2
	(so) two sodium atoms to one oxygen atom		1	
	any **one** from: • (to form) Na^+ **and** O^{2-} • (to form) sodium ion(s) **and** oxide ion(s) • (to form) ions with full outer shells / levels.		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	yellow flame	allow orange flame	1	AO1 5.1.2.5
	any **one** from: • sodium melts • white smoke / solid / powder		1	

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 10 · Mark scheme

June 2023 | 8464/C/1H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(potassium) (burns with a) lilac flame	allow (burns with a) different colour flame	1	AO1 5.1.2.5
	burns faster	allow more vigorous reaction	1	

Total Question 3	9

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 11 · Mark scheme

June 2023 | 8464/C/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	$CH_4 + \mathbf{2}\,O_2 \rightarrow CO_2 + \mathbf{2}\,H_2O$		1	AO2 5.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	hydrocarbon molecules in petrol have fewer carbon atoms than those in diesel petrol has a lower boiling point (range) than diesel	allow converse throughout allow petrol is more flammable than diesel allow petrol is less viscous than diesel	1 1	AO3 5.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	oxygen		1	AO1 5.8.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	air	allow the atmosphere allow from volcanoes	1	AO1 5.9.1.1 5.9.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	global dimming		1	AO2 5.9.3.1

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 11 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	(carbon monoxide is) colourless **or** (carbon monoxide is) odourless	ignore clear	1	AO1 5.9.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	(diesel) burns at a high temperature **or** (diesel) burns at a temperature greater than 100 °C		1	AO2
	(which is) above the boiling point of water		1	AO3 5.2.2.1 5.9.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.8	sulfur dioxide (is produced when diesel is burnt)		1	AO1 5.9.3.1 5.9.3.2
	(which causes) acid rain		1	
	(which results in) any **one** from: • damage to buildings / statues / bridges • damage to trees / plants • damage to aquatic life • acidification of lakes / rivers / soil • respiratory problems	allow (which affects) asthma	1	

Total Question 1	12

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 12 · Mark scheme June 2024 | 8464/C/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	(molecules) made up of carbon and hydrogen (atoms only)		1	AO1 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	$C_{10}H_{22}$		1	AO2 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	(crude oil) is heated		1	AO1 5.7.1.2
	(so some of the hydrocarbons) vaporise		1	
	the column has a temperature gradient	allow the column gets cooler going up	1	
	(so) the hydrocarbons / fractions condense at different heights / temperatures in the column **or** (and) the hydrocarbons / fractions condense at their boiling points		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	$C_{14}H_{30} \rightarrow C_8H_{18} + \mathbf{2}\,C_3H_6$		1	AO2 5.1.1.1 5.7.1.4

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	add bromine (water) (bromine water) changes (from orange) to colourless	 allow (bromine water) decolourises ignore clear MP2 is dependent on MP1 being awarded	1 1	AO1 5.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	polymer	allow plastic allow hydrocarbon	1	AO1 5.2.1.4 5.7.1.4

Total Question 1	**10**

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 13 · Mark scheme

June 2024 | 8464/C/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	plankton (died)	allow (remains of) ancient biomass	1	AO1 5.7.1.1 5.9.1.4
	and were buried (in mud)	allow and were buried (by sediments)	1	
	and were compressed		1	
	over millions of years		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(some) fuels contain sulfur	allow a named fossil fuel for fuels	1	AO2 5.9.3.1
	(which) reacts with oxygen to produce sulfur dioxide		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	acid rain	allow a specific effect of acid rain	1	AO1 5.9.3.2
	respiratory problems (in humans)	allow named respiratory problem eg asthma	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	fuels are burnt	allow a named fossil fuel for fuels	1	AO2 5.9.3.1
	in insufficient / limited oxygen	allow (carbon monoxide is) produced by incomplete combustion	1	

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 13 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	$4\,CO + 2\,NO_2 \rightarrow N_2 + 4\,CO_2$	allow for **1** mark $CO + NO_2 \rightarrow N_2 + CO_2$ with no / incorrect balancing numbers	2	AO2 5.1.1.1 5.9.3.1 5.9.3.2

Total Question 3	**12**

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 14 · Mark scheme

June 2025 | 8464/C/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	iron is less reactive than carbon		1	AO1 5.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	the **mixture** has a lower melting point (than aluminium oxide) (so) less energy is used (to melt the electrolyte)		1 1	AO1 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	$2\ O^{2-} \rightarrow O_2 + 4\ e^-$	allow multiples allow **1** mark for $O^{2-} \rightarrow O_2 + e^-$ with no / incorrect balancing numbers	2	AO2 5.4.3.3 5.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	Cr_2O_3 **or** chromium oxide	allow Cr^{3+} ions	1	AO2 5.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	extracting aluminium uses more energy (so costs more)		1	AO3 5.4.1.3 5.4.3.3

5.3.1.1 Conservation of mass and balanced chemical equations

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(extracting chromium costs more because) aluminium is used in the extraction of chromium		1	AO3 5.4.1.3 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	alloys contain different sized atoms	allow alloys contain different sized (positive) ions	1	AO1 5.2.2.7
	(so the) layers are distorted		1	
	(so the) layers (of atoms) slide less easily	allow (so the) atoms cannot slide over each other	1	

Total Question 4	11

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 15 · Mark scheme

June 2025 | 8464/C/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	a Bunsen burner reaches a higher temperature	allow a water bath will not reach a high enough temperature	1	AO3 5.3.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(magnesium) (contents of crucible) increase in mass (from 0.24 to 0.38 g)	allow a value in the range 0.38 to 0.39 for 0.38	1	AO2
	(because magnesium) gains oxygen		1	AO3
	(magnesium carbonate) (contents of crucible) decrease in mass (from 0.84 to 0.44 g)	allow a value in the range 0.44 to 0.45 for 0.44	1	AO2
	(because) carbon dioxide is released	allow (because) carbon dioxide gas is produced	1	AO3 5.3.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	both reactions produce 0.01 mol of magnesium oxide		1	AO3 5.3.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(if solid escaped) the final mass would be lower for the actual results than for the predicted results	allow (solid cannot have escaped because) same mass of solid product formed allow (solid cannot have escaped because) both form 0.4 g of solid allow (solid cannot have escaped because) the final mass of the contents (of the crucible) are the same	1	AO3 5.3.1.3

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 15 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	(ratio Fe : H_2O) 3:4		1	AO2 5.1.1.1 5.3.1.1
	(formula) Fe_3O_4	allow formula correctly determined from incorrect ratio	1	5.3.2.1 5.3.2.2 5.3.2.3
	3 Fe + 4 H_2O → Fe_3O_4 + 4 H_2	allow multiples allow correct use of an incorrectly determined formula for iron oxide allow **1** mark for Fe, H_2O, Fe_3O_4 and H_2 **or** allow **1** mark for Fe, H_2O, H_2 and an incorrectly determined formula for iron oxide	2	5.4.1.2

Total Question 6	**11**

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 16 · Mark scheme

June 2025 | 8464/C/2H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	a mixture that has been designed as a useful product		1	AO1 5.8.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	91 kJ/mol		1	AO2 5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	Le Chatelier		1	AO1 5.6.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	the proportion of methanol decreases		1	AO2 5.6.2.4 5.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	the proportion of methanol stays the same		1	AO3 5.6.1.4 5.6.2.4

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 16 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(increasing the pressure) increases the proportion of methanol		1	AO2 5.6.2.4 5.6.2.7
	(because) there are more molecules / moles of reactant (than product)		1	
	(so) the equilibrium (position) shifts to the side with fewer molecules / moles		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	(the catalyst) increases the rate of the reaction		1	AO1 5.6.1.4
	(by) providing an alternative pathway (for the reaction)		1	
	(with) a lower activation energy		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.8	reduces the costs		1	AO2 5.6.1.4 5.9.2.2
	(because) less energy is used		1	5.9.2.4
	OR			
	less fuels burned (1)			
	(so) less contribution to global warming (1)	allow (so) less carbon dioxide produced		

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 16 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.9	$CO_2 + 3\,H_2 \rightarrow CH_3OH + H_2O$	allow multiples allow **1** mark for $CO_2 + H_2 \rightarrow CH_3OH + H_2O$ with no / incorrect balancing numbers	2	AO2 5.3.1.1

Total Question 4	**15**

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 01 · Examiner comments

June 2018 | 8464/C/1H | Original Q4

Question 4 (standard, standard / high & high demand)

04.1 Students did not answer this question as well as expected. They were either not aware that chlorine was a gas or were not familiar with state symbols, as answers other than (s), (l) (g) or (aq) were frequently seen. Some wrote the word 'gas' in the space. 36% of students answered correctly.

04.2 This question was very well answered with 64% of students achieving full marks. Students showed a good understanding of the number of electrons involved in this example of covalent bonding, by ensuring that they had two electrons in the overlap area and six other electrons in the energy level of each fluorine.

A common mistake was to include two electrons in the overlap, but still included the seven electrons each fluorine originally contained in the level outside the overlap.

04.3 48% of students selected the correct answer to this question. The question followed the diagram of a fluorine (F_2) molecule in question **04.2** and focussed on this species.

A significant number of students incorrectly selected '9' as their response, which is the number of electrons in one fluorine atom.

04.4 Students are expected to represent the electronic structures of the first 20 elements of the periodic table and to predict and explain reactions of elements from their position in the periodic table.

A small number of students were able to state the correct formula, $AlBr_3$, with AlBr and $AlBr_2$ being the most common incorrect formulae. But, students did show a good understanding of balancing equations, in this case based upon their wrong formula for aluminium bromide. 68% of students achieved a single mark.

04.5 This question was not answered well, with 8% of students achieving three marks for the explanation that included:

- comparative size of atoms
- comparative difference in attraction
- the ease of which an electron was gained.

This last point was the one that was seen the least and the word 'outer' (shell or level) was omitted in a lot of answers.

Often students would repeat the question stem in terms of chlorine and bromine's reactivity without relating it to the whole of Group 7 and in many instances referring to the reactivity series (of metals).

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 02 · Examiner comments

June 2018 | 8464/C/2H | Original Q1

Question 1 (standard demand)

01.1 83% of students achieved this mark. None of the other three possible answers proved to be dominant.

01.2 79% of students achieved this mark. 'The fractions have different melting points' proved to be dominant wrong answer.

01.3 49% of students gained credit, recognising the alkane to be propane. Most popular incorrect answer was butane. Some students gave a formula even though the question asked for the name of the alkane.

01.4 The correct answer of C_nH_{2n+2} was the most commonly selected response by students (77%) although C_nH_{2n} proved to be the most effective distractor.

01.5 56% of students successfully balanced equation for the combustion of methane. Multiples were regularly seen, and credit accordingly given.

01.6 The correct answer of bromine water was chosen by 67% of students. Anhydrous copper sulfate proved to be the most effective distractor.

01.7 28% of students knew the definition from the specification or were able to give an equivalent statement. A large number of vague incorrect responses were seen encompassing issues such as pollution, sustainability, energy and carbon footprint.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 02 · Examiner comments

June 2018 | 8464/C/2H | Original Q1

01.8 In this 'extended response' question students were asked to compare the two methods for the disposal of biodegradable plastic bags using information given in Table 1.

26% of students gained full marks on this question and a further 38% of students achieved marks at level 2. To access level 2, students were expected to 'note the magnitude' of the differences, as stated in the generic level descriptor in the mark scheme.

17% of students achieved marks in level 1 by giving some comparisons of the gases and residue either in qualitative terms or by quoting values from Table 1.

The least creditworthy responses discussed in general terms the effect on the environment of burning waste plastic or the benefits of burning plastic bags to generate electricity. Students writing these responses made little reference to the information in Table 1 and many of these students ignored the key command word, 'Compare'. However, the higher-attaining students had logically worked their way down the information in Table 1, comparing and calculating differences when constructing their answer.

Question 6

This question was mostly high demand.

06.1 Approximately one-third of students identified the balanced equation for the reaction. The first two responses proved to be good distractors.

06.2 A large proportion of students failed to gain any marks on this question. Students need to ensure they consider the command words at the beginning of questions; many described how sodium reacted with chlorine in terms of electron transfer. Very few described what they would actually see. Some students answered the 'before section' by stating that nothing happened. Few students stated chlorine was a green gas or sodium a silvery metal. For marking point 2 students often mentioned the rate of the reaction and formation of gas rather than considering actual observations. The most common observation mentioned in this section was fizzing. It gave the impression with other comments that students were talking about the reaction between sodium and water. For marking point 3 many students described cloudiness, without identifying that a white solid was involved.

06.3 This question achieved a spread of marks and discriminated very well. 'More outer shells' and references to intermolecular forces were often seen; only molecules can have intermolecular forces. References to potassium 'having a higher melting or boiling point' or 'bigger atomic mass or atomic number' were also given as reasons for it being more reactive; these answers displayed confusion in the difference between chemical and physical properties.

There were many vague statements about the trend in reactivity down Group 1, but these did not gain any credit. Students often made statements about electrons and shells but did not specifically mention electrons in the outer shell. Many students understood that there was a force holding the outer shell electron, but it was a common error to not mention the nucleus or that it was a force of attraction. Those students who mentioned that there was a force of attraction often omitted to mention that it decreased down the group. Marking point 4 was the most commonly awarded mark, with students explaining the ease of losing an electron in terms of sodium and potassium.

06.4 This question discriminated very well with only the most able students accessing level 2. Students had an excellent understanding of bonding, covering types of bonding, transfer or sharing of electrons, full shell stability and ion formation. However, the question asked for information on bonding and structure for sodium chloride and hydrogen chloride. Only a

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 03 · Examiner comments

June 2019 | 8464/C/1H | Original Q6

small proportion included comments about the structure, and even fewer made comments that compared the magnitude of forces/bonding within both substances.

Many responses had incorrect or vague statements. Although many students understood the formation of sodium and chloride ions, very few appeared to appreciate the consequence of this in the formation of an ionic lattice. Some students stated both sodium chloride and hydrogen chloride had the same type of bonding. There was also a lot of confusion over types of bonding and forces, with students often contradicting themselves during their response.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 03 · Examiner comments

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 04 · Examiner comments

June 2019 | 8464/C/2H | Original Q7

Question 7 (high demand)

07.1 This question produced a good spread of marks, with around 83% of students gaining some credit for their answer. A minority of students gained all four marks, whilst just over half of the students gained either 1 or 2 marks. Students most commonly did not include the idea that the fractionating column had a temperature gradient. Some students explained in detail what each of the fractions was used for and a few students incorrectly incorporated 'cracking' into their response.

07.2 Almost 60% students were able to correctly identify 'different amounts of oxygen' or state that 'the first reaction is complete combustion and the second is incomplete combustion'. Some students wrote 'carbon dioxide and water' which did not answer the question that was asked. Several students stated that 'in reaction one the hydrocarbon is an alkane and in the other reaction it is an alkene'.

07.3 Just over 43% of students successfully balanced the equation for the combustion of butane. Multiples were regularly seen, and full credit was available if these were correct.

07.4 Many students were unable to describe in detail the greenhouse effect in terms of long and short wavelength radiation. Responses were confused as to which type of wavelength would pass through the atmosphere; 'reflected' or 'bounced off' were not creditworthy alternatives to 'longer wavelengths being re-emitted'. About 32% of students gained one mark for identifying that the 'temperature increases'.

Approximately 10% of students made no attempt at this question.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 04 · Examiner comments

Use of statistics

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Mark Ranges and Award of Grades

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5.3.1.1 Conservation of mass and balanced chemical equations

Answer 07 · Examiner comments November 2021 | 8464/C/1H | Original Q6

Question 6 (standard, standard / high and high demand)

06.1 Just over one-tenth of students gained full marks in this calculation. Having correctly calculated the mass of oxygen the most common error was to incorrectly calculate the number of moles by dividing by the relative atomic mass of oxygen (16) rather than the relative formula mass of oxygen molecules (32).

06.2 Few students realised that without a lid the mass of products would decrease as magnesium oxide would escape during the reaction.

06.3 This calculation was answered correctly by approximately one fifth of students. A small number were not able to round their answer correctly to three significant figures.

06.4 Students found this question challenging. Very few students were able to make the link between the moles of reagents that reacted and the formula of the product. Just under one sixth of students were able to correctly write a balanced chemical equation using their iron oxide product from the earlier part of the question.

Answer 08 · Examiner comments November 2021 | 8464/C/2H | Original Q5

Question 5 (standard, standard / high and high demand)

The idea that nitrogen and oxygen from the air react together in the engine was not well known. Many students incorrectly stated that nitrogen dioxide was present in the fuel. Heat from the engine was insufficient to gain marking point 1 as there must be an indication of high temperature.

Non-renewable was a common response for a “finite resource” which did not gain credit as marks were awarded for the definition.

Students appeared to have a good understanding of the idea of a carbon footprint. Some excellent answers were seen where carbon emissions were linked to each stage in the life cycle of the car. Some students simply focused on the manufacture of both the car and its raw materials and failed to address the disposal.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 09 · Examiner comments June 2022 | 8464/C/1H | Original Q7

Question 7 (Standard/high and high demand)

07.1 Students had to recognise the relative position of a metal in a reactivity series and to deduce the method and conditions used to extract the metal from a compound of the metal. Over 50% of students gained 1 mark. Electrolysis was the most common answer. However, many students then went on to talk about electrolysis of a solution rather than the molten compound. The displacement route was less common and those who chose this method often only scored 1 mark as they failed to mention 'heating' when talking about potassium or magnesium.

07.2 Students had to complete an equation for the displacement reaction between sodium and titanium chloride. Some students were not able to identify the products. Titanium was usually identified, but sodium chloride was often written as $NaCl_4$. Without the correct formulae balancing was not possible. Generally, element symbols were written well with upper and lower case letters in the appropriate place. Nearly 20% of students gained both marks.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 09 · Examiner comments June 2022 | 8464/C/1H | Original Q7

07.3 Students were asked to write the half equation to show the oxidation of sodium. This proved very challenging. Approximately 5% gained two marks with about a fifth of students not attempting the question. One mark was infrequently scored, since identifying the equation and not the balancing proved to be the problem.

07.4 This reacting mass calculation where students had to identify the limiting reagent proved very challenging. Only a small percentage of students were able to show that aluminium was the limiting factor. Although there were several methods available to students, many attempted to use more than one method to get to the answer. Many students could work out the number of moles of aluminium and copper chloride or the ratio of masses that reacted together, but then were unable to use these numbers further. 30% of students scored 3 marks in this calculation but few scored any further marks..

07.5 Students had to describe how sodium metal conducts electricity. More than 50% of students gained 1 mark for stating that delocalised electrons or free electrons were responsible for electrical conduction in metals. The idea that these delocalised electrons carry the charge through the metal was infrequently given (the second marking point). Many students suggested throughout or around, which did not give direction to their answer.

07.6 Students had to explain how sodium chloride conducts electricity. Many students gave the impression that sodium chloride is a liquid or (to a lesser extent) aqueous solution, rather than conveying that conductivity is restricted to when sodium choride is in these states. Many incorrectly described the electrons as the particles that were able to move. 10% of students gained all 3 marks for stating that sodium chloride needed to be either molten or in aqueous solution in order to conduct electricity and went on to mention ions that are free to move.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 09 · Examiner comments

June 2022 | 8464/C/1H | Original Q7

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 10 · Examiner comments June 2023 | 8464/C/1H | Original Q3

Question 3 (standard, standard/high demand and high demand)

03.1 Nearly three-quarters of the students correctly balanced the equation for the reaction of sodium with oxygen to produce sodium oxide.

03.2 This question was a good discriminator. Most students understood the processes involved in this question, but poor use of chemical language meant they often did not achieve the marks. Students often referred to sodium and oxygen, rather than sodium atoms and oxygen atoms and many incorrect terms such as ‘atoms sharing electrons to form ionic bonds’, ‘metal ions losing electrons’ and ‘non-metal ions gaining electrons’ were seen. Formation of O^- was a common misconception, rather than recognising that two sodium atoms each lose one electron, and both electrons are gained by one oxygen atom to form an oxide ion (O^{2-}). A common error was for students to write oxygen ion instead of oxide ion.

Answer 10 · Examiner comments June 2023 | 8464/C/1H | Original Q3

03.3 Students found this question very challenging and instead of giving observations tried to explain what was happening in the reaction. Ver few students gave two observations for burning sodium in oxygen. A yellow flame was a common answer for those who gained one of the marks although ‘flame’ was insufficient. If students wrote ‘smoke’ they often did not state the colour and so did not achieve the mark. Many referred to the reaction of sodium with water so bubbles was a common incorrect response.

03.4 Again very few students gave two differences comparing burning potassium with sodium in oxygen. Most students did not know that potassium burns with a lilac flame. Students did not tend to write ‘burns faster’ for MP2 but they did achieve this mark by making a comparison of the two reactions, for example, by writing the reaction was more vigorous.

5.3.1.1 Conservation of mass and balanced chemical equations

Answer 11 · Examiner comments June 2023 | 8464/C/2H | Original Q1

Question 1

01.1 Four in five students successfully balanced the equation.

01.2 Just over two in five students gained both marks for comparing petrol and diesel. A further third gained one mark. On this occasion, students needed to interpret what the table headings meant, so many weren't able to gain credit as they referred to the range of numbers of carbons, rather than the number of carbons and similarly, though more infrequent, for the boiling points.

01.3 Nearly nine in ten students identified oxygen as the common element in the compounds released from a car engine.

01.4 Just over a third of students were able to identify that nitrogen came from the air. Much more common suggestions were from the engine or the diesel fuel.

01.5 This question tested a little known part of the specification, with fewer than a quarter identifying global dimming as a consequence of particulates in the atmosphere. By far the most common incorrect response was for global warming.

01.6 Just below three quarters of students answered that carbon monoxide is either colourless or odourless. Many students gave both, despite being asked for one.

Answer 11 · Examiner comments June 2023 | 8464/C/2H | Original Q1

01.7 Around one in ten gained two marks on this question, with a further quarter gaining one. The question was applying ideas from across the specification. Just a statement that water evaporates was insufficient for credit, as there needed to be a realisation that water is produced as a vapour, rather than turning into a vapour during the process.

01.8 Around half of students gained at least one mark on this question, usually for recognising that sulfur is responsible for acid rain. The consequences of acid rain were known by about a quarter, however, around than one in ten knew that sulfur enters the atmosphere as sulfur dioxide and so gained all marks. Again, global warming was the most common incorrect response here.

Answer 12 · Examiner comments

Question 1 (standard demand)

01.1 About two thirds of students knew the definition of a hydrocarbon. Those who did not achieve the mark often used words such as 'atom' or 'mixture' instead of compound so were not credited. Similarly, students who gave answers in terms of carbon or hydrogen molecules (instead of atoms) were not given any marks.

01.2 Three-quarters of students achieved the mark for correctly determining the formula of decane. The most common incorrect response was $C_{10}H_{20+2}$.

01.3 This question has typically been targeted at high demand in previous years. However, this year it was set at standard demand, with the diagram containing more detail and the mark scheme for loosened a little to separate the first two marking points. Nearly all students on this tier were able to start the explanation of fractional distillation.

Four marks were available for this question. Most students who gained 1 mark did so for correctly identifying that the crude oil is heated. Some students indicated that the crude oil was heated once it was in the fractional distillation column itself, which was not creditworthy. Fewer students were able to explain that some of the hydrocarbons were vaporised/evaporated/boiled or turned into a gas for marking point 2. A third of students explained that there was a temperature gradient in the column. This could have been explained as a comparative statement, for example, the column is cooler at the top or by using sensible temperature values. Some students were able to explain that the hydrocarbons/fractions condensed or were able to give a clear description of condensation at different heights in the column or at different temperatures.

The most common responses that gained no marks referred to the different sizes and boiling points of the hydrocarbons/fractions.

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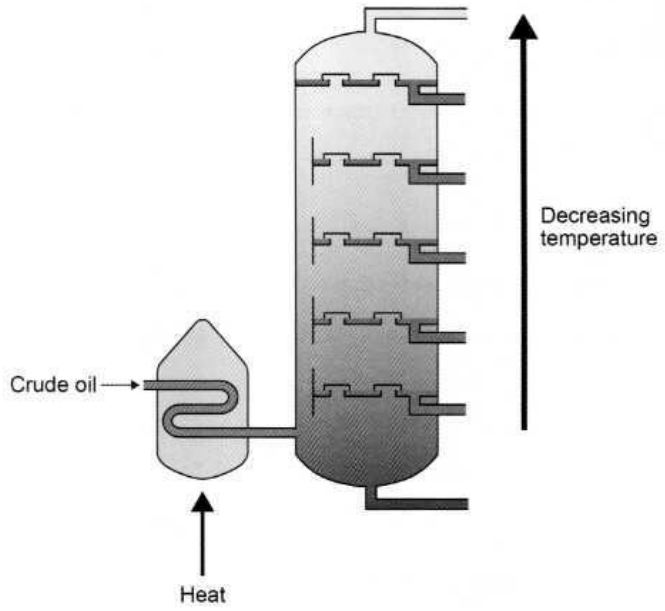
5.3.1.1 Conservation of mass and balanced chemical equations

Answer 12 · Examiner comments June 2024 | 8464/C/2H | Original Q1

0 1 . 3 Crude oil is a mixture of hydrocarbons.

Figure 1 represents industrial equipment used to separate crude oil into fractions.

Figure 1



Explain how crude oil is separated into fractions.

Use **Figure 1**.

[4 marks]

firstly, crude oil is heated until evaporated. Each fractions has different boiling points. The longer hydrocarbons reaches to the bottom fractions as they have very high boiling points, so the small hydrocarbons reaches the top fractions as they have low boiling points, so then at each fraction these condense.

This response gains the first two marking points in the first line. The student then describes the lengths of the hydrocarbons but the language used is very muddled, and is suggesting that the different heights in the column are the fractions. Because of this the mention of 'condense' is insufficient as it is linked to an incorrect interpretation of fraction. No further marks are gained.

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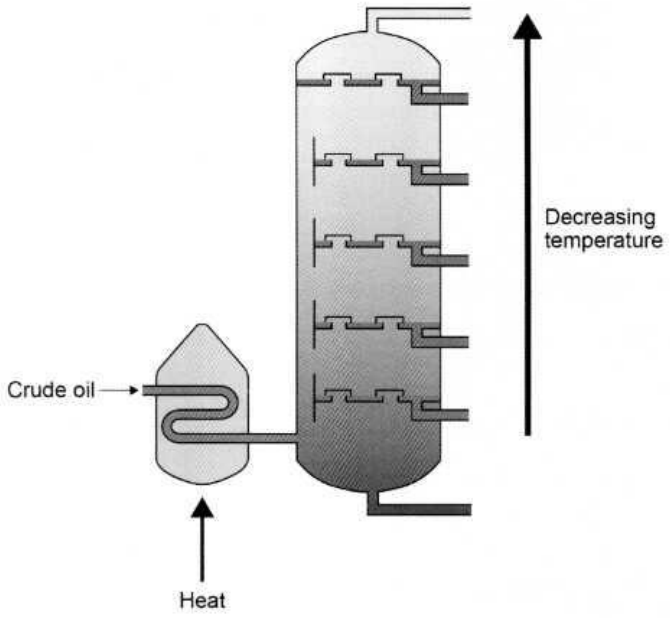
5.3.1.1 Conservation of mass and balanced chemical equations

Answer 12 · Examiner comments June 2024 | 8464/C/2H | Original Q1

0 1 . 3 Crude oil is a mixture of hydrocarbons.

Figure 1 represents industrial equipment used to separate crude oil into fractions.

Figure 1



Explain how crude oil is separated into fractions.

Use **Figure 1**.

[4 marks]

Crude oil is a mixture of different hydrocarbons with different boiling points. First the crude oil is heated to a very high temperature to ~~entirely~~ completely vaporise it, then its passed into a fractionating column which is hottest at the bottom, and coolest at the top. This means ~~hydrocarbons will continue~~ the gaseous hydrocarbons will rise until the temperature reaches their boiling points, causing them to ~~do~~ condense and collect in the trays. This means ~~crud~~ boiling Point is used to seperate Crude oil into fractions

There is nothing creditworthy in the first sentence. Marking points 1 and 2 are gained in the second sentence. The student then goes on to describe the temperature gradient on line 5: '… hottest at the bottom, and coolest at the top' for marking point 3. The description of the gaseous hydrocarbons condensing their boiling points is sufficient for marking point 4.

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5.3.1.1 Conservation of mass and balanced chemical equations

Answer 12 · Examiner comments June 2024 | 8464/C/2H | Original Q1

01.4 Most students correctly balanced the cracking equation.

01.5 Students find the recall of chemical tests challenging, with fewer than half of students gaining both marks on the test for an alkene.

01.6 Fewer than 20% of students applied their knowledge from paper 1 and the scaffolding provided to correctly identify the structure as a polymer, with the mark scheme also allowing hydrocarbon as an answer.

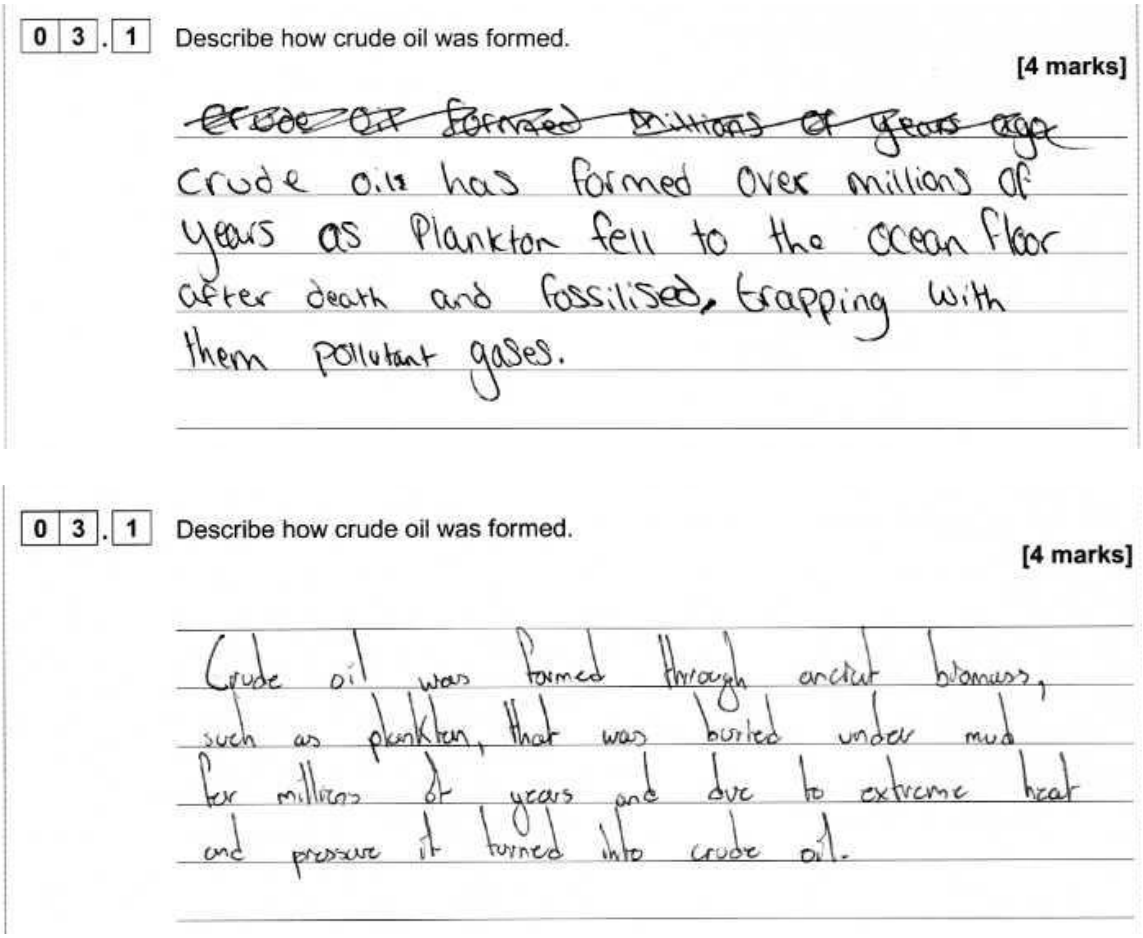
Answer 13 · Examiner comments

June 2024 | 8464/C/2H | Original Q3

Question 3 (standard/high & high demand)

03.1 This question was answered well by most students. There was excellent recall about 'plankton' and the subsequent steps in the formation of crude oil. Some students missed out on full marks as they either omitted the correct time frame or offered a general response such as 'many years' or 'a long time ago'.

A few students misread the question and described the extraction of and separation of crude oil (part of which had been required for question 01.3).



0 3 . 1 Describe how crude oil was formed.

[4 marks]

~~Crude oil formed Millions of years ago~~
Crude oil has formed over millions of years as Plankton fell to the ocean floor after death and fossilised, trapping with them pollutant gases.

0 3 . 1 Describe how crude oil was formed.

[4 marks]

Crude oil was formed through ancient biomass, such as plankton, that was buried under mud for millions of years and due to extreme heat and pressure it turned into crude oil.

The first student gained 2 marks for the time scale and plankton dying.

The second student has given a very clear, concise response to the question scoring all 4 marks.

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5.3.1.1 Conservation of mass and balanced chemical equations

Answer 13 · Examiner comments June 2024 | 8464/C/2H | Original Q3

03.2 Very few students were able to achieve both marks on this question as the identification of sulfur as an impurity in (fossil) fuels was rarely seen. However, more students were able to successfully describe the oxidation of the sulfur to form sulfur dioxide.

03.3 Most students were able to give one problem. Acid rain was most often given as the initial creditworthy response. Those students that did not achieve the second marking point (for respiratory issues or asthma) often offered generalisations such as 'breathing difficulties', 'lung cancer', which was insufficient to gain credit.

03.4 More than 50% of students gained 1 mark. The link between carbon monoxide and incomplete combustion was regularly seen, although some students had difficulty in describing what exactly was being burnt, with many stating that it was the carbon monoxide in the fuel that was undergoing combustion. There were several excellent descriptions of carbon monoxide, its properties, its dangers and how it affects the human body, but this was not what was asked for in the question and these gained no marks.

03.5 This high-demand AO2 question proved to be the most challenging on the paper, with over 90% not receiving any credit. Many students could not give the formula for nitrogen gas and a significant proportion could not write the formulae of carbon monoxide or carbon dioxide. Students who knew the formulae could generally successfully balance the equation.

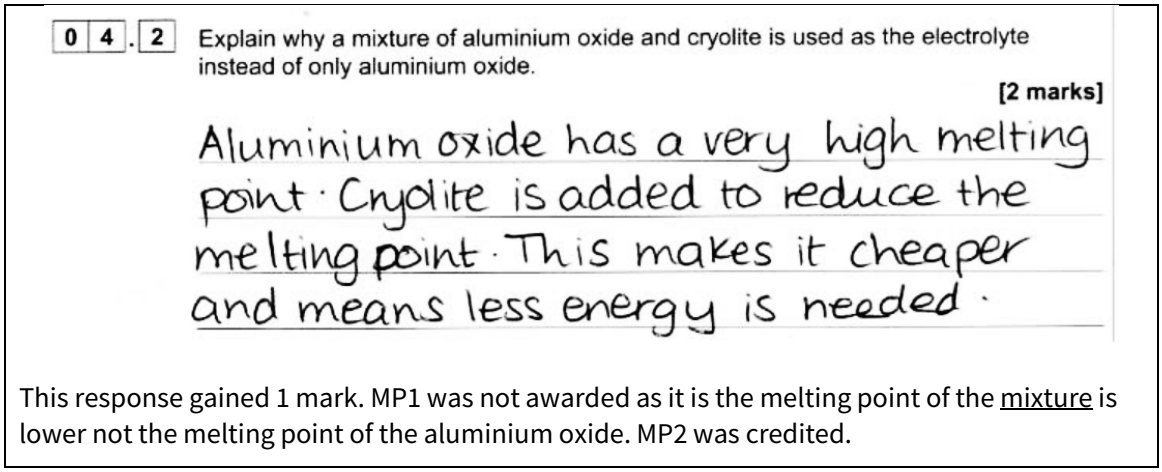
Answer 14 · Examiner comments

June 2025 | 8464/C/1H | Original Q4

Question 4 (Standard, Standard/High and High demand)

04.1 Many correctly stated iron can be extracted by reduction with carbon because iron is less reactive than carbon. The converse statement was the most common incorrect response.

04.2 Very few students were able to achieve both marks on this question as the idea that the melting point of the mixture is lower, was rarely seen. Many responses incorrectly stated that it is the melting point of the aluminium oxide or aluminium that is lowered. A large majority of students gained marking point 2 by stating that less energy is used. However, those who qualified this by saying that less energy is needed for the 'reaction' were not awarded the mark. Many students thought that cryolite was a catalyst.


0 4 . 2 Explain why a mixture of aluminium oxide and cryolite is used as the electrolyte instead of only aluminium oxide.

[2 marks]

Aluminium oxide has a very high melting point. Cryolite is added to reduce the melting point. This makes it cheaper and means less energy is needed.

This response gained 1 mark. MP1 was not awarded as it is the melting point of the mixture is lower not the melting point of the aluminium oxide. MP2 was credited.

04.3 Students found writing the half equation at the positive electrode to show the oxidation of oxide ions very challenging. Many students could not give the formula for the oxide ion (O_2^- was common), oxygen or electron (e either with a + charge or no charge was common). One mark was infrequently scored, since identifying the correct reactants and not the balancing appeared to be the problem.

04.4 Few students identified the species being reduced. Chromium, a product of the reaction, was a common incorrect answer.

04.5 This AO3 question required students to use data to give a reason for the difference in the cost of extracting aluminium and iron. Most provided a comparative, which was good, but many chose to compare reactivity or to state what the extraction methods of the metals were rather than comment on the energy implication.

04.6 Another AO3 question looking for a difference in the cost of extracting aluminium and chromium. Few students answered this correctly. Common answers referred to the rarity or difficulty of extracting chromium ores from Earth.

04.7 Just under half of students gained 1 or more marks. Students should know that pure metals are soft so are mixed with other metals to make alloys, which are harder. Those who gained one mark usually referred to the difference in the sizes of the atoms and the second most common mark was for layers not being able to slide. Layers are distorted was less frequently given. Many students gave good descriptions why metals are soft but their answers for alloys were less accurate. Many referred incorrectly to intermolecular forces.

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Answer 15 · Examiner comments

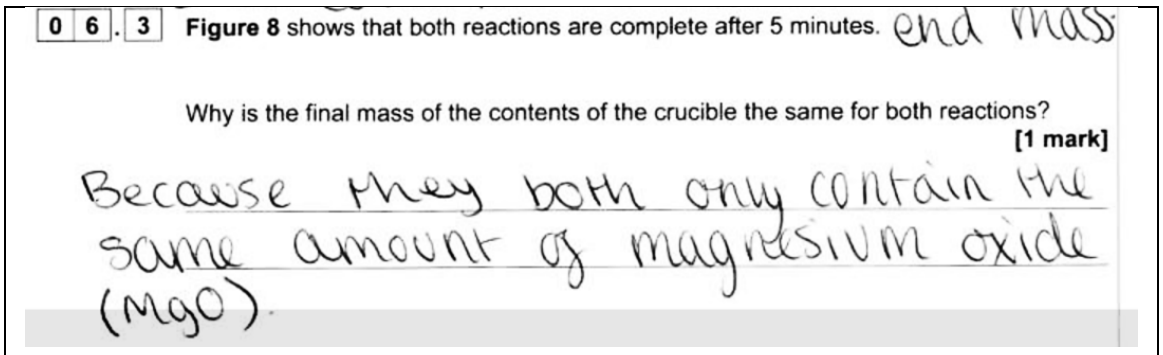
June 2025 | 8464/C/1H | Original Q6

Question 6 (Standard, Standard/High and High demand)

06.1 The reason why the student used a Bunsen burner instead of a water bath is that the Bunsen burner reaches a higher temperature. Common responses which were not creditworthy made no reference to a temperature comparison or stated that a Bunsen burner gives more heat.

06.2 The question asked students to explain the trends in the graph for the first 3 minutes. The trends of magnesium increasing in mass or magnesium carbonate decreasing in mass were described well. Many students who attempted to support their trends with data misread the graph scale so did not gain MP1 and/or MP2; 0.82 g and 0.22 g were common incorrect starting masses, similar errors were made at 3 minutes and others referred to the common mass of 0.4 g at 4 minutes. Reasons for these changes namely magnesium gaining oxygen and carbon dioxide being released from magnesium carbonate were frequently omitted.

06.3 Making the link with the equations and graphs made this a demanding question. When students wrote about moles they usually referred to the moles of the reactants being the same rather than the moles of the product.



0 6 . 3 **Figure 8** shows that both reactions are complete after 5 minutes. end mass

Why is the final mass of the contents of the crucible the same for both reactions?

[1 mark]

Because they both only contain the same amount of magnesium oxide (MgO).

This response did not score but was a near miss. The student is referring to the product from both reactions but the same amount (of MgO) is not equivalent to the same moles.

06.4 This high-demand AO3 question proved challenging. Students could have either described what happened if the conclusion was correct which would result in a final mass lower than predicted or use the graph to conclude that both lines have the same final mass (0.4 g) so solid cannot have escaped. Responses often failed to include mass.

06.5 Many students were able to calculate the ratio of iron to water but only those who gave the simplest ratio were credited with MP1. Most were unable to make the link between the moles of reagents that reacted and the formula of the product so MP2 was rarely awarded. When writing symbols lowercase letters must be discernibly smaller than upper case letters. Many students gave a balanced equation using their formula for iron oxide; FeO and FeO_2 were common incorrect responses which were then used correctly to access MP3 and MP4. Those students who gave the formula of hydrogen as H were unable to access the final 2 marks.

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5.3.1.1 Conservation of mass and balanced chemical equations

Answer 15 · Examiner comments June 2025 | 8464/C/1H | Original Q6

0 6 . 5 Iron reacts with steam (H_2O) to produce an oxide of iron and hydrogen gas.

0.120 moles of iron reacts with 0.160 moles of steam.

Determine the balanced equation for the reaction.

You should determine:

- the simplest whole number mole ratio of Fe : H_2O
- the formula of the iron oxide produced.

[4 marks]

0.12 mol : 0.16 mol

12 : 16 mol

Simplest mole ratio of Fe : H_2O = 12 : 16

Formula of the iron oxide = FeO_2

Balanced equation for the reaction:

$Fe + 2H_2O \rightarrow FeO_2 + 2H_2$

This response was awarded 2 marks. The student has not evaluated the simplest ratio and the formula is incorrect. However, they gave a balanced equation using their formula for iron oxide (FeO_2) so gain MP3 and MP4.

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5.3.1.1 Conservation of mass and balanced chemical equations

Answer 16 · Examiner comments

Question 4 (Standard, Standard/High and High demand)

04.1 Although well attempted, only a third of students were able to accurately describe a formulation. Several students knew that it was a mixture but did not expand on this any further to give the reason for the mixture. Several knew that you needed to add a number of substances together for a purpose but did not know that this would then be a mixture.

04.2 Well over half of students were able to select the correct response of 91 kJ/mol.

04.3 Half of all students could identify Le Chatelier as the scientist, although there were a variety of spellings offered.

04.4 Half of all students were able to select the correct response of 'the proportion of methanol decreases'. The most common incorrect answer was the opposite, being the proportion of methanol increases.

04.5 Again, half of all students were able to select the correct response of the proportion of methanol stays the same. A significant number however selected the proportion of methanol increases.

04.6 Students found equilibrium difficult. A large number of students related the increase in pressure to an increase in energy and number of collisions and hence an increase in the rate of reaction, but did not make any link to the effect on equilibrium.
A common misconception appeared to be that the proportion of methanol in the mixture was equivalent to the yield of methanol. Only a quarter of students gained 1 mark, with very few scoring 2 or 3.

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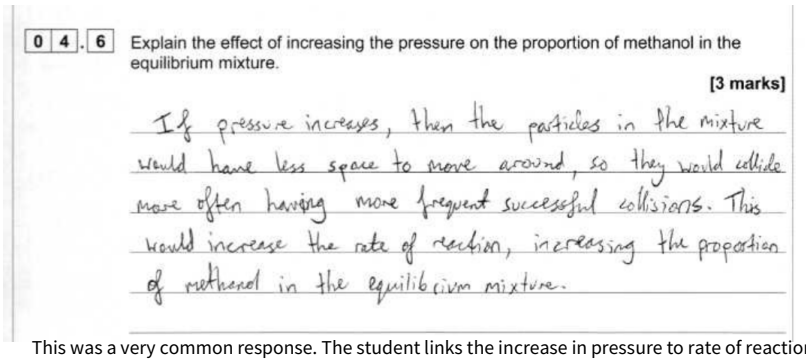
5.3.1.1 Conservation of mass and balanced chemical equations

Answer 16 · Examiner comments June 2025 | 8464/C/2H | Original Q4



0 4 . 6 Explain the effect of increasing the pressure on the proportion of methanol in the equilibrium mixture.

[3 marks]

If pressure increases, then the particles in the mixture would have less space to move around, so they would collide more often having more frequent successful collisions. This would increase the rate of reaction, increasing the proportion of methanol in the equilibrium mixture.

This was a very common response. The student links the increase in pressure to rate of reaction and hence to increased proportion of methanol. One mark is awarded for the increase in proportion of methanol.

04.7 Most students were able to state that a catalyst will increase the rate of a reaction. Less were able to explain that this is due to a lowered activation energy, and even fewer could link this to an alternative reaction pathway.
There was a common misconception that catalysts increase the rate of a reaction due to there being more frequent collisions, as this is a common explanation for how changing other factors affects the rate of reaction. Some students also incorrectly stated that catalysts cause the particles to gain energy.

04.8 Only half of all students answered this question well. Most of these identified that less energy used would be cheaper, but very few linked the idea of less fuels burning and the reduced contribution to global warming.
Some students gave ideas around the speed of the reaction decreasing at a lower temperature so the reaction could be controlled/monitored/more accurate results, lower temperatures being safer to work with, or lower temperatures resulting in less evaporation of methanol.

04.9 Just under a third of students gained both marks.
A large number of students did not know the formula for hydrogen and 6H was commonly used instead of $3H_2$
A small number of students could not gain marks due to errors in the size of the letter used eg Co_2 rather than CO_2 and $H2o$ rather than H_2O.
Students are expected to use subscript, superscript and size of letters appropriately.